

*Ministry of Education and Science
Public Educational Institution of High Professional Education
Tomsk Polytechnic University*

Proceedings of the
18th International Scientific and Practical Conference
of Students, Post-graduates and Young Scientists

**MODERN TECHNIQUE
AND TECHNOLOGIES
MTT' 2012**

April 9 – 13, 2012
TOMSK, RUSSIA

UDK 62.001.001.5 (063)
BBK 30.1L.0
S56

Russia, Tomsk, April 9 – 13, 2012

The eighteenth International Scientific and Practical Conference
of Students, Postgraduates and Young Scientists
“Modern Techniques and Technologies”
(MTT'2012), Tomsk, Tomsk Polytechnic University. –
Tomsk: TPU Press, 2012.- 263 p.

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| Section I | |
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**POWER
INGENEERING**

DEFINING FAULT LOCATION ON OVERHEAD LINES ON THE BASE OF EMERGENCY SIGNALS RECORDER DATA

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The necessity of Defining Fault Location (DFL) on overhead lines appeared in XIX – XX-th centuries – at the beginning of Electric Power Networks (EPN) intensive development in all European countries and the USA. One of the first mentions of such procedure necessity is given in [1]. There is also given the analysis of expected results. DFL began developing practically in post-war years.

The theory and technique of DFL [2 – 4] have been developed but the number of technique and methodological issues still takes place and requires deep analysis. One of the most important issues is the increasing of DFL accuracy at using the method of DFL based on emergency mode parameters.

Nowadays the Emergency Signals Recorder (ESR) are widely used at EPN. This equipment allows to measure and register Arrays of Instantaneous Values (AIV) of electric signals – current and voltage, which include adequate information about physical phenomenon in network. This information can be used for development of more accurate DFL method.

Such method is based on mathematical formulation of overhead lines modes with line equations. The main idea of this method can be described by means of fig. 1

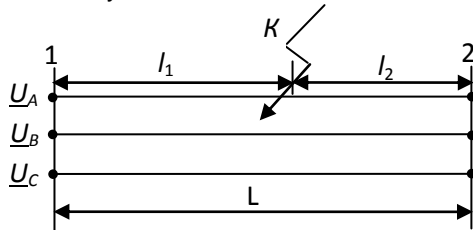


Fig. 1

For defining the distances l_1 , l_2 (see fig. 1) between the ends of line and short circuit place the line equations for long lines on base of hyperbolic functions written for both parts of the line according to the positive sequence network for “special” phase (for example for phase A) are used. Taking into account that $l_2 = l - l_1$, positive-phase-sequence voltage \underline{U}_{A1} at the short circuit point is defined with the following equations:

$$\underline{U}_{A1} = \underline{U}_{A1,1} \operatorname{ch} \gamma_0 l_1 - \underline{I}_{A1,1} \underline{Z}_B \operatorname{sh} \gamma_0 l_1; \quad (1)$$

$$\underline{U}_{A1} = \underline{U}_{A1,2} \operatorname{ch} \gamma_0 (l - l_1) + \underline{I}_{A1,2} \underline{Z}_B \operatorname{sh} \gamma_0 (l - l_1), \quad (2)$$

where $\underline{U}_{A1,1}$, $\underline{U}_{A1,2}$ – vector values of phase A positive-phase-sequence voltages at the beginning and at the end of line;

$\underline{I}_{A1,1}$, $\underline{I}_{A1,2}$ – vector values of phase A positive-sequence currents at the beginning and at the end of line;

$\underline{Z}_B = \sqrt{(r_0 + jx_0)/(g_0 + jb_0)} = \sqrt{z_0/y_0}$ – characteristic impedance of line;

$\gamma_0 = \sqrt{(r_0 + jx_0)(g_0 + jb_0)} = \sqrt{z_0 y_0}$ – propagation constant of electromagnetic mode in line.

Based on the evident equality of equations (1, 2) left parts there can be written an equation (3), that allows to define the distance l_1 between the beginning of the line and short circuit place:

$$\underline{U}_{A1,1} \operatorname{ch} \gamma_0 l_1 - \underline{U}_{A1,2} \operatorname{ch} \gamma_0 (l - l_1) - \underline{I}_{A1,1} \underline{Z}_B \operatorname{sh} \gamma_0 l_1 - \underline{I}_{A1,2} \underline{Z}_B \operatorname{sh} \gamma_0 (l - l_1) = 0 \quad (3)$$

The vector values of phase A positive-sequence voltages and currents, used in the equations (1, 2) can be defined accordingly to AIV of voltages and currents by means of generalized vectors [5]

$$\underline{F}_{A1,i} = \sqrt{2} F_{A1,i} e^{j\phi_{A1,i}}, \quad i = \overline{1,2};$$

$$F_{A1,i} = \sqrt{\frac{1}{N} \sum_{j=1}^N f_{A1,i}^2(t_j)}, \quad i = \overline{1,2};$$

$$\phi_{A1,i} = \arccos \left(\frac{\frac{1}{N} \sum_{j=1}^N (f_{A1,i}(t_j) \cdot h_{A1,i}(t_j))}{F_{A1,i} \cdot H_{A1,i}} \right), \quad i = \overline{1,2},$$

where $h_{A1,i}(t_j)$, $i = \overline{1,2}$; $H_{A1,i}$, $i = \overline{1,2}$ – correspondently AIV and vector module of voltage or current, with which the corner axis of reference is combined.

In its turn, the AIV of phase A positive-sequence voltages and currents can be defined from voltages and currents of each phase AIV (registered with ESR at the beginning and at the end of line) by means of a known way of unsymmetrical three-phase vectors \underline{F}_A , \underline{F}_B , \underline{F}_C decomposition to symmetrical components of forward \underline{F}_{A1} , reverse \underline{F}_{A2} and zero-sequences \underline{F}_0 [6], which obviously can be applied to AIV of voltages and currents:

$$f_{A1}(t_j) = \frac{1}{3} (f_A(t_j) + a f_B(t_j) + a^2 f_C(t_j)), \quad (4)$$

where $a = e^{j120^\circ}$, $a^2 = e^{j240^\circ}$ – operators of turn.

Thus accordingly to the equation (4) there is data shift in arrays of phase B and C voltages and currents at angle 120° or 240° , that are defined with operators a , a^2 (fig. 2, a, b).

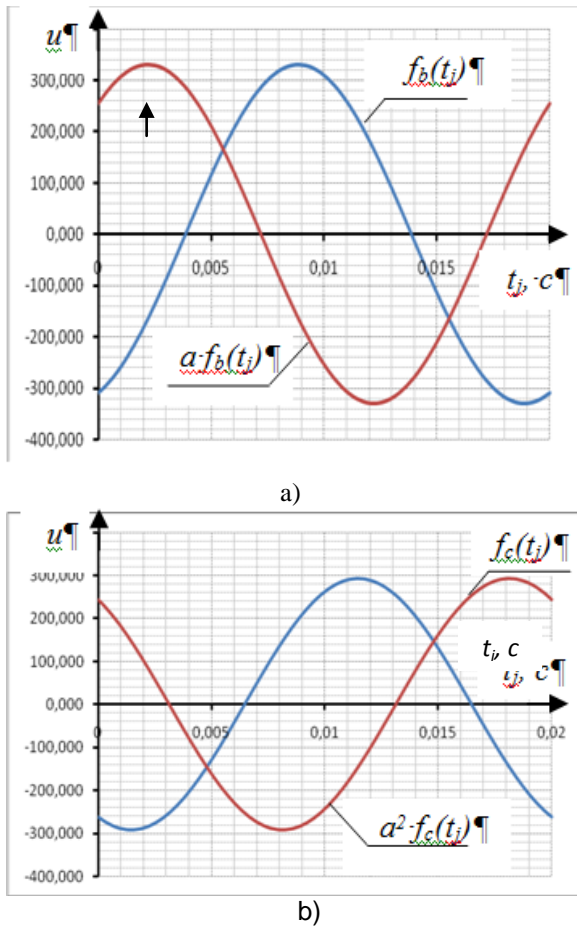


Fig. 2. Data shift in arrays of voltages: a) of phase B, b) of phase C

The accuracy of described DFL method was verified by means of bundled software Mathcad in terms of two single-circuit overhead lines with length 600 and 8 km, nominal voltage 500 kV and total load $S_2=250+j105$ MVA. Linear electrical parameters are equal and are presented in the Table 1.

Table 1. Linear electrical parameters

| r_0 , Om/km | x_0 , Om/km | $g_0, 10^{-9}$ S/km | $b_0, 10^{-6}$ S/km |
|------------------|------------------|------------------------|------------------------|
| 0,022 | 0,301 | 7,333 | 3,694 |

The calculations were completed for all types of short circuit at the distance 200 and 2 km accordingly to lines with lengths 600 and 8 km.

The AIV of voltages and currents in all phases were calculated at the beginning and at the end of lines at discretization interval $\Delta t = 0,317$ ms and at correspond quantity of readout on the period $N=63$. The calculation results of short circuit place by means of defined AIV are presented in the Table 2.

Table 2. The calculation results of short circuit place

| SC type | $l=600$ km, $l_f=200$ km | | $l=8$ km, $l_f=2$ km | |
|-------------|--------------------------|----------|----------------------|----------|
| | l_f , km | Error, % | l_f , km | Error, % |
| $K^{(1)}$ | 200 | 0 | 2 | 0 |
| $K^{(2)}$ | 200 | 0 | 2 | 0 |
| $K^{(1,1)}$ | 200 | 0 | 2 | 0 |

The analysis of calculations results shows the absence of a methodical error in considered algorithm at a discretization interval $\Delta t = 0,317$ ms.

One of the main reasons for error in definition of a place of damage by offered algorithm is using in the equations (1, 2) inexact values of linear electrical parameters which are usually accepted from reference date. For decreasing of this error it is offered to use in the equations (1, 2) the specified values of linear electrical parameters [7] calculated on base of electrical parameters registered in preemergency mode.

In summary it is worth to notice that the further development of DFL technique based on wide use of the equations of a long line, in the long term can lead to construction of new high-precision equipment for defining fault location on emergency mode electrical parameters.

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EFFICIENCY OF KEEPING ELECTRICITY PRODUCTION AND CONSUMPTION IN BALANCE BY MEANS OF STORAGE TECHNOLOGIES

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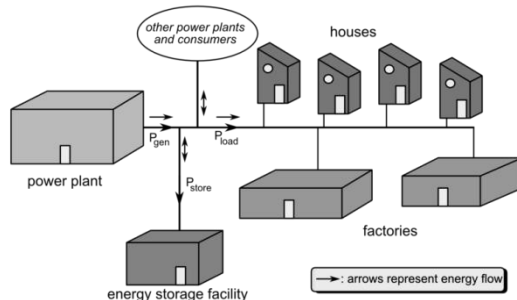
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Electricity production must rapidly follow variations in demand. Otherwise, the total electricity supply system will collapse. Failure in electricity supply system can result in high financial losses for manufacturers. Moreover, the failure can cause significant public risk in essential services, such as data handling centres and operating theatres in hospitals [3].

Many methods to keep production and demand of electrical power in balance are used widely depending on local conditions and required supply reliability. Sometimes electricity exports and imports to and from neighboring countries help to smooth gaps between production and demand, for example in such countries as Italy and Germany. Many developing countries use load shedding (cutting off the electric current on certain lines) in situations when the demand becomes greater than the supply. In the USA, customers can be financially rewarded for voluntarily switching off part of their consumption at times of peak demand. Likewise, cogeneration of electricity and heat to utilize extra electric energy is used very widely in such countries as Denmark and The Netherlands. If there is the problem in variability of output, like in case of renewable sources, flexible back-up generators can be used [3].

Another way to keep electricity production and demand in balance is to use different storage technologies. Using these technologies, electrical energy is stored during times when production exceeds consumption. Then stores are used at times when consumption exceeds production. Power storage has gained high political and technological interest in the light of the development of renewable resources and distributed generation as a way to improve grid stability, to control the fluctuations of variable resources and to reduce carbon emissions [1].



Picture 1 – Energy storage technology in the grid

In order to evaluate economic performance of storage technology several factors should be considered, such as energy cost of produced electricity, construction cost and the time-based patterns of the electric energy to be charged and discharged. System or construction cost (€/kW) depends on many factors and includes all ancillary equipment necessary for the full storage system. While capital cost is important, operations and maintenance costs (€/kWh) is a much more meaningful index for a complete economic analysis. The most important characteristics of operations and maintenance costs include round-trip electrical energy efficiency and number of cycles (discharges) before replacement is required. The frequency of operation is an important parameter for calculating life-cycle cost. Likewise, utility energy storage applications can be roughly categorized by whether a short capacity or discharge is needed (on the order of less than minutes) or whether a long storage or discharge time is expected (on the order of hours)[4].

Key performance indicators of the most popular state-of-the-art storage technologies are tabulated below (Table 1)[1].

Table 1 – Key performance indicators of storage technologies

| Storage technology | Supercapacitors | Electroch. batteries | PHS | Flywheel | CAES | Hydrogen |
|-----------------------|-----------------|----------------------|---------------------------------|-----------------|---------------------------------|-----------|
| Power rating, MW | 0,01-1 | 0,01-40 | 100-5000 | 0,002-20 | 100-300 | 0,002-20 |
| Energy rating | ms-1h | s-10h | 1-24h+ | 15s-15min | 1-24h+ | 15s-15min |
| Energy density, Wh/kg | 0,1-15 | 30-250 | 0,5-1,5 | 5-130 | 30-60 | 800-104 |
| Round-trip efficiency | 85-98 | 60-100 | 75-85 | 85-95 | 42-54 | 85-95 |
| Lifetime, years | 20+ | 3-20 | 50-100 | 20+ | 25-40 | 5-15 |
| Number of cycles | 10^4 - 10^8 | 10^3 - 10^4 | $2 \cdot 10^4$ - $5 \cdot 10^4$ | 10^5 - 10^7 | $5 \cdot 10^3$ - $2 \cdot 10^4$ | 10^3 |
| Power cost, €/kW | 100-400 | 200-2000 | 500-3600 | 100-300 | 400-1150 | 550-1600 |
| Energy cost €/kWh | 300-4000 | 50-1800 | 60-150 | 1000-3500 | 10-120 | 1-15 |

Let us consider the principle of operation of this or another storage technology, its economic performance compared to other alternatives and its application to short- and long-term power variations.

Supercapacitors. The nature of electric energy is such that it can only be stored directly as an electric charge in the capacitor. The basic principle of a capacitor is to store the electricity in an electrostatic field formed between a pair of conductors (two electrodes of opposite polarity) separated by a dielectric or insulator layer. Main differences between conventional capacitors and supercapacitors are enlarged electrode surface areas, the use of a polymer membrane and of a liquid electrolyte instead of the dielectric solid material. Supercapacitors have low maintenance needs, very fast charging and discharging times and they can stand many cycles. They have the potential for fast acting short term power back-up for UPS, transmission line stability (FACTS devices), and spinning reserve provision. They find applications in support to renewable energies and in smart grid systems. Unfortunately, the storage capacity of even the most advanced capacitors is limited to 10-15 Wh/kg and they cost more than 1000 €/kWh of stored energy [3]. Consequently, supercapacitors are only suitable for short-term energy storage.

Electrochemical batteries. If a substantial amount of electric energy has to be stored, many technologies, which convert electricity into mechanical or chemical energy, can be used; the first in this row is electrochemical batteries. Battery storage technologies rely on electro-chemical reactions to store energy. Different chemical types are currently being used, such as lithium-ion (Li-ion), sodium sulphur (NaS), nickel cadmium (NiCd), nickel metalhydride (Ni-MeH) and lead acid (Pb-acid) batteries [1]. Because of high investment costs and limited life spans, electrochemical batteries are also not cost-effective to smooth the variability in power output. They are therefore suitable for small-scale applications, mostly developed for consumers, PV support and vehicles [1].

Pumped hydro (PHS). The basic principle of a PHS system is to store energy by means of two reservoirs located at different elevations. In times of low demand, electricity from the grid is used to pump water to the higher reservoir, while in times of peak demand the water is released to generate electricity, hence operating a reversible cycle of grid electricity. Here, excess electric energy is used to pump water into a high-altitude reservoir so that the potential energy of the water can later be turned into electricity via turbine-generator systems. Storage energy cost of this pumping system is about 60-100 €/kWhn [3]. These costs are much lower than with batteries or capacitors. The main advantages of PHS systems are high storage capacity, quick start capabilities, low self-discharge, long technical life-time and high number of cycles, which make the technology suitable for regulation provision and for supporting the variable electricity generation. To date, approximately 100

GW of pure hydro-pumped storage is installed world-wide (Alpine region) [1].

Flywheel systems. These systems store energy mechanically in the form of kinetic energy. The core element of a flywheel is a rotating mass which is connected to a main shaft powered by an external source of energy. In revolving, the mass builds up inertial energy. Flywheel systems have the advantage of high cyclability, high energy efficiency and fast response time, but they have small energy density [3]. Consequently, they are mainly intended for solving very fast and short-term electricity supply problems rather than covering daily, weekly or seasonal imbalance between demand and supply by generators. Applications that use flywheel storage are those that require very high bursts of power for very short durations such as tokamak and laser experiments [2].

Compressed-air energy storage (CAES). In CAES systems, the energy is stored mechanically, usually in underground caverns, by compressing the air from the atmosphere. A typical CAES system is a combination of natural gas combustion and high pressure of the compressed air to drive the turbines. When electricity is required, the compressed air is drawn from the cavern, then heated in gas burners and expanded in a gas turbine. Main advantages of CAES are the large storage capacity, relatively fast time response, no self-discharge and long life time. Due to incredibly big energy capacity, CAES is represented as comparatively cheap variant regarding the cost of storage energy – about 10-80 €/kWh. The technology is therefore suitable for applications such as load following, peak shaving, frequency regulation, seasonal fluctuation regulation and grid decongestion. One feature of the new generation of proposed CAES plants is that they may be closely integrated with wind farms, presenting a means of firming the capacity of wind energy. Currently, there are two CAES facilities in the world, one in Germany in Huntorf with a rated output power capacity of the 290 MW and the other, McIntosh unit, located in Alabama, USA with a rated power output of 110 MW [3].

Hydrogen-based energy systems. Hydrogen can be used to store electricity via reversible water electrolysis. Hydrogen produced by electrolysis is transformed back into electricity in times of demand by means of a fuel cell or combustion engine [1]. Considering the main advantages such as the large energy capacity, high energy density and the very low self-discharge, the technology appears suitable in connection with very large wind farms, in support to power grids in isolated systems or in systems where grid reinforcement is very expensive. However, this technology have big losses involved in producing energy, thus it can be economically approved just for short-term power regulation [3].

In conclusion it is necessary to say that costs of energy storage systems depend not only on the

type of technology, but also on the planned operation and especially the hours of storage needed. Capacitors, flywheel systems, electrochemical batteries and hydrogen-based systems offer no economical options for the storage of energy for further usage. However, such storage systems can help to smooth short-term variations in output from renewable sources. Meanwhile, pumped hydro with daily use of the capacity renders about low costs per delivered peaking kilowatt-hour, but the amount of suitable locations for pumped hydro is limited. Thus, CAES appears to have the best properties to serve as a quality fuel for both short-term and seasonal balancing capacity.

All of these storage technologies seem to be quite attractive to cover extended time spans when there is no output from wind-based and solar-based power capacity. The fact is that all existing

storage technologies are still expensive and just few of them can be used for long-term balancing. However, with future improvement of existing technologies and development of new technologies, they can be added to traditional methods of keeping electricity production and consumption in balance.

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BUFFER ENERGY STORAGE IN DECENTRALIZED GENERATION PLANTS

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The considerable drawback of using diesel generator (DG) as a drive for synchronous generator – diesel electrical station (DES) – is that the energy efficiency is small, conditioned by high hydrocarbon fuel consumption. For the majority of territories the problem is worsened as the transport costs for fuel are high.

The steady rise of a fuel price led to a high prime cost of 1 kWh – around 1\$, from which a fuel part is 70%.

The possible way to decrease the price of energy produced is to optimize the load of DG. The desirable load for DG is 25-80% of nominal. Higher load leads to the decrease of DG lifetime; lower load implies the higher fuel consumption and carbonization effect due to the gases in the cylinders of generator.

For high-power DES containing several aggregates the problem is partly solved by a rational control of electrical conditions – turning on and off the DG to adapt to a demand curve, which is not possible in the case of one or two aggregates. In the following parts two control strategies are proposed. The conclusion is made with a comparison of the results.

II Load curve and its analysis

Fig.1 shows a probabilistic 24-hours load curve for a rural household, typical for decentralized

customers [1]. For the analysis reasons we make a per unit calculation and choose a maximum power rate as $P_{max} = 1,0$.

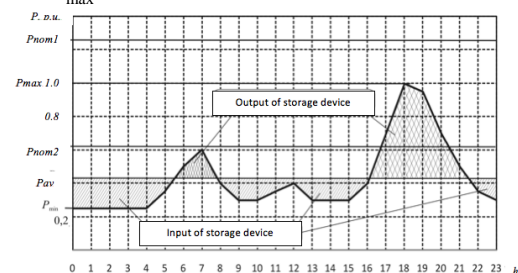


Fig.1. Probabilistic 24-hours load curve for a rural household

The main parameters of mentioned load-curve are:

- Maximum (peak) power $P_{max} = 1,0$;
- Minimum (base) demand level $P_{min} = 0,25$;
- An average load $P_{av} = 0,43$;
- Coefficient of maximum usage (density) of load

$$K_u = \frac{P_{av}}{P_{max}} = 0.43$$

- Coefficient of unevenness of demand

$$K_u = \frac{P_{min}}{P_{max}} = 0.25$$

Now we observe the main strategies to optimize the fuel consumption. Both strategies should provide the constant amplitude and frequency of output voltage.

III One-aggregate (standard) strategy

In the first variant (fig.2) the output voltage on collecting buses (CB) is stabilized by automatic regulation of fuel consumption of diesel motor (DM) and exciting current of synchronous generator (SG) realized by control system (CS). Proposed strategy implies regulating the generation of power according to power demand. This approach allows using relatively easy connection schemes and element base; it is reliable and proved-out by many years experience.

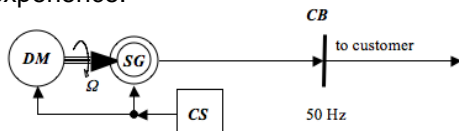


Fig.2 Structure chart of industrial DES

The main drawback of this structure is that DG is forced to work on low-power conditions, which cause shortening of its life cycle.

According to [4] the total power of working DG should cover maximum calculated demand taking into account the self-needs of DES and motor starting consumption. The mathematical expectation of active power in different time points is given with variation coefficients (rms divided by appropriate mathematical expectation) no more than 0,2. For full maximum demand coverage the DG should be chosen with the nominal power of $P_{nom1} = 1,25 \cdot P_{max}$.

In this case the load of DG between 0 and 4 h, 9 and 10 h, 13 and 15 h is 25% of nominal. That has an immediate negative impact on operation conditions and fuel consumption ratio.

IV One-aggregate and energy storage system strategy

The second variant implies the usage of buffer energy storage facility (fig.3) [2].

The strategy of controlling the system in second case is that DG is always loaded with average level P_{av} . When the generated power exceeds the demand level, the surplus of power is stored in buffer energy storage (BES). It is released when demand power exceeds the generated level – in peak hours of demand. For balancing the electrical parameters of system and providing the processes of charge/discharge, DES scheme should be supplemented with rectifying-charge equipment (RCE) and autonomous inverter, which are controlled by control system (CS) [3].

Subject to necessary reserve we get a nominal power for the system as $P_{nom2} = 1,25 \cdot P_{av}$.

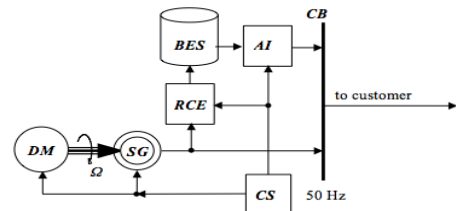


Fig.3 Structure chart of DES with buffer energy storing

V Comparison

For two given strategies of DES construction we make a calculation of fuel consumption.

The absolute fuel consumption of a DG for each i -th stage of 24-hours demand curve is given by a formula:

$$G_i = g_{nom} \times K_{tear} \times K_{reg_i} \times W_{out_i}, \text{ kg}$$

where g_{nom} – DG specific fuel consumption, g/kW·h; K_{tear} – coefficient of tear (for DG after overhaul and with exceeded lifetime the coefficient is taken 1,05); K_{reg_i} – the coefficient of regime which accounts the condition when DG works under load less then nominal:

$$K_{reg_i} = \frac{g_i}{g_{nom}}$$

where g_{nom} - specific fuel consumption by diesel on a given time period, g/kW·h. In case of the absence of technical specification, coefficient can be calculated based on empirical formula:

$$K_{reg_i} = 0.87 + 0.13 \frac{P_{nom}}{P_{cons_i}}$$

where P_{nom} – nominal power of DG, kW; P_{cons_i} – consumed power on i -th stage of 24-hours load curve, kW; W_{out_i} – output power on i -th stage of 24-hours load curve, kW·h:

$$W_{out_i} = P_{cons_i} \times t_i, \quad (1)$$

where t_i – period of i -th stage of DG operation, h. 24-hours consumption is defined by:

$$G = \sum_i G_i, \text{ kg}$$

We take the specific parameters equal for both variants ($g_{nom} = g_{nom1} = g_{nom2}$), and tear coefficient $K_{tear} = 1$.

In compliance with regarded load curve, around 80% of output energy is transferred to CB from DG and 20% from BES.

Taking into account the efficiency ratio of converting the energy in BES η , equation (1) takes a form of:

$$W_{out_i} = \eta P_{cons_i} + (1 - \eta) P_{BES_i} \times t_i,$$

where P_{BES_i} – power on a buffer energy storage at i th stage, kW.

For given efficiency ratio of inverter and rectifier of 90%, the economy of fuel consumption is 14,3%, when

VI Conclusion

The calculated variants have proved the efficiency of including the energy storage facility in

the structure of DES. Though, for technical realization of this variant it's important to solve several serious technical problems:

1. The technical characteristics of BES: deep discharge and fast input/output of large quantities of power.
2. The forecast for daily load curve is essential.
3. The high-performance and highly-efficient electronics are needed for the construction of rectifying charge and inverter equipment.
4. High-level control system is needed to realize a strategy of regulating the DES in real time.

From given problems we can conclude the necessity for an optimal storage facility. The most appropriate technology for constructing the BES is

based on super-capacitors, which are currently too expensive for mass usage.

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POWER QUALITY ENHANCEMENT BY USING H^∞ - LOOP SHAPING CONTROLLER SYNTHESIS.

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ABSTRACT

This paper introduces an analysis of the phenomena of stability as a major part power quality element, so if the stability of a power network is enhanced so the power quality is enhanced too. In the paper an analysis of the stability of synchronous machines under small perturbations by examining the case of a single machine connected to a large system through external impedance, and uses H^∞ - loop shaping controller synthesis to design stabilizer for electric power system

1. INTRODUCTION

THE PHENOMENON of stability of synchronous machine has received a great deal of attention in the past and will receive increasing attention in the future [ELsherbiny M.]. Power System Stabilizers (PSS) are added to excitation systems to enhance the damping during low frequency oscillations. The output of the PSS is applied as a supplementary control signal to the machine voltage regulator terminal. Oscillations of small magnitude and low frequency often persist for long periods of time and in some cases can cause limitations on the power transfer capability. The PSS conventional and the PSS control based on root locus and eigenvalue assignment design techniques have been widely used in power systems. Such PSS ensure optimal performance only at a nominal operating point and do not guarantee good performance over the entire range of the system operating conditions due to exogenous disturbances such as changes of load and fluctuations of the mechanical power. In

practical power system networks, a priori information on these external disturbances is always in the form of a certain frequency band in which their energy is concentrated. Remarkable efforts have been devoted to design appropriate PSS with improved performance and robustness. H^∞ based control approach is particularly appropriate for plants with unstructured uncertainty. In this paper, a PSS based on H^∞ - loop shaping controller synthesis is introduced and results are displayed in time response approach for studying stability of electric power system under different conditions.

2. SYSTEM DESCRIPTION

The power system considered in this study is modeled as a synchronous generator connected through a transmission line to infinite busbar. A simplified model that describing the system dynamics used in this study is given by the following state space equations [MALIK O., K.. Naoto].

$$\dot{x} = Ax(t) + B_1 w(t) + B_2 u(t) \quad (1)$$

$$z(t) = C_1 x(t) + D_{11} w(t) + D_{12} u(t) \quad (2)$$

$$y(t) = C_2 x(t) + D_{21} w(t) + D_{22} u(t) \quad (3)$$

where u represents the PSS output added to the voltage set points ΔV_{ref} , w is an external disturbance represented by the mechanical power ΔP_m . The matrices A , B_1 , B_2 , the vector z , y and the state vector x are defined by

$$A = \begin{bmatrix} 0 & 314 & 0 & 0 \\ -K_1/M & 0 & -K_2/M & 0 \\ -K_4/M & 0 & -1/K_3 T'_{do} & 1/T'_{do} \\ -(K_A/T_A)K_5 & 0 & -(K_A/T_A)K_6 & -1/T_A \end{bmatrix} \quad (4)$$

$$B_1 = [0 \ 1/M \ 0 \ 0]^T, B_2 = [0 \ 0 \ 0 \ K_A/T_A]^T$$

$$Z=[\Delta P_e \quad \Delta \omega \quad \Delta V_t]^T, \quad y=\Delta P_e$$

$$x=[\Delta \delta \quad \Delta \omega \quad \Delta E_q' \quad \Delta E_{fd}]^T$$

where δ , ω , E_q' , E_{FD} , P_e and V_t are respectively the torque angle, the angular velocity the internal machine voltage, the excitation voltage, power output and generator terminal voltage. T'_{do} is the open-circuit transient time constant, the operating conditions for the above systems are completely defined by the values of the real (P) and reactive (Q) powers at the generator terminals and the transmission line impedance X_e noted that the constants K_i ($i = 1, \dots, 6$) are uncertain and depend upon the network parameters, the quiescent operating conditions and the infinite bus voltage.

3. H[∞] LOOP SHAPING CONTROLLER

H[∞] loop-shaping control, proposed by McFarlane and Glover, is an efficient way to design a robust controller and has been applied to a variety of control problems. Uncertainties in this approach are modeled as co prime factor uncertainty. This uncertainty model does not represent actual physical uncertainty, which, in fact, is unknown. This approach requires only a desired open loop shape in the frequency domain. Two weighting functions, W_1 (pre-compensator) and W_2 (post-compensator), are specified to shape original plant G so that the desired open loop shape is achieved. In this approach, the shaped plant is formulated as a normalized co prime factor that separates plant G_s into normalized nominator N_s and denominator M_s factors. In any plant model G , the shaped plant G_s is formulated as [4].

$$G_s = W_2 G W_1 \Rightarrow \begin{bmatrix} A & B \\ C & D \end{bmatrix}$$

$$G_s = (N_s + \Delta_{N_s})(M_s + \Delta_{M_s})^{-1}$$

Where A, B, C, D represent plant G_s in the state-space, form $\|\Delta_{N_s}, \Delta_{M_s}\| \leq \epsilon$, N_s and M_s are nominator and denominator normalized co prime factors. Δ_{N_s} and Δ_{M_s} are uncertainty transfer functions in nominator and denominator factors. ϵ is an uncertainty boundary, called a stability margin.

4. RESULTS

4-a. Result of system without stabilizer:

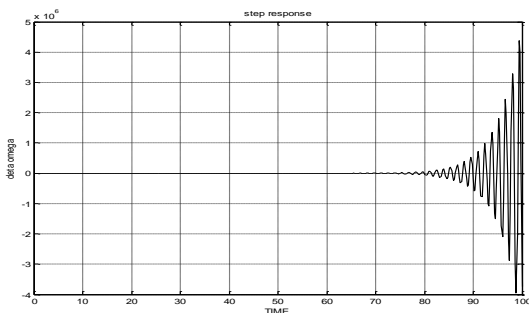


Fig.1 $\Delta \omega$ at P=1 p.u. and Q=0.015 p.u.

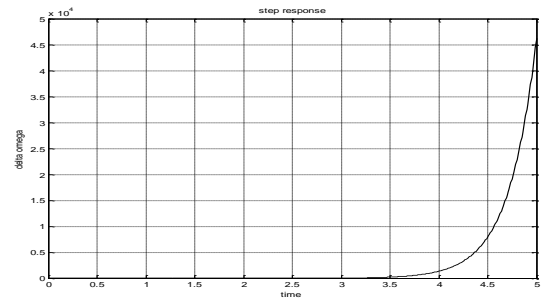


Fig.2 $\Delta \omega$ at P=1.25 p.u. and Q=0.3 p.u., xe=0.997 p.u.

From previous figures, it can be conclude that system is unstable for normal and heavy loading (fig.1, 2) respectively.

4-b. Result of H[∞] loop shaping controller:

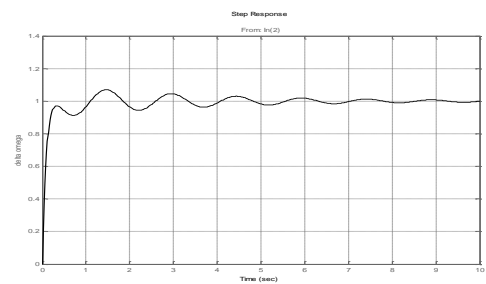


Fig.3 $\Delta \omega$ at P=1 p.u. and Q=0.015 p.u.

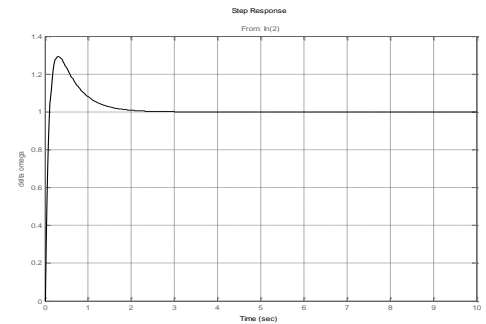


Fig.4 $\Delta \omega$ at P=1.25 p.u. and Q=0.3 p.u., xe=0.997 p.u.

5. CONCLUSION

In this paper the design and evaluation of power system stabilizers based H[∞] technique, H[∞] loop shaping controller has been considered. The simulation results presented demonstrate the effectiveness of these control techniques to improve the stability and transient response of power systems under a variety of operating conditions. The robustness of the controller has been evaluated with respect to model uncertainties of the power system. From the simulation results that were obtained it was clear that the used technique gave faster damping, with less overshooting.

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| Section II | |
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**INSTRUMENT
MAKING**

CELL THERMOSTAT OF CuBr-LASER WORKING SUBSTANCE

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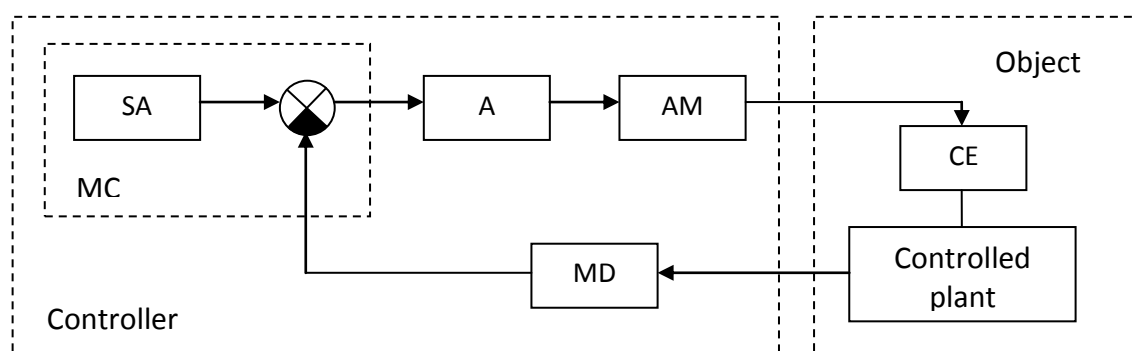
Metal vapor lasers are promising devices for solving a wide range of tasks. The most widely spread is a copper-vapor laser, as one of the most effective sources of coherent radiation in the visible spectral range. The main advantages of these lasers are: sufficiently great practical coefficient of efficiency (compared to other metal vapor lasers), high gain of active medium, and high pulse repetition frequency. However, for creating the necessary metal vapor density high temperatures (1500 - 1700)°C are required, and this factor imposes some restrictions on active elements design, which have quite short longevity [1]. Therefore, to obtain atomic copper in the active medium it is advisable to use its halogenides, especially bromide, which allows us to provide the required concentration of copper at the temperature about 500 °C, which is three time less when pure copper is used. Thereby, it allows us to use cheaper materials in the manufacture of the active elements (e.g. quartz). The use of capacitive-type pumping for vapor lasers on the base of various copper halogenides (CuBr, CuCl) is also known. This type of discharge tubes can increase the life time, because there is no contact of electrodes with chemically aggressive environment of the laser.

One of the main parameters which influences the output characteristic of the laser, is the concentration of copper in the active medium, which is determined by the temperature of the container with copper bromide (CuBr). Currently, in the Laboratory of Quantum Electronics, Institute of the Atmospheric Optics SB RAS, Tomsk, CuBr lasers with an active heat insulator are used [2]. The temperature of the outwall of the discharge tube, the CuBr generator and HBr generator are kept on the selected level by means of a three-channel control unit. The appeared regulating

device provides temperature dispersion in $\pm 5^\circ\text{C}$. It significantly affects lasing properties. At the same time, the price of this device is around 5000-7000 rubles. The aim of the work is to design a system of automatic temperature control only for one channel - the CuBr container. The system must possess the required parameters. The most important is the maximum temperature stabilization at the given level and indication. Moreover, the designed system should be "open" – it should allow us to change the control algorithms and, if necessary, provide the ability of computer control.

Figure 1 shows the functional arrangement of the designed system. The system represents a thermostat, which is made the base of the two-level controller scheme, that operates on the principle "on-off"[3]. By acting on the control element (CE) an automatic controller provides the value of the controlled value. Here, the control apparatus represents a heater or oven, and a controlled plant is a container with CuBr. Since the control apparatus is a device that perceives the impact of control on the object, the control apparatus as a constituent part of the object of regulation will be considered. Chromel – alumel thermocouple is used as a measuring device (MD). Both setpoint adjuster (SA) and adding device are built on the microcontroller (MC). The signal from the measuring device is compared with the given value. If the actual value of the controlled variable is not equal to the given one, on the terminal of the microcontroller there will be 1 or 0 depending on the result of comparison. Furthermore, the output signal applied to the amplifier (A), which is submitted by the driver in the scheme, is required for controlling the actuating mechanism (AM). The actuating mechanism in this case is performed by the transistor switch, which is used for switching the heating element from the power source.

Fig.1. The functional arrangement of the designed system



In this paper AVR microcontroller family, AtMEGA16 is used. The choice of this microcontroller is due to the following advantages: the presence of 10-bit analog to digital converter ADC, three external interrupts and interrupt on change of the port state. An integrated ADC in microcontroller let us convert the signal from the measuring device to be further processed. The signal should be amplified before being applied to the ADC. Differential amplifier based on the operation amplifier is used in the scheme (Figure 2). The operating temperature range of the CuBr vapor laser is (450 – 600) °C. If the temperature is 600°C or higher, vapor concentration exceeds the required amount. This leads to a decrease of energy characteristics (power generation). That's why it was decided to measure the temperature within the operating range. To do this, the voltage applied to the inverting input of operational amplifier (op amp), is equal to the voltage that produces a thermocouple at 400 °C. This value is obtained by a resistive divider R7-R8. Thus, the amplified difference signal will be on the output of the op amp. Moreover, it is possible to calibrate the measuring device by resistor R8, and the presence of a variable resistor R5-R6 allows rather accurately adjust the gain.

To set the desired value of the temperature two external interrupts of the microcontroller are used. To do this, the buttons are connected to the appropriate terminals of the microcontroller. The

LCD display WH1602D is used as an indicator. The display shows the temperature measured by a thermocouple, and the given temperature. Therefore, the presence of the microcontroller helps us to control the temperature of the container with the help of the indicator, and also set the desired value of the temperature. To communicate with a personal computer (PC) the built-in USART module that provides connections on RS-232 through the COM-port is used. The application of this type of communication is more straightforward; however, in future it is planned to implement a connection through USB-port.

To test the designed system a series of experiments was held. The same heater with the maximum power 200 watts was used. As model temperature measuring devices a mercury thermometer and the thermocouple electronic thermometer CENTER 307 were used. The purpose of a mercury thermometer was to calibrate the developed device by the absolute value, and an electronic thermometer - to record temperature deviations from the adjusting value. The temperature deviations at different adjusting values - 450, 500, 550 and 600 °C was researched. The deviations were recorded not only in a static mode (when the laser operates), but also when the load is being changed (the heat exchange with the environment was changed). Thus, the temperature deviation in all cases did not exceed ± 1 °C.

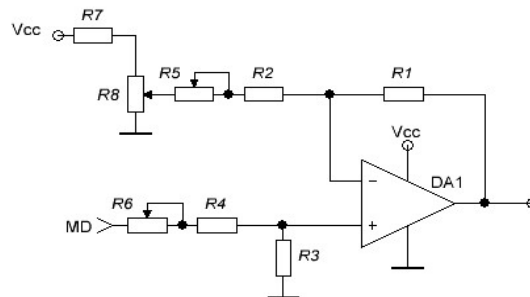


Fig.2. Differential amplifier scheme

Finally, the system of temperature stabilization of CuBr generator for CuBr - laser based on microcontroller AtMEGA16 was designed.

If the mercury thermometer indications are accepted as a reference value, temperature deviations do not exceed ± 1 °C, which makes up only 0.16%.

The system is "open" and makes it possible to carry out changes in the law of control for the optimal management mode when used for various tasks.

In future, the system will be modified and the software for personal computer (PC), which makes it possible to take the curve of the transient process to assess the quality of regulation will be developed.

The designed model will be used in the course of laboratory work on the theory of automatic control.

This work was supported by the Ministry of Education and Science of the Russian Federation, State contract № 7.586.2011

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STEPPING MOTOR CONTROL UNIT FOR LASER PROCESSING SYSTEM

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The purpose of the work is to create a stepping motor control unit for the laboratory bench on laser material micro-processing (e.g. cutting, engraving) based on CuBr vapor laser. At the same time it should be able to control energy generation.

CuBr laser belongs to a class of lasers on self-terminating transitions in metal vapors, where an inversion between the resonant and metastable levels occurs for a short time due to their excitation by electron impact from the ground state [1]. A simplified schematic diagram of copper atomic levels is shown in Fig. 1. In this paper a CuBr laser with the average power of ~ 5W will be used. Energy control in lasing pulse will be carried out by forming a double excitation pulse using a pulse radiation modulation like in [2]. Modulation should be conducted together with the movement of the table where the workpiece is located.

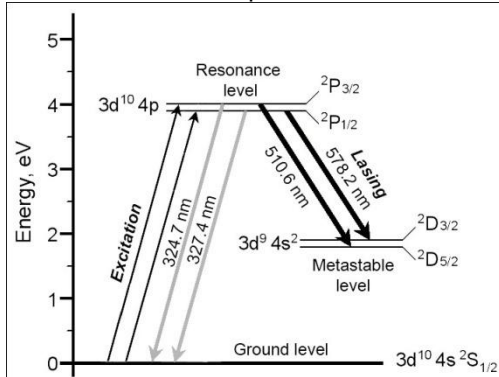


Fig. 1. Copper atom levels scheme

To complete the given task we'll need an x-y stage which operates by means of two unipolar stepping motors. The engine block diagram is shown in Fig. 2.

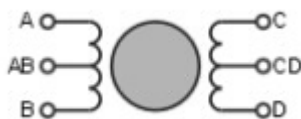


Fig. 2. Unipolar stepping motor block diagram. A, B, C, D – motor phases. AB, CD – common points

One of the basic peculiarities of a unipolar motor is that it has one winding in each phase and in the centre of the winding there are some contacts. This allows us to change the direction of the magnetic field of the winding just by switching the winding halves.

As a result the driver circuit is very simplified. The driver should have only four simple keys. In the unipolar motor the technique of the magnetic field direction change is used. Average winding contacts can be connected inside the motor, so the engine may have five or six wires [3].

The driver will be controlled by the personal computer (PC) program. Therefore, it is necessary to design a software envelope for the PC for processing image vector graphics. The program should have the opportunity to control the depth of cutting (by means of the laser pulse energy control and the positioning table speed), and to determine the laser beam position on the workpiece surface without any tracking device, i.e. only according to the history of the table movements. Moreover, the program should be able to work in two modes: automatic and semiautomatic.

Automatic mode is an independent cutting lines priority regulation which makes it possible to cut complex shapes without the risk of a workpiece to be damaged. Semiautomatic mode is the ability to set this priority manually.

Vector graphics is the use of geometrical primitives such as points, lines, curves, and shapes or polygons to represent images in computer graphics. Vector graphics is based on images made up of vectors (also called paths, or strokes) which lead through locations called control points. Each of these points has a definite position on the x and y axes of the work plan. Each point, as well, is a variety of database, including the location of the point in the work space and the direction of the vector (which is what defines the direction of the track). Each track can be assigned a colour, a shape, a thickness and also a fill. This does not affect the size of the files in a substantial

way because all information resides in the structure; it describes how to draw the vector [4].

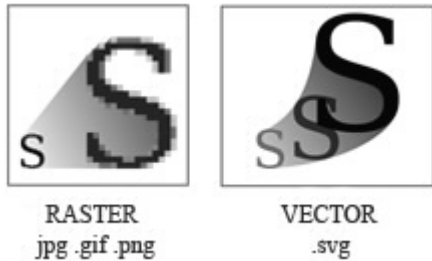


Fig.3. Examples of bitmap and vector graphics

The advantages of a vector style of drawing over a bitmap one are: (1) the size of representation does not depend on the dimensions of the object, (2) the parameters of objects are stored and can be later modified. Also there is an opportunity to convert vector graphic file to raster format, but not vice versa.

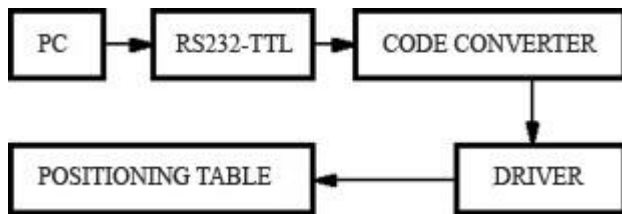


Fig.4. Block diagram of the designed device

The block diagram of the designed device is presented in Fig.4. The connection of electric motor drivers and PC should be provided by a device constructed on the basis of a microcontroller Atmega16, Atmel corp. The link will be realised with the help of the RS-232 interface. In this case a signal level converter (RS-232-TTL) based on max232 driver/receiver is required.

It is easier to implement the device on the base of two microcontrollers. The first microcontroller is

programmed to convert the serial code (obtained from a computer by the interface RS-232) to parallel code and control the laser operation (it's meant the lasing pulse energy control). The second microcontroller is responsible for controlling motors. The software will process vector graphic files and transfer them to the microcontroller by RS-232. In comparison with the USB interface, the RS-232 interface let a device refer to PC. Thus, there is a way to raise an accuracy of material microprocessing [5, 6].

In the present work a unipolar stepping motor control unit is designed. Its circuit is shown in Fig. 5.

The electric motor has two modes of operation. When switch S1 is pushed, the motor rotates clockwise; when switch S2 is pushed, the motor rotates counter-clockwise. The integrated circuit DDR2 is used for current amplification. DA1 and DA2 reduce voltage up to 5 V for microcontrollers and to 12 V for the electric motor and DDR2. It should also be noted that the main part of the device is the microcontroller Atmega16. It contains a program which is used to determine the work of all other elements of the circuit.

So, the device needs only one voltage supply source - 16 V. LM7805 and LM7812 change voltage to 5 and 12 volts respectively. This power-supply circuit design is simple and reliable. The use of integrated circuits in TO220 package gives an opportunity to install radiators to increase output capability.

In conclusion, let us make notes on the key features of the designed device. The positioning table makes it possible to work with objects lighter than 1 kilogram.

With the increase of mass, accuracy is decreased and therefore, losses in motor grow.

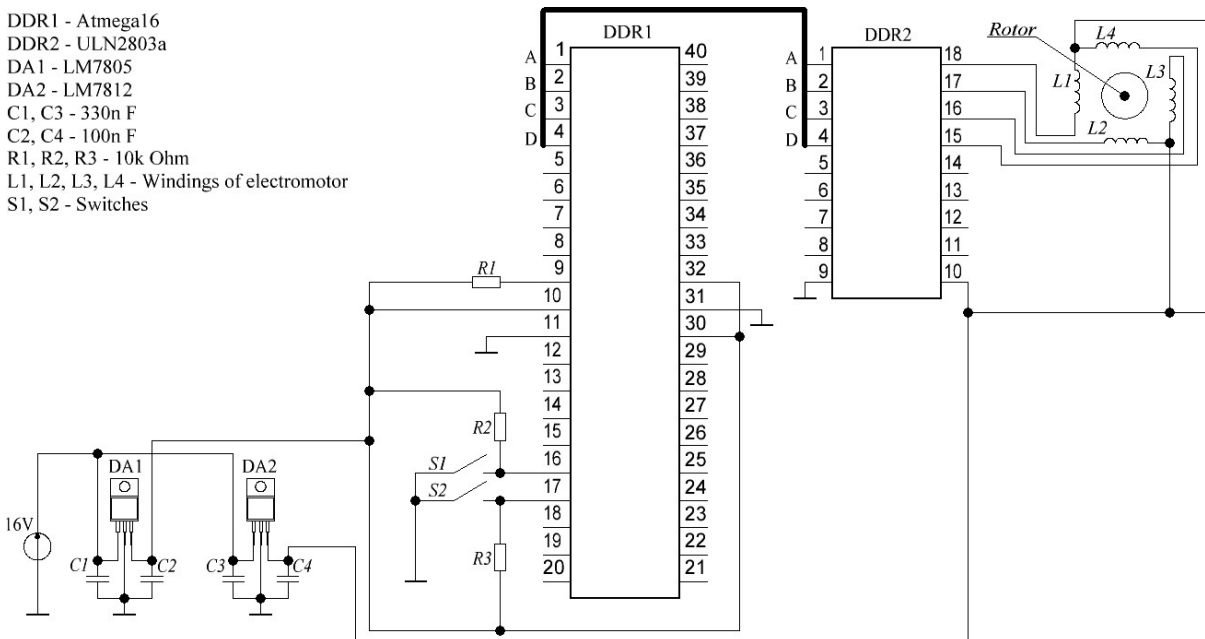


Fig.5. Designed driver circuit

There is no position control system. Position is defined by the previous table movements and it has detrimental effect on accuracy. However, in case of fine tuning the positioning errors can be minimized.

One of the major disadvantages of the laboratory bench is the motor response time. Nevertheless, it can be eliminated by means of complementary devices for 'operating point' position determine.

The ability of lasing energy control enables us to adjust the depth of material processing. One of the potential applications is the fabrication of integrated circuits and printed-circuit boards. Small beam diameter and adjusted radiation intensity allow the result to be better than by traditional chemical etching.

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NEW METHOD OF PHASED ARRAY SIGNAL PROCESSING

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The Ultrasonic Pulse-Echo inspection method is extremely capable of detecting cracks that limit the structural integrity of loaded technical components and systems. However, the applied principles of ultrasonic material testing do not in general allow the characterization of flaws and the required measurement of crack dimensions. Appropriate wave field data sampling at the scanned surface with the subsequent field reconstruction improves both the resolution and the contrast sensitivity of inspection results. We use arrays with elements adapted for the inspection task with an optimized arrangement and element apertures of point source character. First results have been received applying linear arrays that are promising for the quantitative assessment of flaws by high-resolved high contrast imaging of inspection results in real-time.

For various technical measurement systems based on wave physics, optimized wave field data sampling and data processing has become state of the art with the objective of high resolution reflector imaging. Examples are radar applications, optics, hydro-acoustics but also acoustic imaging for medical diagnostics. In some of these areas the resolution limits for measured data with noise have been expanded beyond the classical Rayleigh criterion in the last years, as a result of model-

fitting theories and super-resolution techniques. Improvements for high resolution imaging in non-destructive testing have been proposed too based on compensation for the diffraction effects of finite sized transducer elements. Multidimensional linear filter is applied for compensating diffraction effects and errors of element positioning [1]. The filter replaces conventional phase controlled operations of phased arrays systems and it is designed for real time performance. The objective of this development is the use of array elements of large element apertures for effective pulse transmitting and receiving and the compensation of diffraction artifacts.

To take best advantage of up-to-date principles of imaging but also to comply with the professional requirements, we have to develop systems that can be applied following existing procedures and specification but with additional features that allow for better performance and evaluation of results. A first step was the use of ultrasonic Phased Arrays but processing the full information measured by the array elements. We have called this technique Sampling Phased Array (SPA).

Sampling Phased Array and Migration Array

The Sampling Phased Array Technique was developed for linear array transducers with the objective of real-time flaw imaging with improved

contrast and resolution sensitivity [1-2]. Basic principle for the development has been the viability of fast data processing by optimized algorithms and efficient computing by applying affordable standards [2]. The migration array technique is a generalization of sampling phased array technique. Phase controlled measurement is replaced by position controlled measurement with the possibility of implementation of advanced codes for image generation, a technique we have called wave field data sampling. The final objective of MAT development is real-time high-resolution imaging of flaws measured by matrix arrays and reconstructed and presented in 3D.

Instrument Design

The instrument has been designed in compliance with existing standards for multi-transducer and phased array systems with modular 32 parallel ultrasonic channels and the phase control electronics. The add-on is the parallel measurement of the high-frequency A-scans by each element of the array. Fast data links have been designed for real-time processing of the full array A-scan and element position information [2] but in consideration of standards for easy future upgrades (fig. 1).

Special emphasis was put on amplifier features including high dynamic range and extreme low noise even at highest amplification settings. These help in the operation of array transducers with small element apertures. The system can be operated in all known operation modes of a multi-channel ultrasonic instrument: as a standard multi-transducer inspection system, as a conventional phased array system with up to 16 phased array linear transducers with 16 elements each, and as a system with controlled selectable transmitter pulse control and parallel receiving elements as required for 3D wave field data sampling. Further, the system may be operated in any hybrid operation mode, for example as a multi-transducer system plus one or more phased array transducers.

In addition to supporting current market demands, we plan to use the multifunctional system feature for the validation and certification of the migration array technique.

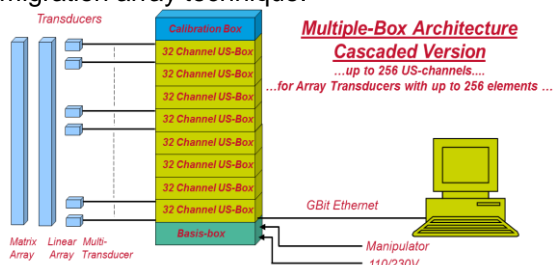


Fig. 1. System Architecture

We propose sparse apertures for array transducers with stacked piezo-elements. We have called these array transducers Migration Transducers because they cannot be applied with standard phased array instruments. The stacking of piezo-elements provides the appropriate element capacity for efficient transmitter and

sensitive receiver characteristics for small aperture elements. The use of sparse apertures with element distribution not in compliance with the sampling theorem can be achieved by data filtering. The design, the materials used and the assembling of migration transducers have to provide low acoustic and electric cross-over needed for a dead zone less than one millimeter (for technical inspection frequencies).

High Speed Scanning

High speed scanning of about 1 m/sec can be achieved only when we do not have to transmit pulses by each of the array elements. The point source character of the elements in combination with the reciprocity theorem offers the approach of reducing the measurement information. When only one element is used as a transmitter and all the other elements are receiving the reconstructed flaw image is almost of same quality. When scanning we sample compound scan data with redundant information that stabilizes the reduced approach. The main difference is caused by the noise because of fewer amounts of data summed up. Assuming a pulse repetition rate of 1 kHz, a wavelength of 2 mm, a scan index of half the wavelength, and a 10 element arrangement in scan direction we may scan at a speed of 1 m/sec with full (redundant) measurement information since transmitter position is moving along the synthetic aperture. However, we have to organize the information flow of data processing with fast data access and links.

The equivalence of the sparse information concept for fast scanning is shown in figure 2. The applied transducer was a linear array of 16 elements and a frequency of 5 MHz. The reflector was point like (1 mm SDH), the angle of incidence 30° longitudinal mode.

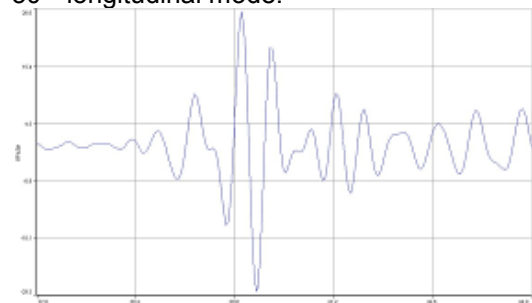


Fig. 2a. Proof of equivalence: Sparsing of Information Content (16x16) Information Matrix: SDH Ø1mm Zoomed A Scan



Fig. 2b. Proof of equivalence: Sparsing of Information Content (16x16) Information Matrix: SDH Ø1mm Zoomed A Scan

Information Content
(1x16) Information Matrix:
SDH Ø1mm Zoomed A Scan

This type of information sparsing asks for improved instrument amplifier characteristics (electronic noise) and highly sensitive array elements. The effect of electronic noise can be seen in figure 2b.

Conclusions and Outlook

Wave field data scanning and subsequent data filtering is a viable approach for high-resolution and high-contrast imaging of flaws. The current state of art in computing, micro-electronics (instrument) and micro-packaging (Migration Array Transducer) enables the development of a system for industrial inspection tasks.

However, we have to consider in more detail the equivalency with existing ultrasonic testing procedures, especially the use of shear waves for the sensitive detection of cracks at the rear side or ID of the inspected component. We can reconstruct images for the shear wave mode but we still need progress with high performance migration array transducers which are under development. Also, validating the equivalent detectability of surface cracks by the longitudinal

mode of Migration Array Technique MAT we may limit the sweep to the critical shear wave angle. Nevertheless, the code developed allows the evaluation of flaw images including mode conversion phenomena.

3D Migration is the final target for future imaging of the flaw geometry by de-convolution of the reflector features by applying rules for its interaction with the wave field.

Engineering rules for optimized Migration Codes will provide support for further progress in inspecting anisotropic materials like light-weight fiber materials, cast materials, and dissimilar welds.

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**SETTING PRINTED CIRCUIT BOARDS FOR
ABSB-100 AND ABS VERTICAL FRAMES.**

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Accumulator battery simulator block (ABSB) (Fig. 1.) is a part of an automated system for complex testing of spacecraft power systems in a series of ground tests. This equipment is used to simulate: the battery work during discharging and charging it, the voltage change in a storage cell of the accumulator battery, pressure alarms, temperature sensors, analog pressure sensors, accumulator battery electric radiators, and also to generate an additional voltage of 30 V.



Fig. 1 ABSB-100 and ABS Vertical frames

ABSB simulators are located in a simulator block (SB) and partly in a control block (CB).

Simulator block contains boards to simulate the pressure and temperature sensors. There are:

- Six TSS-46 boards for temperature sensors simulation
- Four TSS-110 boards for temperature sensors simulation
- Three PSS BCCD (Battery Charge Control Device) boards for pressure sensors simulation which simulate 12 BCCD galvanic isolated analog pressure sensors.
- Two PSS TU BCCD (Threshold Unit BCCD) boards for pressure sensors simulation which simulate 12 PU BCCD galvanic isolated analog pressure sensors.



Fig. 2. Simulator block

Operation of sensor simulator is implemented via RS-485 by the CB controller.

Besides printed circuit boards (PCB) of simulator block also some PCB of the control block which is designed to control and protect ABSB are set up (Fig. 3):

- Pressure alarm simulator PAS;
- Storage cell simulator SCS;
- Three boards of Storage Cell Switch SCSW.

While setting the boards the following actions have been conducted:

1. Missing elements have been soldered.
2. Inspection of board for controlling mounting correctness has been carried out.
3. The board has been ringed out.
4. The board has been powered.
5. Microcontroller has been flashed.
6. Equipment has been calibrated and tested in accordance with instructions.
- 7.



Fig. 3. Control block

The whole setup process was documented. Each simulator has its own setting instructions.

The calibration and testing mode consists in the following:

To enter the calibration and testing mode it is necessary to perform ASCII code of 8 not less than 5 times in any terminal program (*Far* → *COM monitor*).

COM port settings: rate 38400 (bit/s), stop bits "1", there should be no flow control.

Possible operations in this mode:

- 1 - Measurement of the minimum value of the code;
- 2 - Measurement of the maximum value of the code;
- 3 - Calculation of the "K" and "B" coefficients;
- 4 - Testing measurements according to received coefficients (coefficient of RAM);

5 - Testing measurements according to received coefficients (coefficient of main memory);

F - the request for saving the coefficients to the main memory;

Q - the request for the output.

After exiting the calibration mode of the simulator measuring part the self-test procedure automatically starts. During this procedure the simulator parameters measurement, the output of measurement results on the screen with indicating the simulator required value and their differences are done.

If necessary, it is possible to select preset resistors for the purpose to ensure the specified parameters. Particularly, for simulators of resistive temperature sensors SRTS the sensor resistance is set, and for simulators of analog pressure sensors SAPS – the output voltage of the balanced bridge is set.

ABS (Fig. 1) is a modernized ABSB vertical frame. Because of several types of ABS, it has been necessary to develop SCS boards (Fig. 4) of different types, which must have diverse precision simulation parameters for the simulators block. So as the simulation parameters are identical, a universal board has been developed, on which one can get the required characteristics for different simulated batteries by setting preset elements and changing software. However not entirely worked out constructive has led to great costs during setting these boards.

In the boards for the ABS an automatic calibration mode, where the processor itself controls the DAC input code was developed. It also allows to test the channel operability (3 points for each channel).

After the setup and calibration of PCB, alcohol cleaning of boards from the remnants of a rosin mixture, grease, dirt, dust and stray remnants of soldering was carried out. Then the exsiccated printed circuit boards were varnished to provide additional insulation and protection of board elements from the external environment.

As a result, during the development of ABSB-100 LI accumulator battery simulator block, disadvantages which have been founded in the boards for ABS, were taken into account.



Fig. 4. SCS of ABS

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THE SEARCH OF HIDDEN UNLAWFUL ENCLOSURE BY MEANS OF RADIATION TESTING

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INTRODUCTION

Nowadays terrorism has become one of the most acute problems.

To solve the problem is possible at the appropriate level of technology development allowing the state agencies to fight with the terrorism threat.

We consider, screening equipment is the most effective today.

Baggage scanning equipment implies complex technical aids being used for passenger's and their luggage testing and ensuring so the safety of various institutions, public events and public transport. [1]

The priority in the creation of baggage scanning equipment is a complex approach to solving this problem and therefore there is a wide range of devices, for example [2]:

- metal detectors;
- X-ray equipment and systems;
- detectors of explosive vapors;
- detectors of drugs;
- detectors of timer units;
- devices of radiation detection;
- infrared TV monitoring systems;
- endoscopes;
- inspection mirrors.

X-RAY SYSTEMS

X-ray equipment and systems have got now widest application. [3] This type of equipment may be shown by a number of systems designed on different schemes. For example, there are installations using monoenergetic, multi-energy and back scattered radiation. [4]

Detector blocks are built on a wide range of principles in this is action, for example, ionizations chambers, various types of scintillators, in particular, such promising as scintillating glass fiber. Geiger counters or special semiconductive diodes are also used.

As mentioned above, it can be asserted, that in the nearest years the promising places for usage of X-ray screening equipment will be at different enterprises, places of public events and public accumulation (sport stadiums, theatres, concert halls, educational places) and obvious by the objects of customs check. Although even nowadays there is a tendency of supplying all big companies and institutions by similar systems. [5]

From the technical point of view the development of X-rays baggage scanning equipment will mutually integrate with the systems based on other physical phenomena and automation of the testing process.

RADIATION SAFETY

At the passage of the inspection at the airport or at the customs people, in particular, and the staff may receive additional relief to natural background radiation exposure due to man-made radiation sources located in the inspection equipment.

Therefore, the ensuring of radiation safety in the work of the X-ray inspection equipment is as important as the detection of prohibited items during the inspection.

X-rays machines of baggage and goods examination have in their composition an intensive X-rays source with a maximum energy of 160 – 250keV.

Consequently, similar machines under their correct usage are quite safety as for the personnel and for all inspected people.

Besides of personal safety, people trouble about the safety of their luggage, especially the film safety under the impact of X-rays in the process of the inspection.

More over the manufacturer provides the inspected equipment the safety of the film materials in the luggage

or in the inspected shipment which is being used under the control of small doses and exposures.

EXPERIMENT

In order to make the estimated analysis of possibilities of various systems for hidden object detection, an experimental research of internal structure of various objects has been fulfilled aiming to detect the simulators of the hidden enclosures inside the objects. The following equipment has been used for this purpose:

- Portable x-ray apparatus Y.XPO 225;
- Complex of digital radiography PHOSPHOMATIC;
- Portable roentgen - TV equipment NORKA.

The transportation bag of the device NORKA filled with various subjects was used as the first object of testing. The bag was exposed by X-ray within 40 seconds, the current on a tube was 1 mA and the focal distance was 0,5 m. The anode voltage was raised with a step of 10 kV. As the detector, the phosphoric remembering plate PHOSPHOMATIC and the block of a television camera of NORKA were used. In the case of PHOSPHOMATIC usage, the most informative images were taken at anode tension of 50 kV. At the same time, for NORKA, the most informative images were received at tension of 90 kV.

Another object of checking was a pair of used shoes, having a niche in one of the heels, in which a small bag with salt, simulating a hidden enclosure of drugs, was settled down. In the other shoe a microchip was hidden under it's sole. This microchip could be used in the role of possible listening device ("bug").

The roentgenogram received by means of the complex PHOSPHOMATIC, allows us not only to find out the latent enclosures, but also easily identify them. At the same time, using images received by means of NORKA it is difficult enough to identify latent enclosures, because only the presence of heterogeneity inside the object of testing was revealed.

Also, the examining of metal plate having a welded joint was made both with NORKA and PHOSPHOMATIC, as an imitation of a welded connection at industrial inspection.

CONCLUSION

On the basis of the received data it seems to be possible to lead out conclusions that it is possible with high probability to use radiographic equipment

both for the industrial nondestructive testing, and for customs purposes. In particular, the PHOSPHOMATIC complex has shown the results surpassing the quality of the image and detectability indexes of NORKA apparatus. But the main disadvantage of a radiographic complex is much lower productivity of monitoring procedure. So, during the inspection time for one object by means of PHOSPHOMATIC, one can carry out investigation from two to three objects by means of NORKA. Since the speed of examination is considered to be a very significant factor, hence the usage of PHOSPHOMATIC from the point of view of customs testing is, in our opinion, inexpedient.

At the same time, at carrying out nondestructive testing of industrial objects the primary factor is the quality of the testing procedure, and time indicators fade into the background. Therefore, it is necessary to apply the equipment giving the best sensitivity of the testing. So application of NORKA for defect revealing, for example in a welded joint, can lead to the bad quality control and a subsequent failure to operate of the testing object.

Accordingly with this, the universal application of the equipment having even the similar structure or action of a device is not always possible. In particular, the use of NORKA for carrying out nondestructive testing of industrial objects becomes possible only with skilled operator who can achieve the maximum possible quality of testing and in the case of testing those objects which are not concerned to be especially crucial, or together with other methods of the NDT.

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ELECTRICAL BREAKDOWN AND EXPLOSIVE DECOMPOSITION OF PETN MONOCRYSTALS UNDER ELECTRON BEAM IRRADIATION

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Detonation initiation in PETN by high current electron beam (HCEB) has been researched. It was shown that in contrast to laser radiation HCEB initiates detonation in compacted PETN samples with the uncovered surface. The uncovered surface of the sample means suppression of substance expansion from the irradiated region. The cause of distinction in processes in PETN under different types of irradiation has not been found. Two mechanisms of explosive decomposition in PETN under HCEB action were proposed. They are the electrical breakdown [1, 2] and exciton excitation [3, 4]. The first mechanism suggests explosive initiation from "hot spots", and electrical breakdown channels make this "hot spots". The electrical breakdown hypothesis is based on direct experimental results obtained in the research of physical and chemical processes [1, 2, 5, 6]. The experimental results obtained in [7 – 9] show that the electrical breakdown occurs in passive (not endothermic) dielectrics under HCEB. Electron-hole excitation (conductive electrons, holes and excitons) occurring in PETN under HCEB irradiation is considered to be essential as well. It is obvious that to justify the "electrical breakdown" hypothesis we need to prove the existence of electric discharges in the PETN volume under subthreshold levels excitation.

The purpose of the research is to obtain direct experimental proof for electrical breakdown in PETN monocrystals under HCEB irradiation and to determine the threshold for electric discharge initiation.

To solve the problem we need to obtain data per one excitation pulse and separate different types of glow.

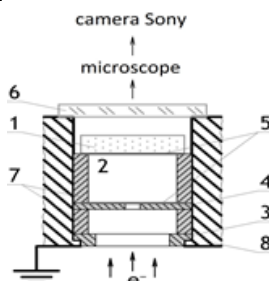


Fig. 1 The scheme of PETN irradiation by electron beam: 1 is the sample (PETN), 2 is a vacuum chamber, 3 is an anode, 4 is a collimator aperture, 5 is an aluminum foil 10 μm thick, 6 is a vacuum chamber window, 7 is metal rings, gaskets, 8 is the accelerator case

The experimental scheme shown in Fig. 1 was used to separate the electric discharge glow against cathodoluminescence and explosive glow.

The tested sample 1 with the cross section of (3 – 7) mm and (1.5 – 2.0) μm thick was placed in a vacuum chamber 2 combined with the vacuum diode of the electron accelerator, and excited by electron beam through the hole in anode 3 and stop 4. The aluminum foil (4 - 9) μm thick was applied to the irradiated PETN surface to localize the electric field in the region of HCEB deceleration. The electron source was a nanosecond electron accelerator which made high-current pulse generator PVG-600 (maximum electron energy is 450 keV, maximum current is of 3 kA, current pulse duration is 15 ns) by Arkadiev-Marks scheme with the vacuum diode initiating high current [10]. HCEB energy density was varied in the range of (0.05 – 75) J/cm^2 by changing the cathode-anode gap, by the stop, and by changing the distance from the anode to the sample. It was determined by radiation-chemical method. High values for H were obtained in HCEB self-focusing [11]. They were found by the formation of the erosion spots on the metal surface differing in their sublimation temperature [9, 12] and calculated by the formulas in [13]. The glow in excitation of PETN by electron beam was shot through the chamber window by the digital camera SONY α 500 through the microscope MBC-10. In the region of HCEB deceleration, when the electron beam energy threshold density was $\sim 0.1 \text{ J}/\text{cm}^2$ bright crystallographically oriented channels were found to be formed against cathodoluminescence.

Streamers diverged at the angle of 60° to one another and make the angles of 90° and 30° (Fig. 2). In some of the experiments streamer discharges developed beyond the irradiated region and were "drown" into the electron beam deceleration region.

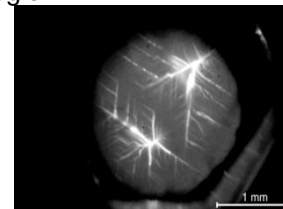


Fig. 2 Integral photography glow streamer discharges initiated by the electron beam in a single crystal of PETN in the $H_{\text{th}} \sim 0.5 \text{ J}/\text{cm}^2$

In PETN irradiation by electron beam with the energy density below the threshold the electric discharges are not initiated and we can observe pulse cathodoluminescence only. Streamer charge formation is followed by destruction of the irradiated PETN surface. The study of the monocrystals morphology by the microvizeore

μ Vizo-101 made it possible to distinguish crystallographically oriented residual electrical breakdown channels located in the region of the electron beam path (Fig. 3). The shape of the discharge obtained after destruction is identical to the geometry of the discharge shape in glowing. Coincidence of electrical breakdown thresholds testifies to the electric discharge mechanism of samples fracture. The electric discharges were found to be initiated in the range of HCEB energy density (0.1 at 75.0 J/cm^2). At $H \geq 0.8 \text{ J/cm}^2$ not complete (partial) explosion of the monocrystal can be observed. The part of the sample which failed to explode is expanded in the experimental chamber.

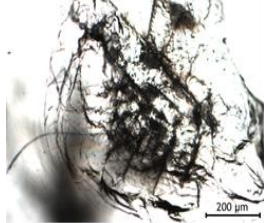


Fig. 3 Images of the destruction of a single PETN crystal after single-pulse electron beam irradiation with the energy density $H_{th} \sim 0.1 \text{ J/cm}^2$.

Plasma jet glow flash in it is expansion and interaction with the stop, destruction of the thin ($10 \mu\text{m}$) aluminum foil, and sharp increase in pressure in the vacuum chamber testified to the sample explosion. As H increases in the range of (0.1 at 75.0 J/cm^2), the number of electrical breakdown channels, their sizes and glow brightness grow. The quantity of the reacted high-energy increases and the sizes of the expanding fragments reduce from several millimeters to several microns. The analysis of the glow spectrum is different at different explosion stages.

The comparison of the experimental results for HCEB initiation of monocrystals and compacted PETN powders testify to sound distinction of chemical reactions in these samples. At $H \sim 60 \text{ J/cm}^2$.

Detonation and complete chemical transformation of the substance can be observed in compacted PETN powders. As to monocrystals the basic mass of the sample is dispersed and rejected in the experimental chamber even if the HCEB energy density is maximal ($H \approx 75 \text{ J/cm}^2$).

Thus, it has been found that in irradiation of PETN monocrystals by HCEB with the energy density $N_{th} \geq 0.1 \text{ J/cm}^2$ crystallographically

oriented streamer discharges are found in the irradiated region. The results obtained confirm the model for PETN initiation by HCEB described in [2, 5, 6]. Micro explosions occurring in the region of electric discharge localization result in monocrystals dispersion, gas-dynamic unloading of evaporation and chemical decomposition products in air, and as consequence, in expansion of the basic mass of not reacted substance. Self-propagating of the chemical reaction beyond the HCEB path (detonation of the total high energy mass) can be observed for initially dispersed PETN compacted powders.

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LASER LIFT-OFF TECHNIQUE

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Energy saving become more and more significant, nowadays. In optical engineering the light emitting diode (LED) is considered to be the most efficient for energy economy. It's new high-tech light source. The main advantage of LED is their high luminous efficiency. Luminous efficiency shows how much energy is converted to light flux. For comparison, efficiency of incandescent lamps is 10-15 lumens per watt (LPW), that of discharge fluorescent lamps is 40 - 80 LPW, and LEDs possess the efficiency of 70-130 LPW. However, the limit of luminous efficiency can be as high as 263 LPW for white light, and scientists seek to achieve this limit.

Currently produced LEDs are made from gallium nitride. Gallium nitride is used because its band gap is 3,4eV. This corresponds to the quant with the wavelength of 585nm. . If we consider the principle of doubling the resonance frequency of semiconductor, GaN LEDs can radiate in the ultraviolet range with the wavelength of 292nm. This fact makes it possible to create white LEDs with luminophore. If we use GaAs doped with phosphorus, we get LED with wavelength 590nm. This is what makes GaAs not appropriate for white LEDs creating.

Our aim is to increase luminous efficiency and lights flux for white LEDs. To perform this we are to solve two problems.

The first problem is high current through the p-n junction which increase heating in the semiconductor by the Joule-Lentz low. This process leads to destruction of semiconductors heterostructure and failure of a LED. Moreover, there occurs the "effect of bottleneck". Bottom line of the effect is that current concentrate in narrow channel. This causes uneven heating and defects in the heterostructure. As a result, absorption increases, and the quantum yield and efficiency decrease.

Second problem is that GaN crystal grown on sapphire (Al_2O_3) only. Sapphire and gallium nitride possess different periods of the crystal lattice and thermal expansion coefficients. Therefore, the temperature change leads to crack formation in the junction of GaN and sapphire. This means that defects in the heterostructure can cause LED breaking.

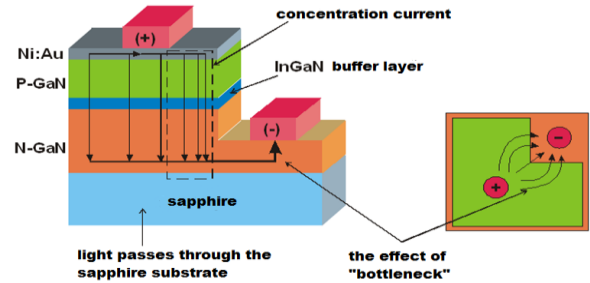


Fig. 1. Horizontal LED structure

The luminous efficiency of the LED and light flux decrease, and in LEDs with the horizontal structure (Fig. 1) in particular. To solve the problem we can separate GaN LEDs from the sapphires substrate. The separation occurs by the formation of plasma and shock wave. The feature of plasma formation process is evaporation of material from the solid phase bypassing the liquid phase. Separation of GaN from sapphire substrates by irradiation of high power pulsed laser from the back side of the substrate is called as a laser lift-off technique (lift-off).

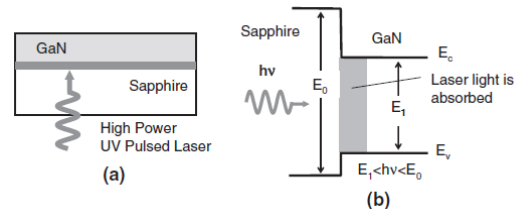
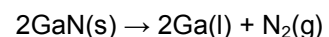


Fig. 2. Schematic overview of laser lift-off processing. (a) Cross section. (b) Band diagram.

Laser lift-off processing is schematically illustrated in Fig. 2, where the band diagram is also illustrated. The high power ultraviolet pulsed laser is irradiated to the interfacial GaN from the backside of the sapphire substrate. The laser energy thermally decomposes the GaN by selective heating up, while the laser light is not absorbed in sapphire. The chemical reaction taking place at the interface can be expressed by



There have been a couple of reports on the thermal decomposition of GaN, in which nitrogen flux $\Phi(\text{N})$ from GaN under vacuum can be expressed by a following equation:

$$\Phi(\text{N}) = N_0 \exp(-E_a/kT) \text{ (cm}^{-2}\text{s}^{-1}\text{)}$$

where N_0 is a constant, E_a is an activation energy for the decomposition, k is the Boltzmann constant, and T is the absolute temperature.

After the laser lift-off, the compressive stress in a GaN film mainly originated from the thermal mismatch between the GaN film and the sapphire substrate is relieved. The relieved stress and vaporization pressure of N_2 formed by the decomposition of the interfacial GaN are the possible origins of the film failure as shown in Fig. 3. Thus, the choice of the laser is the most critical to set up the laser lift-off system since the decomposed area by the local heat up needs to be as thin as possible to reduce the vapor pressure of N_2 and to avoid any damage to the crystal quality of the epitaxial film above. In addition, the area distribution of the laser power needs to be very uniform to achieve the laser lift-off of very thin GaN.

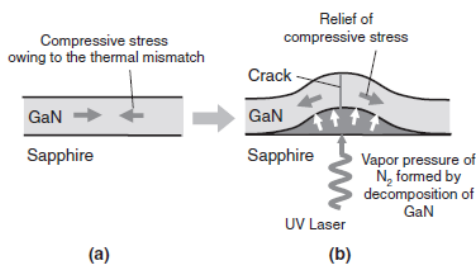


Fig. 3. Mechanism of film failure after laser lift-off. Before (a) and after (b) laser lift-off.

This technology makes it possible to create LEDs with a vertical structure (Fig. 4). This type of the construction solves the problem of the “bottleneck effect”. In this case metal could be used instead of sapphire to solve the problem of excess heating.

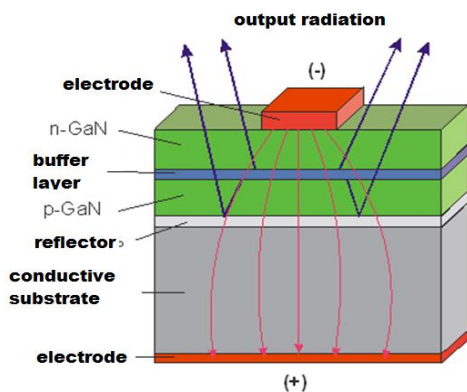


Fig. 4. Vertical LED structure.

This technology was realized in Research Institute of Atmospheric Optics, RAS SB. KrF excimer laser with the wavelength of 248 nm was used for start-up of plasma and shock wave. The excimer laser was used because of several reasons. The first reason is the maximum absorption properties of GaN crystal in UV spectrum range. The second reason is sapphire’s high bandwidth in UV spectrum range. The traditional “CL 5000” laser model possesses the pulse power from 2 to 8 mega Watt, the pulse duration is approximately 50 ns and

plateau of the beam intensity distribution (Fig. 5). To accelerate the production process it’s important to create an uniform illumination in GaN crystal. The optimal pulse power is to be chosen. If pulse energy is exceed the required, the separation does not occur. The crystal is going to melt and crack up due to large quantity of plasma and strong shock wave.

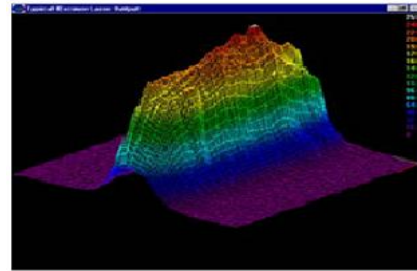


Fig. 5. Plateau of the beam intensity distribution

Another important factor is that lift-off process is to be realized by the single pulse. In case of a several pulses GaN crystal will heat to the melting temperature, the heterostructure of the LED will be damaged. As a result the lift-off process cannot be implemented.

This method of LED production (Fig. 6) will make it possible to achieve the luminous efficiency about 200 LPW without increase in its price. The luminous flux of more than 1000 lumens per one LED can be created. This is going to make breakthrough in lighting.

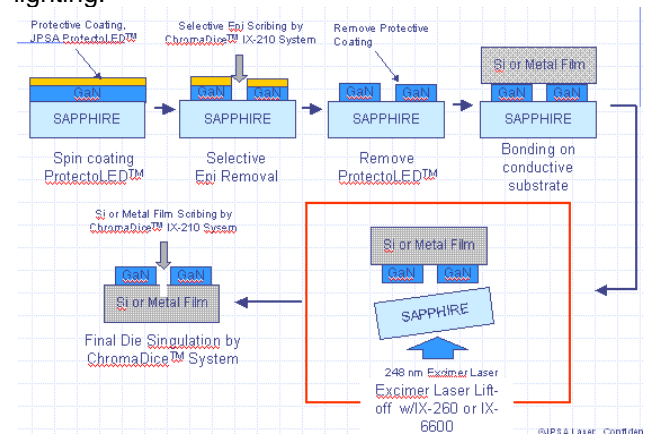


Fig. 6. Method of LED production.

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DIGITAL PROCESSING WITH AUTOMATIC TUNING PARAMETERS

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Constantly increasing role of information technology in the modern world has objectively determined the relevance of the search for new approaches that improve information acquisition and processing [1]. In any digital signal processing system to use certain elements of the preliminary signal conversion is required. It is the main issue for its further digitization. These requirements are strongly marked in the sphere of the high-current electronics.

The article describes a device which allows digitizing signals with the changeable amplitude.

When there are large ranges of processed signal variations, we constantly need to adjust a prior signal conversion.

Fig. 1 shows a simple block diagram of the device which allows carrying out the restructuring of the system when the input signal exceeds the threshold. The input signal is provided to the input voltage converter (VC). Here it is summed up with the constant voltage of positive polarity and definite value to exclude negative voltage at the ADC input.

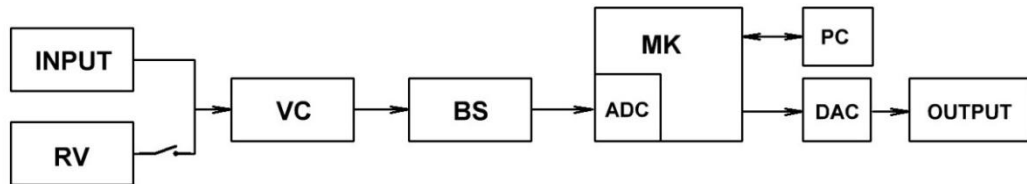


Fig. 1. The block diagram of a digital signal processing: RV - Reference voltage; VC - Voltage converter; BS - Block of scaling; ADC – Analog-to-digital converter; MC – Microcontroller; PC – Computer; DAC – Digital-to-Analog Converter.

From the voltage converter the signal comes to the input of the scaling block. The signal is multiplied by the scaling block transfer ratio to produce a signal with a level not exceeding the threshold voltage of the analog-to-digital converter (ADC). The microcontroller automatically stops the conversion process when the input voltage exceeds the threshold voltage of the ADC.

Then, a digital code of the signal is processed in the microprocessor in accordance with a specified algorithm. The digital code processed by the microprocessor is supplied to the digital-to-analog converter (DAC) input, where the output signal is represented in the form of a continuous analog signal.

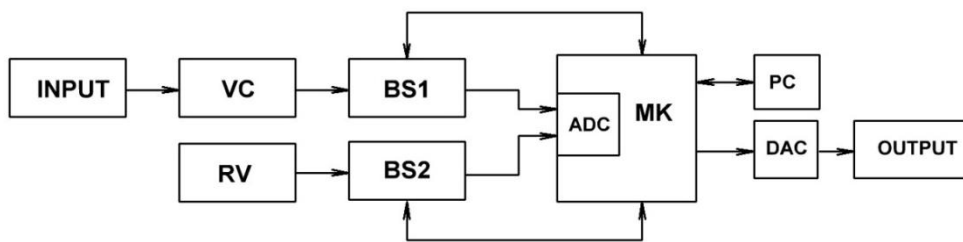


Fig. 2. Digital signal processing block diagram with automatic tuning of parameters: RV - reference voltage, VC - voltage converter, BS - Block of scaling, ADC – analog-to-digital converter, MC - microcontroller, PC - a computer, DAC – Digital-to-Analog Converter.

Fig. 2 shows a block diagram of the device allowing us to carry out the retuning of scaling coefficients automatically. In the circuit two blocks of scaling amplifiers (BS) are used. The first input is supplied with the reference voltage and the second – with the input signal. The microcontroller changes the scaling coefficients BM1 and BM2 blocks due to the change of the digital potentiometer resistance. The signals from the

BM1 and BM2 outputs come to the analog-digital converter input.

The protection system is activated, and ADC shuts down and transfers the input signals to the high-impedance state automatically, when the ADC input voltage exceeds the threshold voltage (3.3V). The microcontroller adjusts the BM1 / 2 blocks transfer ratio by changing the digital potentiometer resistance after disabling the ADC. The processor re-starts the ADC conversion after adjusting the

scaling factor. Therefore, the level of the input ADC signal is controlled.

Fig. 3 shows a schematic diagram of the device implementing the operating principle described

above. The microprocessor TMS320F28335 chip is used as a control block. To digitize an analog signal a 12-bit integrated ADC running at a speed of 12,5 MS / s with 16 multiplexed input is used [2].

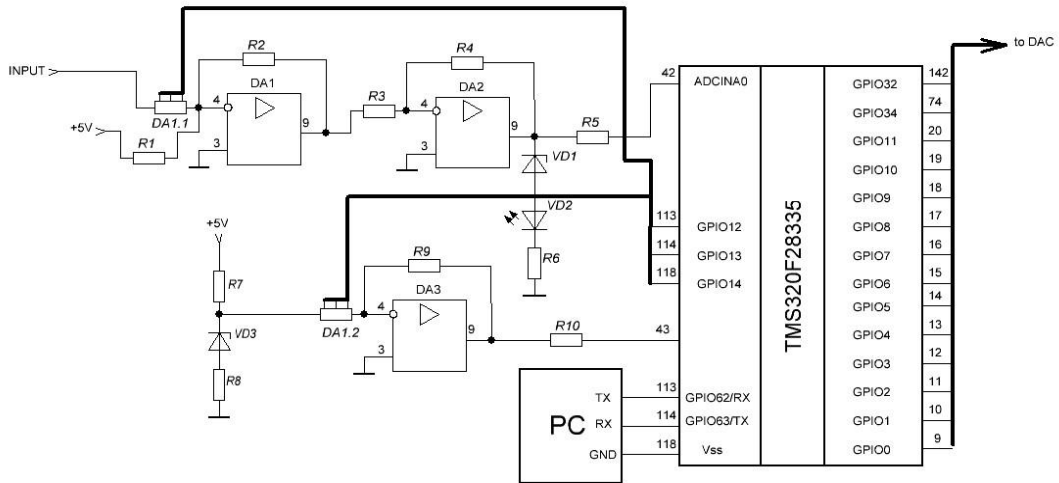


Fig. 3. Schematic diagram of a digital signal processing system with automatic parameter adjustment constructed on the digital processor TMS320F28335 base.

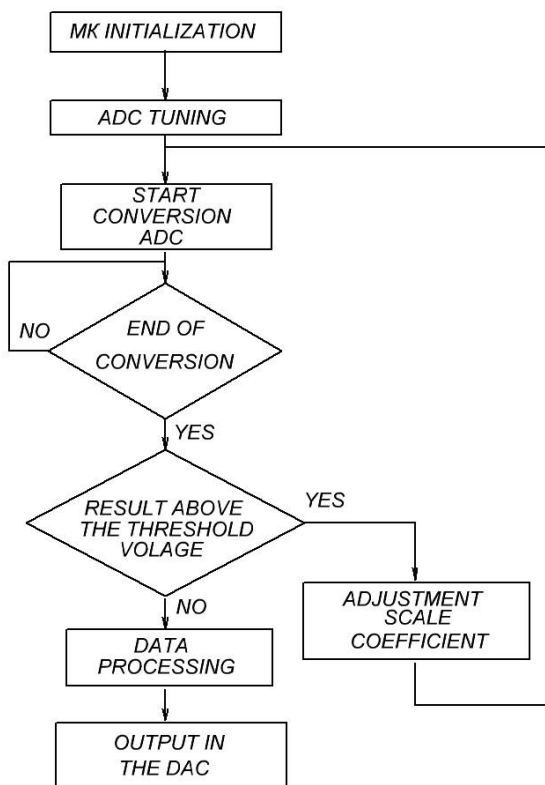


Fig. 4. Digital processor TMS320F28335 algorithm.

Fig. 4 shows the operation algorithm for the microprocessor implementing the automatic adjustment of scaling factors.

Thus, the device presented in the article allows sampling analog signals by automatic adjustment of scaling factors for further processing. Furthermore, the device simplifies a problem of manufacturing digital signal processing.

This work was supported by the Ministry of Education and Science of the Russian Federation, State contract № 7.586.2011

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MICROCLIMATE MONITORING AND CONSERVATION SYSTEM FOR WOODEN ARCHITECTURE IN TOMSK

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Tomsk is one of the oldest towns in Siberia founded in 1604. Until the revolution of 1917 Tomsk was built mainly of wood. For example, in 1810 the town had only 5 stone houses, and in 1855 – 45.

Wooden buildings in Tomsk are the unique world-wide cultural and historical phenomenon, because there are no cities in the world with so large, full-fledged artistic wooden buildings.

The government of Tomsk identified on the map of the city the historical area of 1050 hectares. There are 200 wooden houses on this territory are officially referred to as the monuments of wooden architecture (18 federal, 98 regional and 84 "newly revealed").

All these buildings are united by the same construction material – wood. It is exposed to physical, chemical and biological destruction. The change of properties significantly depends on the conditions rather than on the duration of the construction operation.

The destruction of wood occurs for many reasons: the difference in temperature (outdoor and indoor air), precipitation in the form of rain and snow, wind, sun, etc. Insects and fungi cause the greatest damage to wooden houses. Primarily insects affect humid, porous timber and are found in the joints of logs, because these places accumulate a lot of water and are poorly ventilated. The main fractures are produced by larvae of adult insects, which use wood for their food.

Mould is caused by microscopic fungi spores and affects primarily the wet wood. Mould can develop both in the coating and the wood itself. The growth of fungi occurs at moderate temperatures, presence of moisture and oxygen. Mould usually doesn't do any harm for wood, but it creates conditions for the growth of other fungi.

The blue rot is caused by microscopic spores of coloring fungi, which affect the sapwood of all timber. Blue rot, as a rule, attacks not only the surface layers of wood, but some deeper parts. Blue rot does not influence the structural strength of wood, but it is a favorable environment for other harmful microorganisms growth.

Decay is the most dangerous damage of the wood. Affected by decay, wood loses its stress resistance and mechanical strength. The appearance of mold fungi and blue rot provokes the decay evolution. In wooden houses decay formation occurs under the influence of house

fungi that can moisturize the wood by water arising during the decomposition of cellulose. Therefore, in a poorly ventilated area even dry wood is infected.

Table 1 – Favorable conditions for insects and fungi

| | Temperature, °C | Humidity, % |
|----------|-----------------|-------------|
| Insects | 18-24 | 60-80 |
| Mould | 20 | >90 |
| Blue rot | 25-28 | 35-80 |
| Decay | 18-24 | >25 |

If wood starts rotting, the decayed part, most likely, is to be cut and disposed of. To avoid this, you need to make pre-treatment of wood at the initial stage of construction activities. But if you do not maintain a certain microclimate in the room, the house fungus can completely destroy the house for several years.

As noted above, the primary causes of decay are the blue rot and mould; therefore, having created unfavorable conditions for their uprising, we can considerably reduce the risk of decay. Also we should remember that the optimal temperature of the air at homes for the humans shouldn't be below +18 ° C (in a corner room - not below +20 ° C). In the cold season the optimum humidity is 45-30%; in the warm season – 60-30%.

Table 1 shows that the optimum temperature for the timber, when the risk of blue rot and mold appearance decreases is 18-22°C (the risk of blue rot appearance decreases), and humidity – 30-45% (both the risk of mould and blue rot appearance is reduced simultaneously). When humidity is a little more than 30%, only blue rot can appear. And the risk of its occurrence in this case is very small (it will develop much more intensively if humidity is 60-80%). Moreover, the temperature of 18-22°C, which is optimal for a human, is not favorable for blue rot.

Thus, we can say that the durability of wooden structures depends largely on the microclimate, namely temperature, humidity, and ventilation of the room. Keeping this in mind, there is a need of creation an automated system to monitor and maintain the basic parameters of microclimate.

This system should contain the temperature and humidity sensors, humidifier, the air-conditioning device and heat. If the parameters are deviated from the given ones, the necessary equipment will be switched and return the parameters to optimal values.

To determine the sensors placement location is necessary to make measurements of temperature and humidity in different parts of the premises, i.e. to identify the areas with the highest and lowest humidity, and warmest the coldest places in the house. The sensors should be placed there where humidity reaches the highest point, i.e. in these places mould and blue rot are most likely to appear. Air-conditioning device should be put in the same place. Accordingly, the heating device shall be located in the very cold place. Humidifier can be located in any place.

Let's consider the location of sensors on the example of the house number 31/1 in Tatarskaya Street. This house belongs to the monuments of wooden architecture of the Tatar village. Therefore, there is an actual problem to maintain a satisfactory state of the house, and extend the life time.

After determining the locations with the highest humidity, the sensors are set in these places (Fig. 1).

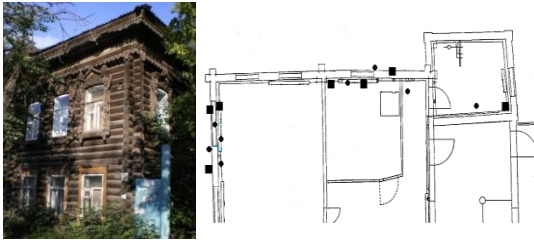


Fig. 1 - Location of sensors in the house number 31/1 in Tatarskaya Street (squares - temperature sensors, points - humidity sensors)

The sensors are also installed outside the house. This allows obtaining accurate information about the temperature and humidity in the street. The LT/LF type sensors, which measure temperature and humidity are used. A temperature sensor is a conventional thermistor (Fig. 2). The humidity sensor is a capacitor with dielectric; its dielectric constant depends on the humidity. These sensors may be connected together, therefore we can get information about humidity and temperature at once [1].



Fig. 2 – LT type temperature Sensor

The information from the sensors is transmitted to the measurement unit, which contains the analog-to-digital converter and the constant-voltage unit. The measurement unit converts analog signals from sensors into digital form, and then transmits this code by the wire to the next block. You can connect up to 12 sensors to one block simultaneously. The blocks are connected in series and form a ring system of data transmission. From the last block output information is transferred to the personal computer (Fig.3).

Monitoring of the information from the sensors is performed with the help of the computer by means of the special computer program «Temperature / Humidity DATA Logger».

This program was developed by the German professor Harald Garrecht specially to visualize the results of measuring temperature and humidity [2].

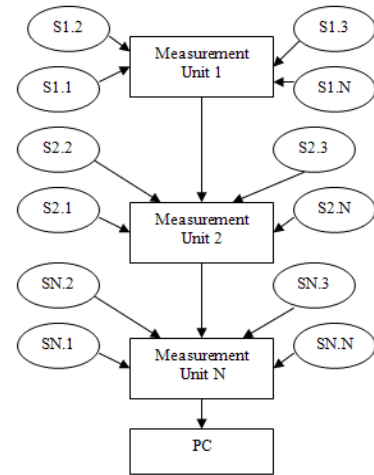


Fig. 3 – Structure of measurement system

This program was developed by the German professor Harald Garrecht specially to visualize the results of measuring temperature and humidity [2].

Every sensor is given a peculiar name. For the sake of simplicity, its name involves the name of a measuring parameter, and location of the sensor. For example «LT Keller» is a temperature sensor in the basement.

This program gives information in a temperature–time and humidity–time diagram (Fig. 4). It is possible to select specific sensors, and the readings will be displayed on the graph. For example, you can choose sensors located in the same room.

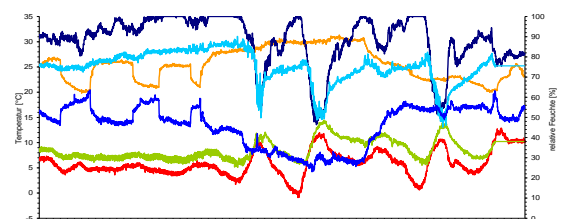


Fig. 4 - Temperature and humidity changes in time in different parts of the premises

T/H DATA Logger automatically saves all measured data to the hard drive. This allows to compare and contrast the readings obtained at different times, and to make a detailed schedule of climate changes.

Thus, using this system we can get accurate data and maintain the optimum parameters of humidity and temperature for each part separately and for the whole house. This monitoring system makes possible to minimize the processes of wood destruction.

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LASER WELDING TECHNOLOGY

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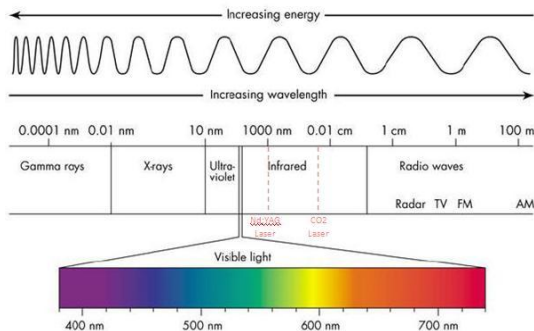
The purpose of the research is to take an up-to-date look at laser welding technology currently being utilized.

During the last decade a number of laser manufacturers in Europe and the USA have started producing laser welders, which are designed solely for a specific industry and application. This has made the technology more affordable and user friendly, and therefore contributed to a wider uptake of the technology.

The focus of this paper is predominantly on laser welding equipment that is affordable and applicable to the majority of manufacturers. The paper will discuss the types of lasers currently available, laser safety, laser applications and the advantages and disadvantages of lasers.

In its basic form a laser produces intense light that can be focused to a precise spot, with enough energy to weld metals. The initial technical factors to consider when selecting a laser source are its Wavelength and Output Power. The wavelength of a laser affects how the beam will react with materials i.e. if the incorrect wavelength is used, the laser beam will just reflect off the surface and have no effect on the metal. To better understand wavelengths and where lasers fit in, we need to take a quick look at the electromagnetic spectrum:

Fig. 1. Electromagnetic Spectrum.



Nd:YAG: Refers to the type of crystal used in the laser, which produces a wavelength of 1064 nm. This wavelength is just outside the visible range of our eyes (400nm to 700nm) so we are unable to see it. However, a laser with the

wavelength of 1064 nm is effectively absorbed by conductive metals, making it ideal for welding. The output powers available for Nd:YAG lasers range typically from 30W to 800 W. Nd:YAG lasers are well established technology, and are currently the most popular for laser welding applications, which require small spot or seam welds with a few millimeters penetration depth.

Due to the wavelength of Nd:YAG lasers being close to our eyes visible range, we can use the same optics to manipulate the laser beam, as for our own eyes. This benefit has resulted in a number of different Nd:YAG laser systems being available, for a range of applications.

These systems can be categorized in the following three groups:

1. Manual Laser Welding: These are usually complete systems with a small welding chamber where the operator holds the piece in their bare hands, or uses basic jiggling. The operator positions the piece whilst looking through a microscope and then fires the laser via a foot peddle. They are ideal lasers for small volume production, and lower budgets. Most manual welders are classified as Class1 (the same as a DVD player), which means they require no additional safety precautions.

2. Semi-Automatic and Fully Automatic Laser Welding: Semi-automatic and automatic laser welders with built in xyz motion and optional rotation axis are used for controlled seam welds, higher volume production and/or higher precision & repeatability. The piece is moved either by a remote joystick or automation software. Often these systems can also be used in the manual mode; however in these instances it is important to ensure the system has not compromised the ergonomics. Added features of these systems are the ability to do incline laser welding, and a visible red pointer laser to aid in automation setup.



Fig. 2. Semi-Automatic and Fully Automatic Laser Welding.

3. Mobile Laser Welding: These lasers are fairly new to the market, and are used where the item to be welded is not easily moved i.e. for large tool and mould repairs. These systems are on wheels and the laser head is positioned on the end of a free moving or motorised arm, so you can take the laser to the work area. Inclined welding is possible on certain models. Due to the higher power requirements of the intended applications, these systems often require 3 phase power.

Fig. 3. Mobile Laser Welding



There are 3 main advantages most people consider when looking to invest in laser technology, which are as follows:

1. Laser technology can allow you to do a process that no other technology can achieve.

For example:

- Welding complex alloys, or dissimilar alloys
- Precise welding of small parts
- Welding in close proximity to heat sensitive components
- Repeatable welds
- Clean hermetic seals
- Solder free welds
- Contact free welding
- Welding complex structures

2. Product improvements:

- Stronger welds
- More visually appealing welds. Consistent welds with no flux used.
- Smaller heat-affected-zone, resulting in less distortion and less strain on neighboring components, increasing product life.
- Competitive advantage

3. Process improvements:

- Reduced preparation time prior to laser welding i.e. no heat treatment
- Faster welding process than alternative technology
- Reduced post welding process i.e. no cleaning of the weld or grinding
- Repeatable results from each operator
- Easy for employees to be trained on and use, no specialized skills required
- Less welding fumes in the process
- Reduced running costs i.e. no expensive solders, non contact and no mechanical wearing parts.

The main disadvantage is the Capital Cost. The cost of a laser welding system can start from just under \$30000 and range up to \$100000. This is less of an issue if the above advantages can be realised when manufacturing high value or high volume products.

The other disadvantage is related to mobility. There have been recent developments in making lasers more mobile, however they are still not as mobile as MIG and TIG welders.

Some people cite laser safety as a disadvantage; however for most applications there are now many laser systems that are correctly enclosed to meet Class1 classification.

In conclusion it should be noted that laser welding continues to become more widely used in our world, and in a growing range of applications.

Nd:YAG lasers are still the most popular choice in areas where small precise laser welds are needed. For applications that require larger welds and more brute force, CO₂ lasers are the preferred choice.

There is now a large range of Class1 enclosed laser welders available designed for a range of specific applications. These lasers are available as manual, semi-automatic and fully automatic systems.

The main advantage of laser welding is that it enables you to produce a product or process that was not previously possible with other technology. Other advantages are centered on improved product quality and reduced process times. The competitive advantages gained from laser welding technology can be balanced against the disadvantages when realized for manufacturing high value or high volume products.

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RESEARCH OF THE WORK OF THE POWER TRANSISTOR KEY WITH APPLICATION OF THE PACKET SIMULINK

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In this text we will describe only the bipolar transistor because this transistor is involved in our scientific research. The work of transistor is observed, and there is some information about it. From all types of transistors only one type, may rely on electric field for management of the form and conductance. This transistor is called a field-electric transistor. For the best representation about this transistor we will consider its kinds. They are divided into the MOSFET, the JFET, the MESFET, HEMT, the MODFET, the IGBT, the FREDFET, the DNAFAD. The MOSFET is Metal–Oxide–Semiconductor Field-Effect Transistor, which consists of SiO₂. The JFET is Junction Field-Effect Transistor, which uses the p-n transition. The MESFET is Metal–Semiconductor Field-Effect Transistor, which uses replacement p-n transition to the transistor Schottky with connection JFET. The MODFET is Modulation-Doped Field Effect Transistor. IGBT is insulated-Gate Bipolar Transistor. IGBT-devices are the compromise technical decision, allowed to unite advantages of bipolar (small power failure of a broach, and high pressure), and MOSFET-transistors (low power of management, high speeds of switching). At the same time losses there grow proportionally to a current, instead of a current square, as in field transistors. This kind of the electric - field transistor will be considered in the practical part. The FREDFET is Fast Reverse or Fast Recovery Epitaxial Diode FET, which is needed for restitution of the characteristic of diode. [2, 4]

In this research work there is a description of the power transistor switch with a package Simulink, a review of the power components of the library SimPowerSystem. It is necessary to look into this package and the library. Subsequently, we will simulate the system of a reactor. In this article we study the Simulink model of IGBT as an example. We have the initial data for the system to work. Now let us consider a better bipolar transistor with an isolated transistor and all its varieties. IGBT combines the advantages of two basic types of transistors: bipolar and field-isolated gate. IGBT combines a lot of advantages from these two transistors. The transistor with isolated-gate has high input impedance, low control power. Bipolar transistor has a low residual stress in the incorporated state. [1]

IGBT combines the advantages of two basic types of transistors: high input impedance, low control power from transistors with insulated gate

low value of residual stress in the ON state-of bipolar transistors. In the IGBT there are positive attributes of BJTs and MOSFETs. BJTs have lower losses when open, especially in devices with high-voltage block, but they have more time to switch, especially when you turn them off, while the MOSFETs can be switched on and off much faster, but their losses of conductivity in the open state are greater, especially in devices designed for higher voltage blocking. As a result, the IGBT has very good characterization. Namely, it has a high speed of switching and lower on-tate voltage drop. IGBT by itself has the characteristic of a bipolar transistor and relay output. It works and is controlled by voltage, as well as MOSFET. In the manufacture of the transistor it has a parasitic element, called a diode. This is a body diode, it reduces the performance of the transistor, so it is very careful when choosing the initial parameters. The other option reduces the parasitic transistor performance, which leads to overheating of the transistor. With this loss there is a breakdown of dynamic gate emitter. For better understanding of IGBT let us turn to the figure which shows graphical notation (Figure 1). [2, 3]

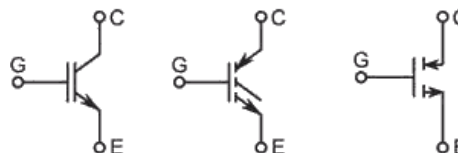


Figure 1. Conditional graphical notation of IGBT-transistor

In our practical part, IGBT was presented on vie1w of the block from the gate, drain, drainage and access for indicating instrument. The indicating instrument is not used, the Simulink block, called the scope is used in the package. The scope shows the graph of the flow of electricity.

Take a closer look with the Simulink package in Matlab. Simulink is an interactive instrument for modeling, simulating and analysis of a dynamic system. It gives facilities to build graphic cell-diagrams, to imitate dynamic systems, to research the functionality of systems and to perfect projects. Simulink contacts fully with Matlab, providing immediate access to wide specter of the instruments of analysis and projecting. Besides the theoretical part, the research contains the practical part. It includes the research of the work

of the power transistor key with application of the packet Simulink.

For the power transistor key we have IGBT module, and the necessary parameters for calculation. This practical part is used for studying of the packet Simulink.

In my work we have analyzed sources of data, which are necessary for further work. Videlicet: the voltage source with internal resistance and inductance, the load of resistance and inductance, frequencies on wide impulse modulation and duration of impulses. As a result I get Closed circuit with module of IGBT. It includes voltage source, two consecutive RL circuits, IGBT module, scope, pulse generator, which is used for giving the control pulse, diode, which is used as a protective device, and ammeter, which is used for measuring current. Closed circuit with module of IGBT is shown in Figure 2.

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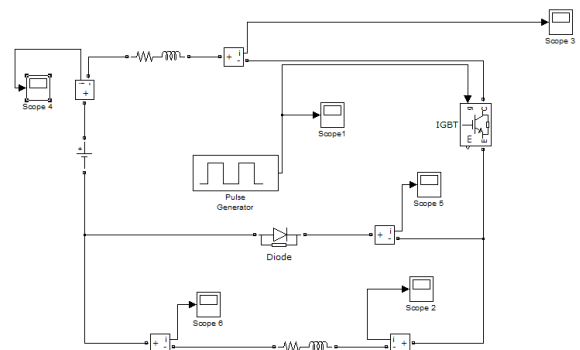


Figure 2. Closed circuit with module of IGBT

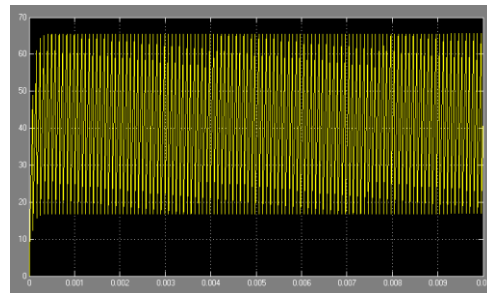


Figure 3. The scope 4

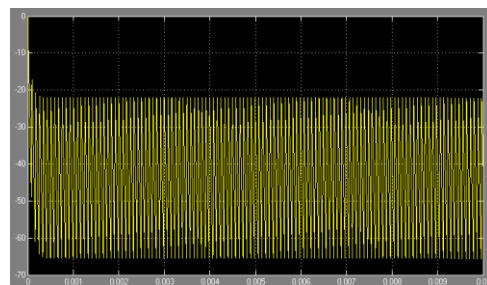


Figure 4. The scope 6

ECONOMIC ASPECTS OF UTILIZATION OF LIGHT EMITTING DIODES

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Nowadays emitting diodes (LEDs) are gaining application in different spheres of life: all kinds of luminous advertising, interior and furniture design, architectural and landscape highlighting, vision panels, displays of large video screens, internal and external lighting of cars, road signs, traffic lights and etc.

LEDs are widely used for lighting since their advantages over traditional light sources (LS) are absolutely obvious: service time of a LED is up to 50 000 h.; its high light efficiency with the resonant-mode power supply is 140 lm/W.

Replacement of traditional lamps by LED is considered to be important due to the fact that LEDs are energy saving light sources.

Nevertheless, economic characteristics of traditional light sources are still better [1].

The cost of a light energy unit (LEU) may be used to make the comparative analysis for different LS (to demonstrate the LS index) [2].

LEU costing can be calculated by the formula:

$$G_{12} = q \cdot \eta_v^{-1} + C_{LS} \cdot (\Phi \cdot \tau)^{-1},$$

where q is the electricity rate [RUR/kW·h], η_v is LS of light efficiency [lm/W], C_{LS} is the cost of LS [RUR], Φ is LS luminous flux [klm], τ is LS service time [h.].

Table №1 shows the characteristics of LEDs in comparison with luminaries produced by "Tegas Electric", (Krasnodar, Russia) [3]. Data for a compact fluorescent lamp (CFL) produced by this

firm, incandescent lamp (IL) by “EISfera” (Moscow, Russia) [4], high-pressure sodium arc lamp (SAL) by “Reflax” (Moscow, Russia) [5], and a linear fluorescent lamp (LFL) by the Dutch firm “Philips” [6] are presented for comparison.

To choose a LED we need to know where it is going to be applied and the characteristics of the object to be illuminated. The parameters of the LED and alternative light sources are to be compared as well.

The cost LEU for different LS varies. It is to be noted that five LEDs luminaries by “Tegas Electric”

(not included into the Table) with equal parameters of P , η_v , Φ and τ , differ in their highest and lowest prices (5330-4250=1080 RUR (26%)). The values for G_{12} (from 51.1 to 43.4) are found to be considerably different as well.

The dependence of LEU on the light efficiency (the left axis) is plotted in Fig. 1; the right vertical axis shows the G_{12} values for LEU, the incandescent lamp with $q=2$ RUR/(kW·h) is taken as a base measurement unit.

Fig.1. Dependence of the cost for LEU (in absolute and relative units) on η_v

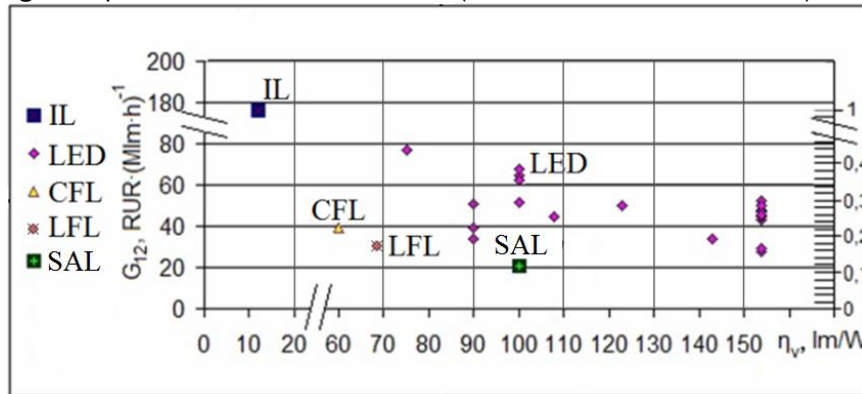


Table1. Cost of LEU G_{12} calculated for LEDs vs. traditional LS: incandescent lamp, compact lamp, linear fluorescent lamp, and high-pressure sodium arc lamp (fragment).

| Trade name of the LS (in italics), and lighting devices (LD) | The main parameters: power, luminous flux, service life, etc. | | | | | G_{12} , $RUR \cdot (Mlm \cdot h)^{-1}$ with q , equal to (for USD it is by [7]) | | | |
|--|---|--------------|----------------|-----------------|----------------|--|------------|-------------|-------------|
| | P, W | Φ , klm | τ , th.h. | η_v , lm/W | C_{LS} , RUR | 2 RUR kW·h | 3 RUR kW·h | \$0.16 kW·h | \$0.12 kW·h |
| <i>LED pear-shaped, E27; D60.</i> | 5 | 0.5 | 35 | 100 | 780 | 64.6 | 74.57 | 3.1 | 2.3 |
| <i>LED pear-shaped, E27; D60</i> | 6.5 | 0.8 | 35 | 123 | 950 | 50.2 | 58.30 | 2.4 | 1.8 |
| <i>LED straight-sided. E14; D65</i> | 5 | 0.5 | 35 | 100 | 750 | 62.9 | 72.86 | 3.0 | 2.3 |
| <i>LED spot. E14</i> | 4 | 0.3 | 35 | 75 | 530 | 77.1 | 90.5 | 3.8 | 2.9 |
| <i>LED tubular-sh. G13; D26</i> | 6.5 | 1 | 35 | 154 | 566 | 29.2 | 35.7 | 1.6 | 1.2 |
| <i>LED tubular-sh. G13/A; D26</i> | 13 | 2 | 35 | 154 | 1050 | 28.0 | 34.5 | 1.5 | 1.3 |
| <i>LED L-shaped G24.</i> | 7 | 1 | 35 | 143 | 700 | 34.0 | 41.0 | 1.8 | 1.4 |
| <i>LED L-shaped E40</i> | 50 | 4.5 | 35 | 90 | 4500 | 50.8 | 61.9 | 2.7 | 2 |
| LD square-sh. 4*600. | 26 | 4 | 35 | 154 | 4250 | 43.4 | 49.9 | 2.1 | 1.6 |
| LD right-angled-sh. 2*1200. | 26 | 4 | 35 | 154 | 4840 | 47.6 | 54.1 | 2.2 | 1.7 |
| LD right-angled-sh. 2*600. | 13 | 2 | 35 | 154 | 2760 | 52.4 | 58.9 | 2.4 | 1.8 |
| LD right-angled-sh. 1*1200. | 13 | 2 | 35 | 154 | 2400 | 47.3 | 53.8 | 2.2 | 1.7 |
| LD right-angled-sh. 2*1200. | 26 | 4 | 35 | 154 | 4500 | 45.1 | 51.6 | 2.1 | 1.6 |
| LD right-angled-sh. 1*600. | 6.5 | 1 | 35 | 154 | 1300 | 50.1 | 56.6 | 2.3 | 1.7 |
| LD right-angled-sh. 2*600. | 13 | 2 | 35 | 154 | 2300 | 45.9 | 52.4 | 2.1 | 1.6 |
| LD round-sh.; D241/115. | 7 | 0.7 | 35 | 100 | 1180 | 68.2 | 78.2 | 3.2 | 2.4 |
| LD L-shaped; 510/240/200. | 100 | 9 | 35 | 90 | 5500 | 39.7 | 50.8 | 2.4 | 1.8 |
| LD L-shaped; 630/275/112. | 120 | 13 | 35 | 108 | 11999 | 44.8 | 54.1 | 2.4 | 1.8 |
| LED module; 6.5W. | 6.5 | 1 | 35 | 154 | 580 | 29.6 | 36.1 | 1.6 | 1.2 |
| LED module; D54; 5W. | 5 | 0.5 | 35 | 100 | 550 | 51.4 | 61.4 | 2.6 | 1.9 |
| LED module; 140/95/2. | 50 | 4.5 | 35 | 90 | 1820 | 33.8 | 44.9 | 2.2 | 1.7 |
| IL general-purpose | 60 | 0.7 | 1 | 12 | 6,6 | 175.8 | 259.2 | 13.6 | 10.2 |
| TL-D 36W/33-640; 36W | 2.5 | 2.5 | 12 | 69 | 51 | 30.5 | 44.9 | 2.4 | 1.8 |
| SAL-150 E40 | 150 | 15 | 28 | 100 | 454 | 21.1 | 31.1 | 1.6 | 1.2 |
| CFL LDip. E27. | 85 | 5.1 | 15 | 60 | 449 | 39.2 | 55.9 | 2.9 | 2.2 |

Conclusion

The cost of LEU for LEDs is lower than that for incandescent lamps; however, it is noticeably higher than the cost of compact, linear fluorescent lamps, and high-pressure sodium arc lamps. If we take LEU cost for LEDs equal to one unit, the cost for an incandescent lamp is 3.7, for a linear fluorescent lamp it is 0.6, for a compact fluorescent lamp and high-pressure sodium arc lamp the cost is 0.8 and 0.4, respectively.

No absolute superiority of LEDs over traditional LS can be observed. However, LEDs are being rapidly developed and in the near future they may become dominant.

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LASER DOPPLER VELOCITY AND LENGTH OF EXTENDED PRODUCTS AND METHODS OF SIGNAL FILTERING

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Accurate and reliable measurement of velocity and length of cables, wires and optical fibers is an important factor in improving the efficiency of manufacturing processes, cutting and commercial metering products in the cable industry.

Traditionally used mechanical contact devices based on the measuring roller and track belts do not meet modern standards of accuracy, speed and reliability. Moreover, they have certain limitations of their application, e.g. for high temperature adhesives and deformable materials [1].

Nowadays different models of laser Doppler velocity and length (LDMS) are offered. Optical measuring instruments based on the raster analyzer and a CCD-camera (charge-coupled devices), which apply incoherent light sources, time-pulse and correlation meters, are not so widely spread.

At present, the majority of Doppler meters are acquired abroad and due to the variety of expenses, in addition to the cost of the device, such purchase is considered to be fairly expensive. Therefore, the development and market introduction a Russian equivalent of LDMS is an urgent and viable issue.

The main objective of this development is the creation of the instrument, whose technical and metrological characteristics are no inferior to national and foreign counterparts.

All industrial LDMS are based on the differential optical scheme. According to this scheme, in the LDMS optical unit a laser beam is divided into two approximately equal power beams. These beams are then dimensionally spread. Two coherent beams that converge at a slight angle come out of the optical block. In the spatial zone of ray crossing the interference light lattice is formed on the object's surface. The passage through this area of the object causes the dispersion of laser light with a frequency which is not equal to the frequency of the incident light. According to the Doppler Effect, there is a dependence of the reflected wave frequency on the velocity of the object and knowing the light source wavelength we can calculate the velocity of the object.

The laser beam separation technique in the optical unit has considerable importance. If the beam is divided by a semitransparent mirror, the meter does not determine the object travel direction. If the separation is performed by means of an acousto-optic modulator (Bragg cell), the meter is able to determine the direction of motion.

Recognition of the direction of the cable on the production line is a significant advantage [2].

As a result of the Doppler Effect, laser radiation dissipated over the object is shifted in frequency proportional to its velocity. In the research work a semiconductor light-emitting diode is used as a light source. As a receiver a photodiode is applied.

In the first LDMS models gas lasers used as a radiator determined the large size and relatively high cost of the equipment. They were mainly used in the steel industry in terms of management systems, cutting control, and hot and cold rolling.

At present, the transition to semiconductor lasers (PPL) allowed to bring down the cost of LDMS, reduce the size of the sensor and to increase its reliability. This, in its turn, made it possible to expand the scope of LDMS application radically [3].

The work done by the moment can be divided into several stages. At the initial stage of the project a mathematical model to estimate and calculate the basic characteristics of the optical system unit was developed. There were also constructed the plots showing the dependence of Doppler frequency of the scattered light on the velocity of the object, the wavelength of the laser beam and its incidence angle.

In the basic case, the Doppler frequency can be found on the basis of the following formula (1). If interference bandwidth is:

$$\Delta S = \frac{\lambda_0}{2 \sin \varphi}, \quad (1)$$

and band repetition frequency (2) is:

$$F = \frac{|V|}{\Delta S}, \quad (2)$$

the Doppler frequency (3) is given by:

$$F = \frac{2 \cdot |V| \cdot \sin \varphi}{\lambda_0}, \quad (3)$$

where F - the Doppler frequency; λ_0 - the wavelength of the PPL; φ - angle of incidence relative to the normal.

Having analyzed the data obtained from mathematical modeling, it was decided to use the high-speed diode with a wavelength of 600 nm and power of 210 mW, a photodiode with a cut off frequency of 10 MHz and to set the angle of incidence equal to 12°.

The next stage in the research was the creation of the experimental setup of the device, including optical design, electronic circuit simulator, and a moving object. The block diagram of the experimental setup is shown in Fig. 1.

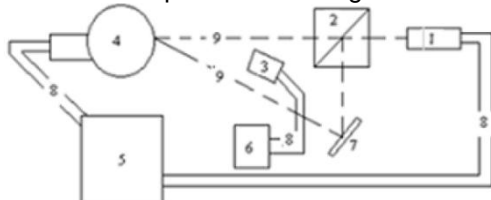


Fig.1 Block diagram of the experimental setup: 1 - laser; 2 - prism-divider; 3 - photodiode; 4 - a rotating disk; 5 - power-supply circuit; 6 - analysing and signal processing unit; 7 - mirror; 8 - connecting wires; 9 - ray path.

At this development phase the experimental model assembling is being finished, the components are being rearranged, and, thereby, the signals received from the detector are being analyzed.

Since the Doppler signal is a sequence of pulses with random amplitudes and moments of advent (phases), it is accompanied by the noise of the radiation source, a photo detector and the input amplifiers of the electronic processing system. As a result of the Doppler signal processing either static characteristics of the process or a signal proportional to the instantaneous values of speed will eventually be introduced. Doppler signal processing systems include spectrum analyzers, tracking filters, frequency demodulator with feedback frequency, as well as systems of discrete frequency measurements (countable pulse frequency demodulator). Due to the processing an analogue or digital signal proportional to the instantaneous values of speed is produced, which is later exposed to further transformations [4]. Since the basic information about the desired speed is contained in the high-frequency part of the signal, a band pass filter becomes an essential part regardless of the principle of the Doppler signal electronic processing system. The purpose of a band pass filter is to suppress noise and photo detector constant component.

The main objective of the research is to separate the Doppler frequency. At first, it is necessary to detect this component, and then treat the data obtained by means of a logical block. In the simplest case, a signal processing unit is a comparator operating at a Doppler frequency and organising the required TTL-level signal. The logical unit should be able to calculate the signal frequency received from the comparator, the velocity of the object and its length over a certain period of time. Finally, we get a new promising device in the sphere of automation/robotization.

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MICROPROCESSOR ANALYZER FOR MEASURING COLOUR COORDINATES OF POLYMERIC OPTODES BY RGB SENSOR

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Key words

Polymeric optode, colorimetric scale, digital color analysis, color coordinates, RGB sensors, metrological characteristics

Introduction

The technique of digital colometric analysis (DCA) using optical sensors (optods) [1] is presented in the patent [2]. The dependence of optode color difference on the concentration of the substance being tested is used in the analysis. For defining the optode color coordinates and subsequent computer processing, the designing of hardware and software is required which makes it possible to carry out the substance concentration analysis not only in special laboratories, but in the field conditions.

Main part

The device developed is used for measuring the color of transparent polymeric optodes. Microprocessor analyzer includes the following blocks:

- a) gage unit with red-green-blue (RGB) sensor [3]. This unit contains current to voltage transformer and four white Light Emitting Diodes (LEDs);
- b) AVR ATmega 128 microcontroller intended for LEDs turning on and off, digitizing the analog voltage and transferring code derived into the Personal Computer (PC) memory [4];
- c) FT232RL chip providing analyzer and PC connection via USB interface [5];

Experimental analyzer prototype and control program front panel are shown in fig. 1 and 2.

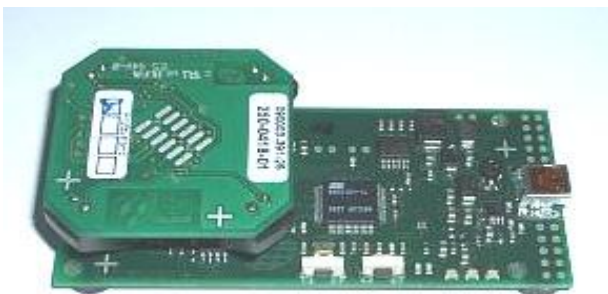


Fig. 1. Experimental prototype of analyzer

For the analyzer in this scheme the AVR ATmega 128 microcontroller which houses 128 kbyte EEPROM and 10-byte Analog-to-Digital

Converter (ADC) of serial transformation was selected. This makes it possible to lower the cost of the device developed as compared with the prototypes (e.g. the evaluation board of MAZET GmbH Company[3]).

For controlling the measurement process and inputting the data into the PC memory with subsequent processing, the control program in the form of Virtual Instrument (VI) was developed (Fig.2).

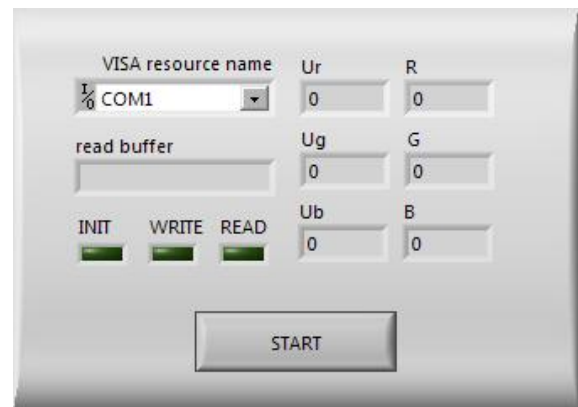


Fig. 2. Control program front panel

This program is included into the software complex implementing the data processing and visualizing and the evaluating the substances concentrations defined [7].

The device connection port is chosen in the "Visa resource name" inlay to connect analyzer with PC (e.g. COM 1.), Fig.2.

The "read buffer" window is used for visualization of the information. In this window the accepted data in hexadecimal format are displayed. "Ur", "Ug" and "Ub" indicators display the voltage level taken from gage unit for red, green and blue channels accepted from the measuring block. In "R", "G" and "B" windows the measured optode colours are presented in the 24-bit RGB code.

Analyzer and control program operates in the following sequence:

- Initializing the control program interface in PC memory;
- Calibrating the RGB sensor;
- Setting-in the optode investigated;
- PC command to start measuring;
- On receiving the PC command microcontroller generates the voltage for LEDs

glowing which enlighten the optode within the set time interval (20 – 30 ms);

– The light reflected from the base plate goes through optode. Then it gets on the RGB sensor and is transformed into red, green and blue channels photocurrent.

– Operating amplifier transforms photocurrents into corresponding voltages (U_r , U_g and U_b). Then, they are digitized by a microcontroller's ADC. And the codes obtained are transmitted by an USB interface into control program housed in the PC memory where they are transformed into color coordinates (24-byte RGB –code).

Since the measurement is performed only once, the microcontroller switches to stand-by mode and is waiting for the command to measure.

The analyzer is supplied from +5 B via USB port permitting to be switched on to notebook and to eliminate searching for additional power supplies for operating the device developed.

Implementation and prospects

The device developed is intended for defining color coordinates of transparent optical sensors with consequent defining the quantity of the substance being analyzed by color scale.

Using RGB sensors makes it possible to change-over from bulky and expensive measuring instruments to more compact and cheap instruments preserving their high metrological characteristics.

This device can be applied in different fields of national economy, chemistry, and medicine, as well as helps organize express analysis in the field conditions.

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| Section III | |
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**TECHNOLOGY, EQUIPMENT
AND MACHINE-BUILDING
PRODUCTION AUTOMATION**

NEW WELDING TECHNOLOGIES IN THE SHIPBUILDING

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The objective is to overview the material about new technologies welding used in the shipbuilding. Welding is defined as “a jumping process that produces coalescence of materials by heating them to the welding temperature, with or without the application of pressure alone, and with or without the use of filler metal. Modern welding techniques are employed in the construction of numerous products. Ships, buildings, bridges are fabricated by welding processes. Welding is also used extensively in the manufacture of automobiles, farm equipments, home appliances, computer components, mining equipment. Hundreds of products we use in our daily life are also joined together by some type of welding processes. Before welding, ships were being constructed by using clinches. Currently there are many traditional technological methods used in shipbuilding:

- *Shielded Metal Arc Welding (SMAW)*. This method is also known as Manual Metal Arc Welding or Stick Welding. An arc welding process in which coalescence of metals is produced by heat. The heat comes from an electric arc that is maintained between the tip of a covered electrode and the surface of the base metal in the joint being welded [2].
- *Submerged Arc Welding (SAW)*. Submerged arc welding is a method in which the heat required to fuse the metal is generated by an arc formed by an electric current passing between the welding wire and the workpiece. The tip of the welding wire, the arc, and the workpiece are covered by a layer of granulated mineral material known as submerged arc welding flux [6].
- *Gas Metal Arc Welding (GMAW)*. GMAW, by definition, is an arc welding process which produces the coalescence of metals by heating them with an arc between a continuously fed filler metal electrode and the work. The process uses shielding from an externally supplied gas to protect the molten weld pool [1].
- *Gas tungsten arc welding (GTAW)*. Gas Tungsten Arc Welding (GTAW), also known as tungsten inert gas (TIG) welding is a process that produces an electric arc maintained between a nonconsumable tungsten electrode and the part to be welded. The heat-affected zone, the molten metal and the tungsten electrode are all shielded from atmospheric contamination by a blanket of inert gas fed through the GTAW torch [1].
- *Oxyacetylene Welding (OAW)*. The oxyacetylene welding process uses a combination of oxygen and acetylene gas to

provide a high temperature flame. When mixed together in correct proportions within a hand-held torch or blowpipe, a relatively hot flame is produced with a temperature of about 3,200 °C [3].

Along with traditional methods new improved methods of welding have appeared nowadays. They are ceramic welding, robotic welding.

Ceramic Welding. In recent years, especially for the shell plate of the vessels, ceramic welding is being started to be used as a welding technique. The welding is being done by using ceramic weld backings. X-ray quality, full penetration welds from one side and in a single pass can be achieved with this method. On the other hand, finished high quality weld and savings of labor, materials and time are also been achieved [1]. Weld backings can be used to compensate for poor fit-ups, and is valuable when welding conditions are not ideal or where the back side of a weld joint is inaccessible. In the ceramic welding the welder should do root opening. Then backing is applied on the material and welding starts. After finishing welding process, ceramic backing should be removed. This method is applied for welding of the shell plates of the ships. High quality, full penetration, time and economical savings can be achieved with this method. Therefore the delivery times of the projects are being shortened [5].

Robotic Welding. Robots are used in a wide range of industrial applications. The earliest applications were in materials handling, spot welding, and spray painting. Although the automotive industry is the major user of robotic welding, the usage of robotic welding is also improving in the shipbuilding industry day by day. The two basic welding types in shipbuilding are spot welding and arc welding. Arc welding robot is one of the most common functions in industry today. During this process, electricity jumps from an electrode guided through the seam, to the metal product. This electric arc generates intense heat, enough to melt the metal at the joint. For the robotic arc welding system, much more controller is also required. The automated welding has begun improving upon manual welding in the industry due to increasing speed, quality and throughput. The shipbuilding industry is suitable for the robotic welding. The robot welding automation is much safer and more cost-effective. The welding can be done completely at the unreachable areas. Due to the automation, the faults regarding human factors will not be come across with this method.

For the first time in the world the compact and intellectual welding robot which intuitively and automatically does welding works, was designed and developed. Robot beforehand knows which welding work it's going to make. It knows what kind of features of welding construction it's going to meet in the process, and after it defines these features through its sensors it starts welding according to the rules. The robot observes the whole welding process [2].

In case of service (for example cleaning or changing the oil) process is being severed and robot automatically moves in the service position. Here the operator does the whole service. Then robot comes back to the position to renew the welding process. That's why the use of robot needs the minimum of operator's preparation. It guarantees optimal work. One operator can work with 4 robots at the same time using the simple user interface. Have entered a new period, and have opened possibilities which seemed impossible only some years ago. Our European partners managed to establish new standards for application of the welding robot for the heavy industry by system engineering which isn't limited to classical rules and traditional technologies [1].

In understanding of all area of welding, «Inrotech» has developed a product which combines high technologies and simplicity in work that moves the robotized technologies from experts for usual people.

It became possible, not to endow flexibility and reliability, and to work even with the increase of these parameters. Automation in close places where access by means of welding robots didn't go right till now, now became possible with a compact and mobile robots «Inrotech». The robot completed with the welding device, the block of management and cables moves on a simple monorail through hatches. There are no more sick knees, back traumas and a welding smoke in lungs. The robot takes all pain up and all bad working conditions for operators now concerned to the past. Seldom robots were more salutatory among welders [4].

The expectation of a recouperment within one year meant that OSS, without fluctuating, invested in the project of automation with mobile welding robots though necessary indirect investments of the manufacture have made almost half of the budget.

Profitability improvement from Inrotech has given the Mobile robotized decision even more

than it was supposed. Besides the reduction of time of welding, there was a considerable improvement of internal logistics and a production cycle. Because of the innovative decision, it was possible for OSS to automate problems which were impossible earlier. Labor-consuming welding problems are made faster now, it is better and with smaller quantity of direct labors, than earlier [7].

The bulk ship Blocks of ballast tanks which represent a double bottom of the bulk ship, in the size about 32 x 16 m., and consist of 48 closed premises in which there is an access only through hatches in the size of 60x80. Robotics systems get through these hatches, weld 90 % from total number of welding works. Robots turn from the platforms located on the end of each block of a vessel [1].

Today welding robots and ceramic welding are intensively used not only in shipbuilding industry; also it's very effective in car-building, tank-building and other branches of industry. They are properly new, economically effective. Robotic technology meets quality, cost and delivery requirements and also offers flexibility in welding. Potential safety hazards associated with arc welding include arc radiation, air contamination, electrical shock, fire and explosion, compressed gases, and other hazards. Robots can replace humans in the performance of dangerous jobs and are considered beneficial for preventing industrial accidents. The welding robot is one of the most difficult mechanisms. There's a row of companies manufacturing welding robots, for example Austrian IPSHandelsGmbH, Japanese FANUC CORPORATION, Kemppi, ESAB, LincolnElectric, ITS-engineering, etc.

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EFFECT OF CUPRUM ON THE MICROSTRUCTURE AND PROPERTIES OF IRON-BASED HARDFACING ALLOYS DEPOSITED BY PLASMA TRANSFERRED ARC PROCESS

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1. Introduction.

Iron-based alloy coating has been used widely due to its higher hardness and wear resistance, especially its lower cost compared to nickel-based and cobalt-based alloy coatings [1]. Nevertheless, traditional Fe–C–Cr alloy coating could not be used at elevated temperature for its bad wear resistance at this temperature. Therefore, the alloy elements, such as vanadium, niobium, tungsten and molybdenum were added into iron-based alloy powder in order to increase its wear resistance at elevated temperature, but the high cost could not be prevented [2].

The solubility of copper in austenite is relatively high, but its solubility in α -Fe is low. Depending on the copper content and heat treatment, the precipitation of the ϵ -Cu occurs in ferritic and ferritic–austenitic stainless steels [3]. The presence of the ϵ -Cu in ferrite increases the hardness and wear resistance of ferrite steel. Unfortunately, the early work mainly focused on the utility of copper in the steel, little attention has so far been paid to the application of copper in the iron-based alloy coating deposited by plasma transferred arc process. Especially to the application of Rietveld refinement method in this coating has not been reported still now. The effects of different heat treatments on the iron-based alloy coating with 3 wt.% copper have been conducted. It has been found that the highest hardness and the best sliding wear resistance could be obtained when the deposited coating was aged at 773 K for 35 h. In this paper, therefore, the detailed information about the effect of the heat treatment at 773 K for 35 h on the microstructure and properties was investigated.

Moreover, in order to investigate the relationship between the ageing treatment and the phase contents, Rietveld refinement method was conducted to analyze X-ray diffraction spectra.

2. Experimental procedures.

The PTA process was performed using a L4-400PC apparatus. The atomized iron-based alloy powder used in this experiment was spherical in shape with a size of 45–105 μm , the chemical composition is given in **Table 1**. The substrate was 200.35.20 mm³ annealed low carbon steel plate whose composition is listed in **Table 1** and has not been preheated before PTA treatment. The

substrate was rinsed with ethyl alcohol just before the PTA process. The 3 wt.% copper powder with a size of 50–110 μm having a purity of over 99.5% was added into the iron-based alloy powder. Detailed PTA process conditions, as listed in **Table 2**, were optimized in terms of dilution, surface hardness and deposition thickness after several experiments. Ageing treatment of the as-deposited coating was performed in a chamber furnace under argon atmosphere. The deposited coating was held at 773 K for 35 h and subsequently cooled to room temperature. The as-deposited and as-aged specimens for metallographic examination were first cut perpendicular to the coating surface with a wire cut machine. The cross-sections of the coatings were polished by mechanical procedures and were etched using nitromuriatic acid. Then the microstructures of the coatings were studied by means of optical microscope and SEM.

Microhardness for the cross-section was conducted using a HV-1000 machine loaded at 0.1 kgf. Sliding wear resistance was evaluated on a ring-block sliding wear machine loaded at 5 kg during the wear test. Weight loss was measured to within 0.01 mg and the average value for each specimen was calculated using three data.

3. Results.

In the present work, the Fe–Cr–C–Cu coating deposited by PTA process consists of α phase with b.c.c crystal structure, M23C6 with f.c.c crystal structure, and M7C3 with orthorhombic crystal structure. The ageing treatment at 773 K for 35 h leads to the precipitation of ϵ -Cu particles. The ϵ -Cu particles with different sizes block the movements of the dislocations.

Figs. 1 and 2 show the microhardness and wear resistance properties of the deposited coatings. It can be found that the microhardness and wear resistance for the as-aged coating are higher than those for as-deposited coating. The relative contents of the total Cr-rich carbides in the as-aged coating (28.7 wt.%) are higher than those in the asdeposited coating (22.8 wt.%). Meanwhile, as discussed above, ϵ -Cu particles precipitated from the martensite matrix when the deposited coating was aged at 773 K for 35 h. Furthermore, the ϵ -Cu particle blocks the movement of the dislocation, enhancing the strength of the as-aged coating. All these results are beneficial to increase the microhardness and the wear resistance.

Table 1
Chemical compositions for the iron-based alloy powder and the substrate (wt.%)

| | C | Si | B | Mn | Cr | Ni | Fe |
|-------------------------|------|------|-----|------|----|----|------|
| Iron-based alloy powder | 0.5 | 3 | 1.6 | – | 18 | 8 | Bal. |
| Substrate | 0.12 | 0.30 | – | 0.45 | – | – | Bal. |

Table 2
Experimental conditions for PTA process

| Parameters | Units | Value |
|-------------------------|-------------------|---------|
| Transferred arc current | A | 180–190 |
| Transferred arc voltage | V | 30–32 |
| Main gas pressure | MPa | 0.3 |
| Ion gas flow | m ³ /h | 0.4 |
| Powder feed gas | m ³ /h | 0.2 |
| Powder supply | g/min | 63 |
| Oscillation rate | times/min | 20 |
| Travel speed | mm/min | 110 |
| Cooling water pressure | MPa | 3 |
| Torch gap | mm | 7 |

4. Conclusion.

- (1) The ageing treatment at 773 K for 35 h leads to the precipitation of ϵ -Cu particles. The ϵ -Cu particles with different sizes block the movements of the dislocations. The relative contents of the total Cr-rich carbides increase from 22.8 wt.% to 28.7 wt.%, but the relative content of the α phase decreases after the ageing treatment.
- (2) The ageing treatment at 773 K for 35 h can increase the microhardness and the sliding wear

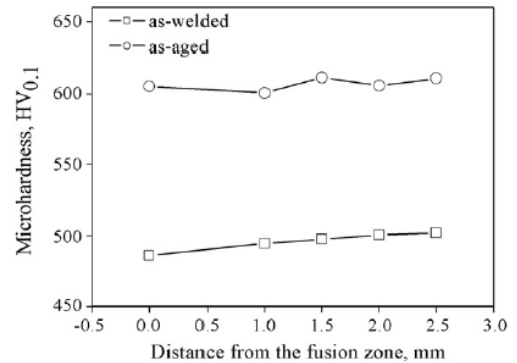


Fig. 1. Microhardness of the Fe-C-Cr-Cu coatings

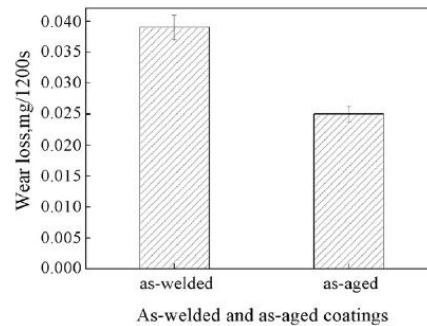


Fig. 2. Sliding wear resistance of the Fe-Cr-C-Cu coatings.
resistance of the Fe-Cr-C-Cu coating deposited by PTA process.

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MODELING OF WELDING WITH A MOVING LASER

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Introduction

Mathematical modeling opens wide perspectives for many areas of science and technology. For the first time it was used in nuclear and aerospace spheres. At present, mathematical modeling has penetrated into all branches of

natural sciences and in the spheres of human activity, such as oil and gas production, transport, socio-economic sphere, medicine, etc.

COMSOL Multiphysics is a powerful interactive environment for modeling and calculating the majority of scientific and engineering problems

based on differential equations in partial derivatives (PDE) finite element method.

Main purpose of this work is to model the process of welding with a moving laser in COMSOL Multiphysics.

Modeling of process

Laser beams are commonly used to heat locally the surface of various substrates, for example, in laser welding or thermal annealing such as on layered silicon devices. The laser beam typically moves over a surface periodically to produce the desired localized heating. In the case of layered silicon devices, each layer is very thin; making the modeling of the penetration depth caused by the moving laser a strongly time-dependent problem.

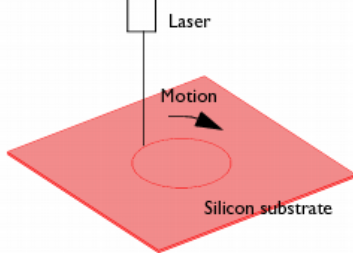


Figure. 1. A moving laser heats a thin silicon substrate

The simplest example model, the localized transient heating, caused by a laser beam that moves in circles over a silicon substrate is considered. The beam's penetration depth, which can be described with an absorption coefficient, depends on the ambient temperature. The geometry under study represents the top layer of a silicon device. The model examines the penetration depth and the influence of the laser motion on the transient temperature distribution.

This model considers the laser beam as having an infinitesimal width and thus treats it as a line heat source. As such it is not meaningful to study the maximum temperature because it is mesh dependent. However, the overall heat flux and temperature distribution on a macroscopic level are both accurate.

Model Definitions:

The model simulates the substrate as a 3D object (fig 1) with these dimensions:

- Thickness: 1 mm
- Width: 10 mm-by-10 mm

It handles the variation of laser intensity with penetration depth using a 1D geometry that represents the substrate's thickness (fig. 2).

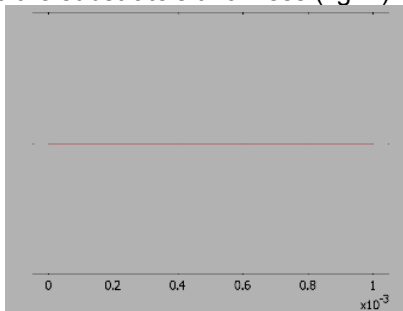


Figure. 2. The 1D model geometry

The model makes use of the Conduction application mode to describe the transient heat transfer in the 3D geometry. The transient energy-transport equation for heat conduction is

$$\rho C_p \frac{\partial T}{\partial t} + \nabla \cdot (-k \nabla T) = Q,$$

where ρ is the density, C_p is the specific heat capacity, k is the thermal conductivity tensor, and Q is the heat source term, which is here set to zero (this case models the source in a different way).

The material properties are those of silicon, using an anisotropic conductivity of $(k_{xx}, k_{yy}, k_{zz}) = (163, 163, 16)$ in units of $W/(m \cdot K)$, a density of 2330 kg/m^3 , and a specific heat capacity of $703 \text{ J/(kg} \cdot \text{K)}$.

For the model, assume the boundaries are insulating.

In the 1D geometry, this model uses the Weak Form, Subdomain application mode to model the laser penetration. In the equation describing the penetration

$$\frac{\partial I}{\partial x'} = -k_{abs} I.$$

I represents the relative laser intensity (the variable in the Weak Form, Subdomain application mode), x' represents the 1D coordinate, and k_{abs} is the absorption coefficient. The absorption coefficient can be dependent on the temperature, and the expression used in this model is

$$k_{abs} = 8 \cdot 10^3 \text{ m}^{-1} - 10(m \cdot K)^{-1} (T - 30K).$$

The volumetric heat source term, Q , in the 3D geometry is then

$$Q = P_{in} k_{abs} I,$$

where P_{in} is the total power of the incoming laser beam.

Both of these equations are included in the Weak Form, Subdomain application mode; where they become one equation

$$I_{test} \cdot (Ix - k_{abs} \cdot I) + k_{abs} \cdot I \cdot P_{in} \cdot T_{test}.$$

The first part of this expression describes the penetration equation, and the second part comes from the heat-source term in the 3D Heat Transfer application mode.

At the left boundary, homogeneous Neumann condition should be applied, and at the right boundary the relative intensity should be set I , to unity. The total incoming laser power, P_{in} , is 50 W.

The model implements the heat source's motion when coupling the 3D temperature variable, T to the 1D equation. It does so with a subdomain extrusion coupling variable using a general transformation. A time-dependent transformation

expression results in a moving heat source. This case describes a circular repeating motion using the transformation expressions

$$x = R \sin(\omega t), y = R \cos(\omega t), z = x',$$

where $x, y,$ and z correspond to the 3D coordinates, and x' represents the 1D coordinate. Furthermore, R is the radius of circular motion ω is the angular velocity, and t is time. The model uses the parameter values $R = 0.02$ m and $\omega = 10$ rad/s, the latter value corresponding to a period of roughly 0.628 s for the laser motion.

This method - using a separate geometry and equation to model the source term - is very useful because it provides that term directly at the test-function level. Furthermore, it models the source motion separately with the transformation expressions, making it simple to alter. It is indeed the best way to model a moving point or line source. The 3D model makes use of an extruded triangular mesh, which has a fine resolution close to the laser incident line and is coarse elsewhere. This results in a high-resolution solution with minimum computation requirements. The mesh results in around 10,000 elements and 6200 degrees of freedom (fig 3).

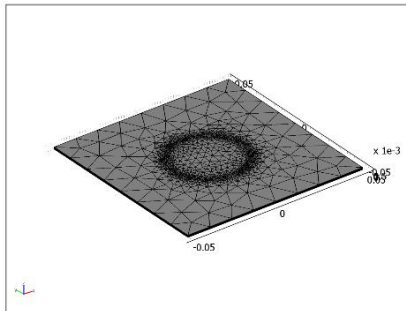


Figure 3. The 3D mesh produced by extruding a 2D triangular mesh, refined along the circular laser incident line

Results and Discussion

Figure 4 depicts the temperature distribution at the laser-beam incident surface (fig 4).

The figure clearly shows a hot spot where the laser beam is located at a specific time. Furthermore, the results show a cold side and a warm side next to the vertical line below the laser beam. The warm side represents the area where the beam has just swept through.

After creating a simple model, it can be complicated and changed by various options. For example, you can change the trajectory of the laser welding, the ambient temperature. Then you can carry out experiments that are impossible in reality: to change the initial coefficients, experiment with the size of the laser and other characteristics.

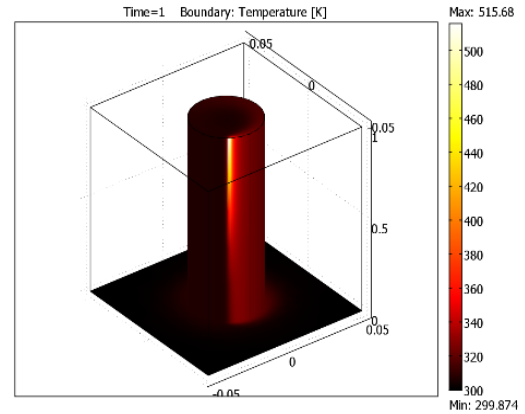


Figure 4. Temperature distribution after 1 s of laser heating

Finally, Figure 5 shows beam penetration into the substrate. The heating at the bottom of the substrate is practically zero (fig 5).

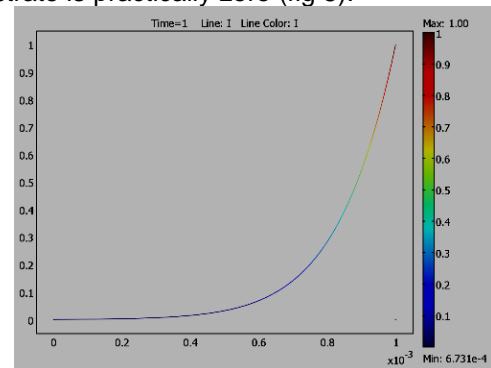


Figure 5. Relative laser-beam intensity as a function of sample depth

Conclusion

The modeling is based on deep and solid theoretical knowledge of the domain. Therefore, using Comsol Multiphysics requires a careful study of many mathematical methods for the realization to see visible results. Modeling is also very important for solving engineering problems, because it reduces development time and helps to avoid difficult or expensive experiments in the real life.

As a result we have a model of welding process with a moving laser. The results will be used in the future – in the development of more sophisticated models.

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| Section IV | |
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**ELECTRO
MECHANICS**

ERECTION TORQUE MOTOR WITH BAND WINDING

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The input of the erection torque motor is supplied with the electric signal of direct and alternating current and on the output electromagnetic moment is obtained. Therefore, this motor is called electromechanical.

Erection torque motors are often used as executive elements in modern automatics systems.

The most widely spread erection torque motors are erection torque motors with permanent magnets.

The operating principle of the electric motor is based on the interaction between current in a management winding and a field of a permanent magnet. The essential value of an erection torque motor with permanent magnets is comparatively small power consumption per torque unit, because basic magnetic flux is provided by permanent magnets.

Electromagnetic erection torque motors operating in the blocked mode are widely used in instrument-making industry as elements of "electric springs", correction devices and others. Along with the positive characteristics, e.g. proportionality of the developed torque from the current, there are also negative ones. Among the most important disadvantages are: (1) rather small working range of the angles of rotor and stator relative position and (2) small quantity of the developed torque. The first drawback is related to the structural features of the engine, the second is connected with the limited intensity of current in the winding. [1]

Basic characteristics of erection torque motors include the dependence of the developed torque on the current and the connection of the torque and the angle of the relative rotor and stator position at the constant control current. [1]

When creating a greater torque on the shaft, the current increase is restricted by the permitted overheat of the winding and its possible destruction. Various techniques of the windings cooling, especially forced ones, make the construction more complicated.[1] At the department of Precision Instrument-making the research work on the study of this type of engine is being conducted. The suggested construction of the engine can provide the required current within the specific parameters of the machine. Moreover, it enables to take the heat onto the engine body where it will dissipate into the environment. A new type of the active element (equivalent to stator windings) is used in such types of electric motors. A thin conducting tape winding is used as the basis.

The basic motor characteristics obtained by the experiment are given below. Its active element (stator winding equivalent) is made of the conducting tape winding.

To make the research a specific installation (Fig. 1) was developed. The setting includes erection torque motor model with the loading device, the power supply and the contact sensor, which allows defining the load torque overcoming by the engine.

The model of the engine is mounted on the dielectric base so that there is a possibility to rotate its stator relative to a rotor. While conducting the research, the rotor must be set relative to the base; the latter is connected with the contact sensor functioning principle.[2]



Fig. 1. Experimental installation

To set the desired position of a stator relative to a rotor there is a scale on the base. When a stator is adjusted to the desired position it is firmly fixed to the base with the help of the clamping screws. The band winding located on the stator was constantly supplied with the direct current. The current was slowly changed from zero to the value when the contact sensor responds (i.e. overcoming of loading torque by the engine). The data were fixed and further used to determine the engine characteristics. While carrying out the experiment the current did not exceed 5 A.

The construction of the engine model is presented in Fig. 2 and 3.

Fig. 2 shows the technique of torque formation with the help of the calibrated load slung on a string through a block and connected with a rotor at the given arm. The loading torque is created by

an electric contact between a mobile part - rotor - and a base.

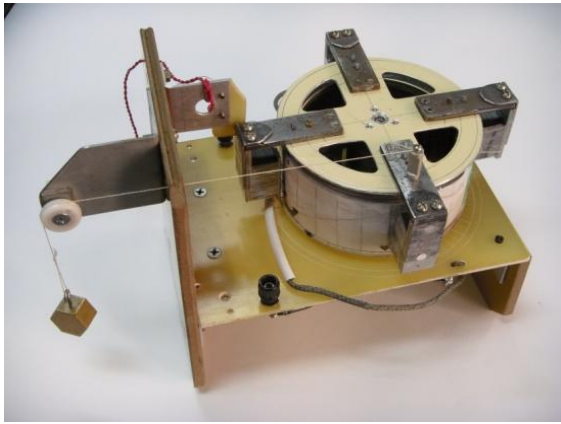


Fig. 2. General view of the engine model

The basic elements of the model are presented in Fig. 3, where 1 is a winding made from a 0,07 mm thick aluminium tape and isolated by paper on the one side.

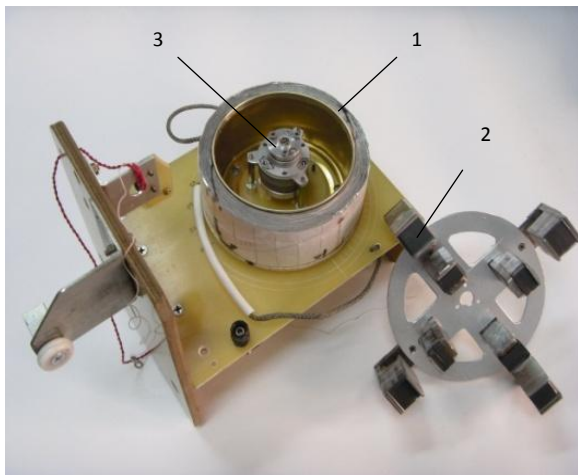
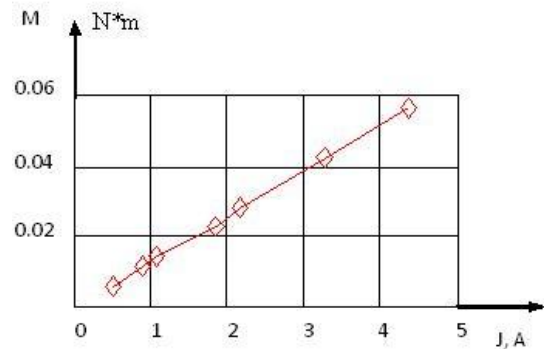


Fig. 3. Basic elements of the model

The winding is done on the thin-walled anodized aluminium glass. There are 70 coils there and each coil includes 4 areas related to the pole pitch. In the winding tape there are 5 supplementary lateral cuts per each pole pitch to obtain equal torque characteristics within the operating range of a rotor and stator relative position. Rotor magnetic system (2) consists of four pairs of permanent magnets made on the basis of rare-earth elements which are not sensitive to the degauss effect of current flowing on the anchor winding. The air-gap clearance is 20 mm. The direction of the magnetic induction vectors equal in each case to 0,06 T takes turns at nearby magnets. The rotor suspension node (3) performed on ball bearings is taken from a serial electric drive.[2]

The specified type of erection torque motor refers to electro-magnetic motors having linear dependence of a torque and current. This is

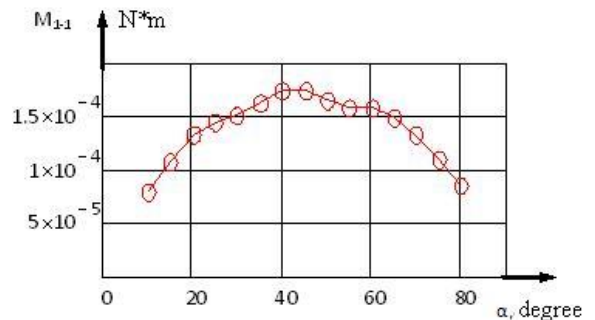
confirmed by the experiment (Fig. 4.) In this case the rotor magnets were located in the center of the tape elements marked by the basic lateral cuts.



Picture 4. Dependence of torque on current

The linear dependence of the developed torque on current allowed obtaining the characteristics of torque distribution depending on the angle of the rotor and stator relative position when the current flowing through the winding equals 1 A.

Fig. 5 presents the characteristic in relation to one coil of the winding.



Picture 5. Torque distribution on the rotation angle

The results of the experiment allowed us to obtain data about the parameters of the engine with a new type of the active element - stator band winding.

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AN ACTIVE ELEMENT OF A TORQUE MOTOR

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The torque motor is the electromechanical transformer, wherein the signal of mainly permanent current is given on the input. The output is the electromagnetic torque. The rotor of a torque motor is immovable or rotates with small rotation velocity in the operating mode [1]. The torque motors are widely used in different areas. They are used as the correcting devices in gyroscopes and accelerometers, as the stabilizing devices in the management systems of position of the antennas, the cameras, the solar batteries etc., as the elements of "electrical springs" in the systems of measuring and automatics. Nowadays the contactless torque motors with permanent current are widely used in the instrument making.

Any electrical machine is assessed by two main parameters: the induction of magnetic flux in the air gap and the linear load [2]. A linear load is the necessary current in the given motor sizes. High-coercivity permanent magnets provide sufficient magnitude of magnetic induction in the working gap. But this magnitude is relatively small. Working gap equals to several millimeters. The winding with the big quantity of coils can be placed to this working gap. Then, in spite of a little magnitude of magnetic induction, the necessary torque will be got on the motor shaft. Further torque increasing can be achieved by current increasing, flowing in the stator winding. However this may cause overheating and the destruction of stator winding, with bad heat sink from the winding's conductors in the slots, which is limited by the slot insulation. The slot insulation of the electrical machine is a big thermal resistance.

To solve described problem the necessity of creation a new active element of contactless motor arose. This active element must provide necessary linear load and possibility of relatively simple heat rejection on the motor case. The base of a new active element represents winding from the thin electroconductive tape. In this case the process of making the active element is simplified and the best cooling of the active element at the expense of increased surface is provided.

The most heat-generating executive device is a torque motor, which is permanently working in the deferred condition. The great starting current flows in the winding of this motor. In the first place, a new type of an active element intends for torque motor, which is permanently working in the deferred condition. An active element realized in the form of a spirally wound electroconductive tape coated with a layer of insulation material. The similar method of tape utilization was realized in

the pack elements of torque motor and linear motor [3, 4].

Let's consider the construction of the torque motor, where an active element with tape winding is applied. The main elements of this motor are illustrated in figure 1 [5].

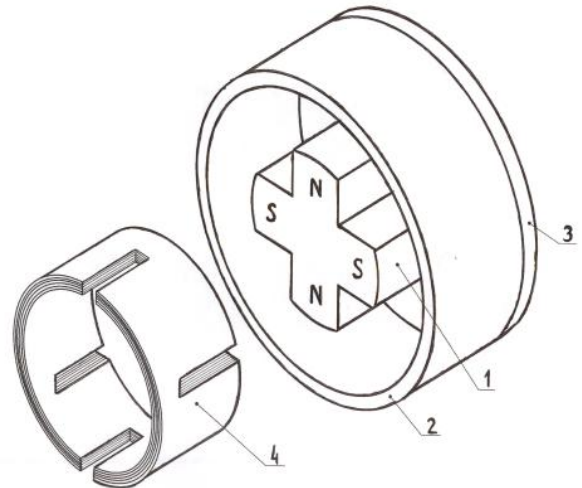


Figure 1 The main elements of a torque motor

- 1 - a multipolar permanent magnet;
- 2 - a magnetic conductor;
- 3 - a non-magnetic diaphragm;
- 4 - an active element

The rotor comprises a multipolar permanent magnet 1, which connects with a magnetic conductor 2 and with a non-magnetic diaphragm 3. The stator represents an active element 4 in the form of a spirally wound electroconductive tape coated with a layer of insulation material. At the side edges of the tape there are narrow transverse cuts arranged in turns at both edges. These cuts at each turn of the tape winding are above and under similar cuts on underlying and overlying layers. These cuts create side slots on a wound active element, besides, the distance between adjacent slots corresponds to a pole division of the magnet. A DC source connects to the ends of the wound tape [5].

The current consists of two components (fig. 2). There are J_n – the longitudinal component, directed along the tape, and J_o – the transversal component, directed across the tape. The direction of a transversal component coincides with the axis of a rotation of torque motor rotor. In the figure 2 the magnet's poles are showed as rectangles N and S. The interaction of transversal components of a current J_o with the magnetic field of the poles causes the forces F , which are acts on the

magnetic field source. The total action of these forces causes the torque moment. This moment aspires turning the magnetic system relative of the winding tape.

The main sources of heat, extracted with the current flowing will be places of the narrow spot of a tape, formed by cuts. These parts will cool at the expense of tape zones, where current density is not high, and the cooling surfaces have necessary sizes, and at the expense of heat rejection on the motor case.

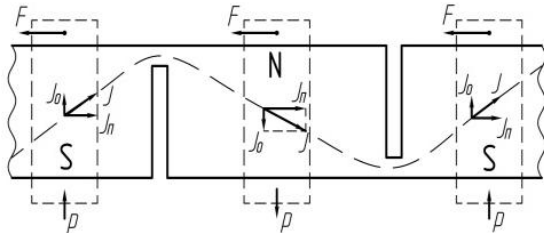


Figure 2 The fragment of an active element

The real character of current flowing on the tape has more complex form (fig. 3).

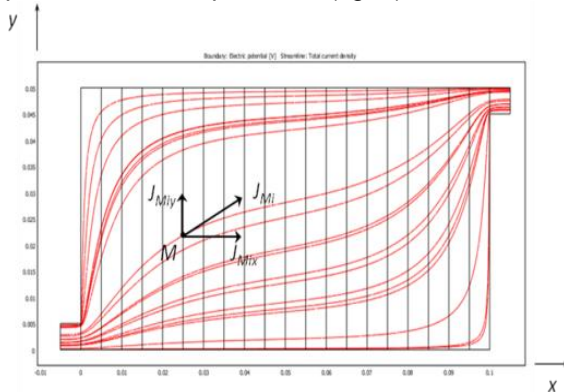


Figure 3 The character of current flowing on the tape

In fact, dispersed current flows on the tape fragment. The character of its distribution describes by equations in the partial derivative. The application of COMSOL Multiphysics, which is based on the finite element method, allows receiving the decision of the task of the current flowing on the fragment of an aluminum tape. The value of current is equal to 10 Ampere. The

fragment of a tape has the next sizes: length – 0.12 m, width – 0.04 m and thickness – $7 \cdot 10^{-4}$ m. After integration of the current density components on the highlighted areas (fig. 4) and intermediate calculations was got that the linear load of a multilayer winding would have the magnitude close to the real values of electrical machines of low power.

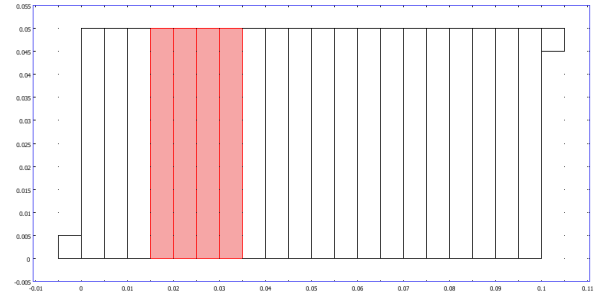


Figure 4 The character of subdividing the tape fragment on the areas of integration

In addition, the temperature of the tape fragment heating with the prolonged current flow with value the 10 Ampere is not exceeded 70-800 °C. This allows to make a conclusion, that for increasing the linear load of the considered torque motor it's necessary to increase the operating current.

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| Section V | |
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**THE USE OF MODERN TECHNICAL
AND INFORMATION MEANS
IN HEALTH SERVICES**

CORRELATION ANALYSIS OF DATA IN THE SOFTWARE PACKAGE STATISTICA

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Introduction

Mathematical methods in medicine is a combination of quantitative research methods and objects state and behavior analysis of the systems that are related to medicine and health care.

These methods detect patterns characteristic of biomedical objects. They identify the similarities and differences between groups of objects, estimate their impact on a variety of external factors and evaluate the relationship between indicators.

Analysis of a large number of health indicators is a very difficult and sometimes a painful process. In addition it is accompanied by large economic costs and time-consuming [1].

Problem statement

The problem is the following: we have nine groups of children:

- healthy children;
- children with an aggravated genetic history (indicated - genetics);
- children without an aggravated genetic history (indicated - patients).

Age: 0-12, 13-24, 25-36 (month).

The following parameters were measured: complete blood count (CBC) and biochemistry. It is necessary to determine the relationship of indicators with the help of the pair correlation within each group. There are several ways to fulfill it. The most relevant is the construction of correlation matrices in the STATISTICA.

STATISTICA is an integrated system of statistical analysis and data processing.

STATISTICA works with four different types of documents which correspond to the major structural components of the system.

They are:

- a spreadsheet, which is designed for data input and conversion;
- a spreadsheet to display Scrollsheet numerical and textual analysis;
- a timetable; it is a document in a special graphical format for visualization and graphic representation of numerical information;
- a report: it is a document in RTF (rich text format) to display textual and graphical information [2].

To solve this problem a preliminary analysis of raw data is required: verification of the groups homogeneity;

- check of distribution normality.

To determine the distribution normality and outliers observations a graphical way of box and whisker plot are used. In this case, the symmetry in the parameters sample means normal distribution.

Whisker plot is determined by five variables:

- median Q_2 ;
- quartile Q_1 ;
- quartile Q_3 ;
- the lowest value of the observations – x_{min} ;
- the greatest value of the observations – x_{max} .

These values are deposited on the real axis. Q_1 and Q_3 define the boundaries of the box, which includes 50% cases, Q_1 is the lower bound, Q_3 is the upper bound.

Then it is necessary to determine the location of Q_2 in the box:

- if the median is in the centre of the box, then the distribution will be symmetric;
- if the median is in the right (upper) part of the box, then the distribution has left-handed asymmetry;
- if the median is in the left (lower) part of the box, then the distribution has right-handed asymmetry.

The presence of outliers in the sample is determined by the rate $IQR=Q_3-Q_1$, where IQR is an interval scale.

After that it is necessary to find out if the bound gets into the box. For this purpose, values $1.5IQR$ and $3IQR$ are determined.

Values $1.5IQR$ and $3IQR$ are protracted from the bound Q_1 to the left and from the bound Q_3 to the right.

Values $1.5IQR$ on the right of Q_3 and on the left of Q_1 define the boundaries of the inner fence.

Values $3IQR$ on the right of Q_3 and on the left of Q_1 define the boundaries of the outer fence.

The observations, located between Q_1 and $1.5IQR$ are homogeneous. The observations, located between Q_3 and $1.5IQR$, are homogeneous too.

The observations, located between the inner and outer fences are weak emissions. These observations should be additionally analyzed.

Those observations that are beyond the outer fence are the outliers observations. These observations should be analyzed too [3].

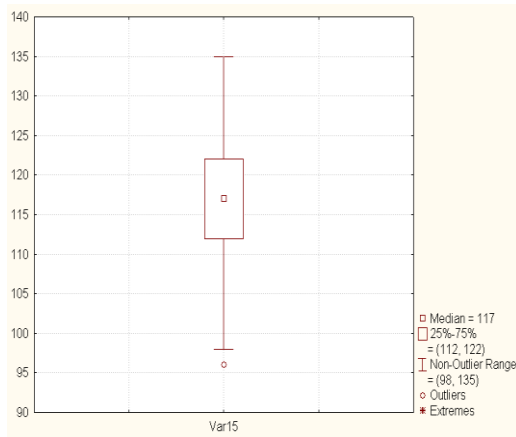


Fig.1. The outliers of the observations CBC (hemoglobin)

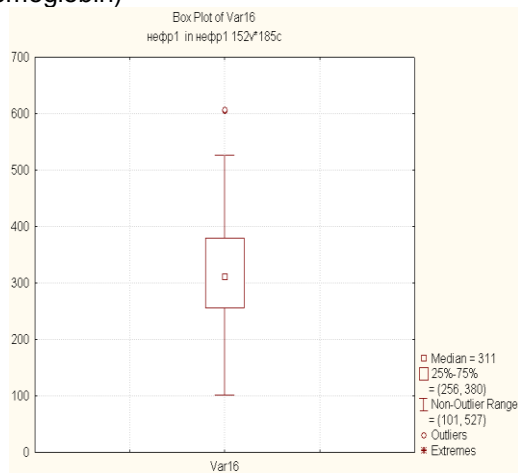


Fig.2. The outliers of the observations CBC (platelets)

The correlation analysis is an excellent analytical tool when it is implemented correctly. While learning to use this method, it is important to specify the problem being studied carefully, and the statistical methods being used.

The correlation is the statistics that measures the linear relationship between two random variables or two sets of data. The values for correlations are known as correlation coefficients. The range of possible values for correlation coefficient is from -1.0 to +1.0. Numbers that are less than 0 represent a negative relationship between variables and numbers greater than 0 represent a positive relationship.

The correlation coefficient of Spearman is used for evaluation of the interconnection of indicators [4]. The correlation matrices are built in the software package STATISTICA. The most important correlation coefficients are highlighted by the red color. The significance is $\alpha = 0,05$.

| Variable | Var8 | Var9 | Var10 | Var11 | Var12 |
|----------|-----------|-----------|-----------|-----------|-----------|
| Var8 | 1,000000 | -0,565308 | -0,090909 | 0,199582 | 0,408568 |
| Var9 | -0,565308 | 1,000000 | -0,189133 | -0,222571 | -0,705329 |
| Var10 | -0,090909 | -0,189133 | 1,000000 | 0,820272 | 0,684431 |
| Var11 | 0,199582 | -0,222571 | 0,820272 | 1,000000 | 0,728318 |
| Var12 | 0,408568 | -0,705329 | 0,684431 | 0,728318 | 1,000000 |

Fig.3. Correlation matrix for indicators (CBC) of healthy children aged 0-12 months

| Variable | Var8 | Var9 | Var10 | Var11 | Var12 |
|----------|-----------|-----------|-----------|-----------|-----------|
| Var8 | 1,000000 | -0,565308 | -0,090909 | 0,199582 | 0,408568 |
| Var9 | -0,565308 | 1,000000 | -0,189133 | -0,222571 | -0,705329 |
| Var10 | -0,090909 | -0,189133 | 1,000000 | 0,820272 | 0,684431 |
| Var11 | 0,199582 | -0,222571 | 0,820272 | 1,000000 | 0,728318 |
| Var12 | 0,408568 | -0,705329 | 0,684431 | 0,728318 | 1,000000 |

Fig.4. Correlation matrix for indicators (biochemistry) of healthy children aged 0-12 months

Conclusion

As a result it was found out that there is a difference of correlations between groups of patients.

By analysing the correlation between all the studied variables we observe that there is a strong correlation between the interconnections among the children at the ages of 0-12, 13-24, 25-36. The group aged from 13 to 24 months differs from the others. In addition, the correlation in figures of the children with an aggravated genetic history is severe for all ages. It suggests the genetic history is a factor that causes stress of the regulatory mechanisms.

In general, the presence of pathology is a factor influencing the interconnection of indicators. This conclusion is based on comparing interconnection of indicators of healthy children and patients [5].

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MODELING OF ELECTRICAL SIGNALS IN THE CARDIAC TISSUE USING SOFTWARE PACKAGE COMSOL

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Introduction

The software package COMSOL Multiphysics (previously called FEMLAB) allows the user to simulate any physical processes. Their description is possible by using a system of differential equations in partial derivatives.

The package provides users with comprehensive tools for modeling: model building, description of the physical process of mesh partition, simulation, and post processing of results [1].

Modeling

This article is devoted to the modeling of the electrical system of the man's cardiac tissue. This modeling is an important step in understanding the contractions and dilations in the heart. The heart produces rhythmic electrical pulses that are begun from a point known as the sinus node. The electrical pulses, in their turn, cause the mechanical contractions of muscles. In a healthy heart these electrical pulses die out, but a great number of heart diseases is related to a risk of re-entry of the signals. This means the violation of the stability of pulses, a severe and acute condition which is often referred to arrhythmia [2].

During the medicine developing it has been shown that many important characteristics of electrical signal propagation in cardiac tissue can be reproduced by a class of equations that describe excitable media or materials consisting of elementary segments or cells with the following basic characteristics:

- Well-defined rest state;
- Threshold for excitation;
- A diffusive-type coupling to its nearest neighbors.

Excitable media is a rather general term, which is used for modeling of a number of different phenomena from the electrical signals in cardiac tissue including nerve pulses to the spreading of the forest fires and certain types of chemical reactions. One of the most important qualitative characteristics demonstrated by excitable media is the immediate damping out of signals below a certain threshold. On the other hand, signals exceeding this threshold propagate without damping [3].

The FitzHugh-Nagumo equations for excitable media describe the simplest physiological model with two variables, action potential (the activator variable) and gate variable (the inhibitor variable).

In this heart model the activator variable corresponds to the electric potential, and the inhibitor is a variable that describes the voltage-

dependent probability of the pores in the membrane being open and ready to transmit ionic current.

The equations are the following:

$$\frac{\partial u_1}{\partial t} = \Delta u + (\alpha - u_1)(u_1 - 1)u_1 + (-u_2),$$

$$\frac{\partial u_2}{\partial t} = \varepsilon(\beta \cdot u_1 - \gamma \cdot u_2 - \delta).$$

Here u_1 is an action potential (the activator variable), and u_2 is a gate variable (the inhibitor variable). The parameter α represents the threshold for excitation, ε represents the excitability, and β , γ , and δ are parameters that affect the rest state and dynamics of the system. The boundary conditions for u_1 are insulating, using the suggestion that no current is flowing into or out of the heart. The initial condition defines an initial potential distribution u_1 where one quadrant of the heart is at a constant, elevated potential V_0 , while the rest remains at zero. It is convenient to implement this initial distribution using the following logical expressions, where TRUE evaluates to 1 and FALSE to 0:

$$u_1(0, x, y, z) = V_0 ((x + d) > 0) \cdot ((z + d) > 0),$$

$$u_2(0, x, y, z) = v_2 ((-x + d) > 0) \cdot ((z + d) > 0).$$

Here d is equal to 10^{-5} , and it is included in the expressions to rise slightly up the elevated potential from the main axes [4].

A simplified geometry can be created using the drawing tools in COMSOL Multiphysics.

The results presented here are intended only as a first rough estimate of the qualitative behavior. That is why the specialist can only expect how the system will show itself in these conditions. Consequently, higher-order elements, finer mesh and smaller relative and absolute tolerances give more correct simulation results. These refinements can require several hours of computing time to solve the equation, while the coarse model described here should be resolved within about 20 minutes on a standard PC.

To understand the processes occurring in the body it is necessary to deal with the electrical heart system. First of all, cardiac muscle consists of four divisions. It is divided into two upper chambers (atria). From there the blood goes to the two lower chambers (ventricles), where it is pumped back into the lungs and other body parts. The role of the drummer in the heart carries the control rate, called the sinus node (also known as: sinoatrial or SA node). It provides a well-coordinated work of all parts of the heart by passing weak electric signals.

Thus, the SA node triggers an electrical chain reaction that spreads to both atria, like waves on a smooth surface.

The received three-dimensional model in Figure 1 is a simplified model of the heart with the two upper chambers (atria) and two lower chambers (ventricles). To imagine a solution to the inner side, a quarter of the external shell of the heart and one of the surfaces of the chamber are presented in cross-section.

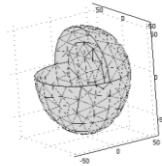


Fig. 1. Three-dimensional geometric heart's model

After entering the data and expressions in the appropriate fields in the software package for this model for the complex equations of FitzHugh-Nagumo a visual solution can be built. To get the visual solution it is necessary to press the Solve. In such a way we obtain three-dimensional model. In this model there is the spiral wave propagation (depending on time) starting from the cavity of the heart in the place where the sinus node of the man's heart is supposed to be. Further, the waves propagate to the lower chambers and decay in the periphery.

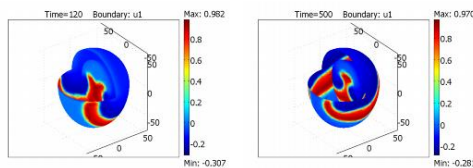


Fig. 2-3. Solution of the FitzHugh-Nagumo equations at times $t = 120$ s (left plot) and $t = 500$ s (right plot)

After a period of $T = 95$ seconds, the waves are formed again. There is the wave propagation in time 120 sec (Fig. 2) and 500 seconds (Fig. 3). The parameters used in the model along with the initial moment u_1 , lead to the re-wave, which, as seen from the graph, move the tissue without

damping by special spiral pattern. To get more precise solution this software package allows changing mesh parameters of received model. At the same time it is not necessary to change any of the parameters in the geometric body. Obtaining a fine grid is possible due to the changes of mesh box parameters in settings in the software package Comsol. It is known that the building of the three-dimensional models is based on the finite element method. It means that geometric body is a set of piecewise continuous linear functions defined by a finite number of parameters. Through appropriate selection of parameters, these functions satisfy the conditions of the equations approximately. Thus, there is an approximation to the exact solution (given more precise mesh in the mesh settings allows building more accurate model).

Conclusion

As a result of this work three-dimensional model of the heart muscle was created. For this purpose software package COMSOL Multiphysics3.5a version was mastered. Moreover, a lot of literature [4] about heart electrical system was learned for creating of this model and the finite element method was studied in detail and used during the model construction.

Besides, creating of this more precise model can be useful in a medical sphere. For example, entering the human data in the description of such a model allows the physician to find out if the person has the predisposition to an arrhythmia.

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STROKE REHABILITATION

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Stroke, also known as a cerebrovascular accident (CVA) or a brain attack is a form of cardiovascular disease. It occurs when an artery or blood vessel supplying oxygen to the brain is either blocked by a clot or ruptures resulting in brain damage in the area of the event. Stroke has been described as a "a clinical syndrome characterized by rapidly developing clinical symptoms and/or signs of focal, and at times global, loss of cerebral function lasting more than 24 hours or leading to death with no apparent causes other than vascular origin." Stroke is the third leading cause of death and the leading cause of long-term disability. [2] Rehabilitation of patients after the brain injury requires employing of all available mechanisms of neuroplasticity. To achieve it, the voluntary activation of brain systems that are involved in the signal processing, represents the most effective tool. There are millions of people who care for stroke survivors and whose own lives are personally affected. The goal of rehabilitation is to enable an individual who has experienced a stroke to reach the highest possible level of independence and be as productive as possible. Because stroke survivors often have complex rehabilitation needs, progress and recovery are unique for each person. Although a majority of functional abilities may be restored soon after a stroke, recovery is an ongoing process.

One of the widespread types of rehabilitation is Biofeedback therapy.

Biofeedback is the use of technology to give a person feedback on the current and on-going activity of various body systems, such as their own muscle tension, electrical activity in the brain, heart rate, and blood pressure. Some type of visible, audible, or tactile sensation is given through a biofeedback device, in order to help the patient learn how to control these body systems and functions that are generally considered involuntary. This systematic review examines the effect of biofeedback more broadly in enhancing the training of motor skills after stroke. Unlike previous reviews, it includes clinical trials where any form of biofeedback was provided during the practice of the whole activity (rather than practice of part of the activity) and where outcomes were measured during the same activity. The focus is on activities involving the lower limb such as sitting, standing up, standing and walking, since independence in these activities has a significant influence on quality of life and ability to participate in activities of daily living. [3]

Biofeedback has been applied to many aspects of stroke rehabilitation, with mixed results. This is largely due to the varying modalities, differences between study designs, and methods of measuring success and progress. How well biofeedback works appears to be inversely related to the direct observability of the function about which information is being provided. The more covert the function (e.g., swallowing muscle activity, attention, cortical functioning, etc.), the more helpful biofeedback is likely to be. However, biofeedback in general can have a very positive impact, even through indirect means. Improvements in self confidence, shifting of locus of control, and instantly being provided information regarding changes in one's physical functioning as a result of mental activity can be helpful in setting the tone for success in rehabilitation more generally.

One of the best ways to help in rehabilitation is using stabilometric platform.[4]



Fig 1 - Stabilometric platform

The stabilometric platform assesses in a reliable and objective way the posture and balance of patients both on static or wobble conditions. The exploration of the balance different sensorial inputs becomes possible thanks to rigorous measures. It is stabilotest platform is the thinnest (1cm) and the lightest (less than 4 kg) platform on the market. It also makes the difference with its frontline electronics and its measuring system of the forces within the axis of supports. With the assessment software Posturewin 2 you can analyse the patient's recordings and assess the situation of his posture and balance. Each session is recorded in

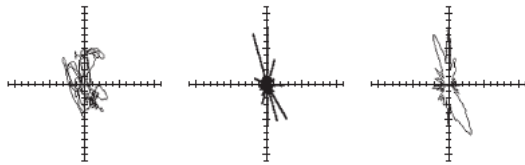
order to observe the evolution of the patient's state.

Stabilometric platforms are usually a part of the automated system called computer posturography. They enable objective and reproducible evaluation of the balance. Computer program continuously records the data and displays them in a graphical form for the evaluation of movements of the gravity centre on the basis of its projection onto the plane of the supporting basis.

The examined person stands on a rigid stepping square platform (420x420x15 mm – Fig 1). Projection of the gravity centre and its movements relative to the centre of the platform is monitored by four mechanic-electric sensors (tensometers), which support the platform. Electrical signal is digitalized, evaluated by special computer program and results are visualized on the monitor and recorded for future statistical evaluation.

Evaluation of the balance dexterity is the first step before the training of balance skills. As the routine examination methods are aimed on the analysis of the vestibular apparatus impairments, a special sequence of tests was developed to study patients with brain impairment, aimed at the ability to shift and relocate the weight and gravity centre.

Open eyes
 1 seg. = 1.0 mm 1 seg. = 0.2 mm/s 1 seg. = 0.2 mm/s



Closed eyes
 1 seg. = 1.0 mm 1 seg. = 0.2 mm/s 1 seg. = 0.5 mm/s

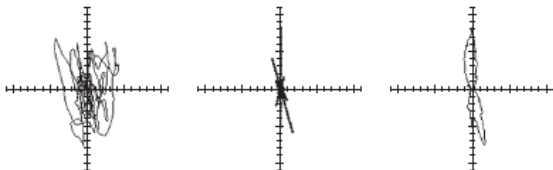


Fig 2 - Graphical presentation of results from the test of stance.

Stabilometric platform and its computer evaluates automatically some parameters (type of

the trial, location of target points, length of the ideal trajectory, the length and speed of the real trajectory of the projection of the centre of gravity between target points) (Fig 2). As criteria of improvement two parameters were selected: the speed of movements of the projection of the centre of gravity and the accuracy of movements expressed by the ratio between the real and ideal trajectory. Numerical data from the evaluation are presented in the form of tables or they can be converted into the graphical charts.

The presented methods of objective recording and evaluation of the balance skills and abilities of patients enables to assume modern approach in medial fields of kinesiology, which is traditionally based on the subjective evaluation only, however, in the era of evidence based medicine it will require the objective assessment of the patient's status.

The designed system, which employs visual biofeedback derived from a posturometric platform, allows also analysing theoretical questions of the mechanisms of balance disorders, the dynamics of the transfer of the learned memory trace from the declarative to procedural memory, and the role of rehabilitation techniques in the process of recovery. The system will help to classify balance disorders, to measure the dynamic of their improvement during rehabilitation and to use this data for the prognostic purposes.

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MIND-MAP VISUALIZATION IN EHR SYSTEMS

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It is an open secret that in last decade the development and implementation of IT in our lives increased impressively. The medicine is not an exception. Health information technology (HIT) can be the real power when creating a convenient system that could make doctors work more efficient. But the thing is that even though this gives a chance to get to a new level in health care, the effective use of HIT depends on managing changes as much as it does on information management [1]. And health care has never been a sphere that could accept changes easily. The only way to succeed is to make a well-structured system with the most friendly graphical user interface (GUI) and clear visualization. The first condition is improved with the application of standards (ISO 13606) but the solution for an efficient clear visual layout is still being investigated.

The research deals with a concept of visualizing electronic health records (EHR). EHR is an in-patient card in digital format. EHRs can include a range of data: medical history, medication and allergies, previous visits to the physician, immunization status, laboratory test results, some personal information such as age, weight, billing information and so on. Each patient has its own medical history, each disease has different symptoms, required tests, methods of treatment, time bounds and so on. That is why medical data is quite difficult to visualize and its versatility must be reproduced. Medical data should:

- be well interpreted;
- be structured by standards;
- have clear interconnection.

The idea is to use a sort of mind map as a method of visualization. A mind map is a diagram used to represent words, ideas, tasks or other items linked to and arranged around a central idea. Mind maps are used to generate, visualize, structure and classify ideas, and as an aid to studying and organizing information, making decisions.

Mind map should give an ability to explore information about the patient in the convenient way.

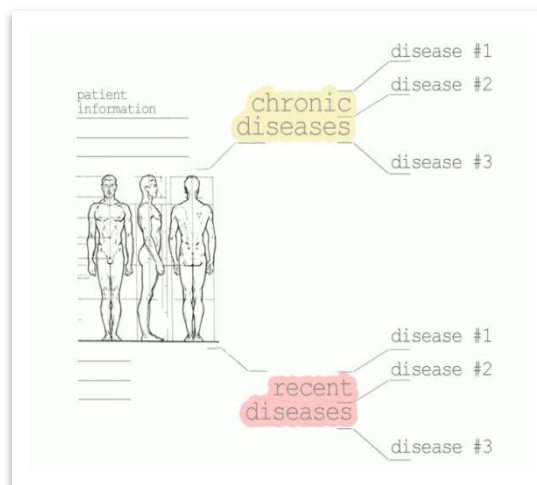


Fig.1. Mind map concept for HER

This figure shows only the concept. The idea is to connect all the history of a patient to just one list, but with the possibility for physician to change parameters in the way it is necessary in specific situation. Each disease will have such parameters as: symptoms, test results, instituted therapy, and results of therapy. Also there should be a branch: present disease. It will show up only if the field "Results of therapy" is not filled.

The ISO 13606 data model can serve as a basis for a generic visualization method. To make such method generic and most efficient the knowledge concerning the presentation should be kept separate from the medical concept. Therefore, we introduce a visual medical concept that will complement the archetype layer with a presentation layer, separating medical knowledge from visualization knowledge.

The visual medical concept has to meet the following requirements. It has to:

1. confirm the requirements and constraints of a ISO 13606 reference model;
2. contain information on the data to be visualized and on how to visualize the data;
3. provide multiple device support;
4. support different views on the same data;
5. be stored separately from the visualized data;
6. be platform independent.

The visualization module that we develop within our project uses the visual medical concept. This allows to meet the requirements mentioned above. The visualization module that can work in parallel with all EHR systems that are already installed in the practices consists of two main logical parts. The first part is a designer that generates an

archetype based on visual medical concept in XML format. The designer enables the user to add customization data to the visual concept. The generated view definitions will be stored as separate files allowing to reuse and share visual concepts. The second part creates a presentation layer and displays the data to the user based on the visual structure and on the data from the EHR.

The visual concepts can be combined into users' profiles – sets of medical concepts with specific purposes (Figure 2). Doctors and patients with different needs will have the possibility to visualize different perspectives on the medical record. The presentation layer for doctor will provide a user-friendly data presentation using summary views and graphical charts.

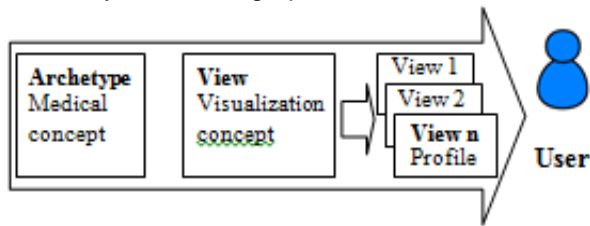


Fig.2. Hierarchy of medical abstracts

For now this is only a project but prior to start its realization there are some questions that should be answered. First of all, the number of physicians who are ready to use the system should be counted since the realization could be very difficult and unprofitable. We think it is quite difficult to make changes in this sphere. The apparent certainty of the adoption of HIT needs to be constantly reexamined. There are some difficult

questions left. One is whether the administration's current decentralized, market-based approach to promoting its spread will prove effectiveness in realizing the promise of HIT. The medicine informatics has actually not been developed yet in Russia. Therefore it is so difficult to talk about the implementation or even creation of this system.

A second question is if this systems aim is simplification and convenience for physician won't it cause carelessness or light-mindedness. Since there is always a risk that physician seeing all the chronic diseases will have a temptation to relate new symptoms to some already found diseases. But we think that using the mind map could do more good than harm.

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SYSTEM FOR ASSESING EXTERNAL INFLUENCES ON A HUMAN BODY

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The World Health Organization stresses that health technologies should be thoroughly evaluated prior to their widespread use. That's why people need a system for assessing the external effects on a human body. For the convenience let's examine a certain impact, for example, the source of such exposure is considered to be ultrasonic waves. Its negative impact is proven by experiments based on sampling. Our task is to assess ultrasound impact (or any other external impact) with the help of a non-invasive method.

Ultrasonic waves cause not only mechanical distortion of DNA but also field one. This means that the genetic program may be crashed:

distorting fields will form damaged tissues so that a healthy body is not able to develop using them. The proposed system would be able to assess and prevent any external impact on a human body.

Although ultrasound is expensive, routine scanning is of doubtful usefulness, and the procedure has not yet been proved to be safe, this technology is widely used, and its use is increasing rapidly without control.

In the living human body the set of the so-called "essential" variables can be specified. They are closely related to each other, so that significant changes in any of them sooner or later lead to significant changes in other variables. They can

describe the local physic-chemical properties of the organism internal environment (pH, temperature, concentration of various substances, etc.) and physical characteristics of the organism as a whole (stroke volume and heart rate, respiratory minute volume, peripheral vascular resistance and so on).

Any change in parameters or structure that has happened in any system of the body, immediately applies to all the systems, causing changes in each of them. However, if this perturbation is not too large, the equilibrium of the system that existed before the disturbing factor, restores again, but will have some other values of the variables.

Ultrasound screening during pregnancy is now in widespread use without sufficient evaluation. Research has demonstrated its effectiveness for certain complications of pregnancy, but the published material does not justify the routine use of ultrasound in pregnant women. There is also insufficient information with regard to the safety of ultrasound use during pregnancy. There is as yet no comprehensive, multidisciplinary assessment of ultrasound use during pregnancy, including: clinical effectiveness, psychosocial effects, ethical considerations, legal implications, cost benefit, and safety.

To measure its effect and evaluate the process of adaptation we use the entropy criteria.

Traditional methods for studying human adaptation characteristics allow estimating the dynamics of the individual parameters of the body. And under the influence of a large number of unaccounted factors variability in the parameters of "normal", low accuracy non-invasive methods give reliable results only at significant gross deviations. As a rule, it is impossible to register the nature and tendency to change the state of the organism.

To obtain quantitative characteristics of the adaptation process the entropy indicators of the bio-system have been introduced. This allows us to estimate absolute values of the physiological (or any other) characteristics of the state of the organism, and their tendency to change under the influence of external factors or conditions.

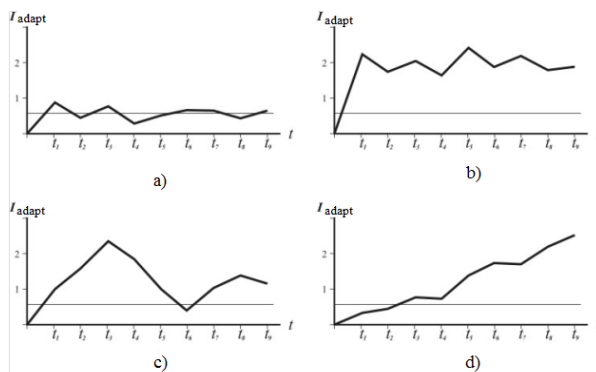


Fig. 1. Types of adaptation strategies: a) adaptive; b) compensatory; c) adaptive compensatory; d) maladaptive

Information-entropy method is an example of the so-called external description of the state of large systems. This approach goes back to the ideas expressed by Aristotle, according to which the importance of a superior is more valuable than importance of its components.

It is known that the entropy of living systems is a measure of the uncertainty distribution of the state of biological systems defined as:

$$H = - \sum_{i=1}^n P(X_i) \cdot \log P(X_i)$$

Where H - entropy; $P(X_i)$ - the probability of i state from the field X ; n - the number of states of the system.

With equal probabilities the system is completely disorganized, because in any time it can change to any state (in this case the system has maximum entropy). Increasing order means an increase in the dependence of factors that determine the behavior of the system, which leads to predictability of its behavior.

Adaptation mechanisms resist to an increase of entropy in the transition from normal to abnormal state. General adaptation syndrome mobilizes functional systems, which leads to an entropy decrease. Stress and depletion of regulatory mechanisms is accompanied by an increase in entropy.

The entropy of the system can be determined by any structural or functional characteristics.

An important characteristic of living systems is the conditional entropy, which characterizes the uncertainty distribution of the biological system with respect to the known (reference) distribution.

The parameters of the reference system for bio-system can be presented by variety of factors. One of them is environment variables. The measure of conditional entropy can be used to assess the evolution of living systems over time. In this case the reference distribution is the distribution of acceptance of the probability of a system of its state at some points in time. And if the number of states at the same time remains unchanged, the conditional entropy of the current distribution of $P1$ relative to the reference distribution $P2$ is defined as:

$$H(P1/P2) = - \sum_{i=1}^n P(X_i) \cdot \log [P(X_i)/P2(X_i)]$$

In general, changes of entropy accompany to all life processes and serve as one of the characteristics in biological phenomena analysis.

Based on the above, we have to choose some parameters of the human body functioning. These parameters should indicate any external influence. They should be independent and perform the most important processes in human body.

The following characteristics were chosen: heart rate (ECG), namely the distribution of R-R intervals over time, galvanic skin response (GSR) - the level of resistance of the skin at the site of impact and the level of blood filling identified with

the help of rheogram of the examined organ. Thus, pre-designed system block diagram is shown in Fig.2.

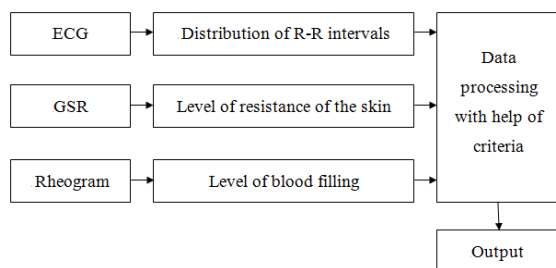


Fig.2. Block diagram of the system

The technical realization of such system will be presented as a device which takes bio-information from a person. Then it is processed by the software, and returns a verdict about the impact of an ultrasound on a human body.

Thus, using this system it becomes possible to evaluate any kind of external impact on a human body: ultrasonic waves, electromagnetic field or just sudden alteration of weather conditions. Firstly, bio-information is taken from a body by means of ECG, GSR and rheogram. Then external impact influences the bio-object and bio-information is taken for the second time to be processed and compared with the help of entropy criteria. After all we can see if there are any changes so that appropriate treatment can be

applied. And if it is possible, try to avoid and prevent any of these explored influences.

Since this system is only an idea, and no human studies were performed using this apparatus, the findings are just our assumption.

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THE MEDICAL INFORMATION TECHNOLOGY DEVELOPMENT

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The main purpose of the information systems implementation in health protection is new information technologies creation at all levels of health protection management and new medical computer technologies improving the medical and preventive attendance quality and facilitating the main function of public health purposes realization (an increase expectation of people's life).

The first attempts of medical information systems introduction were made in the middle of 1950-s in the United States of America. It was preceded by the invention of multi-purpose computers. "Medinet" developed by General Electric was the first medical information system. After its introduction, the era of information technology in the area of medicine was evolving rapidly and spreading to other countries of the

world. As a result a sheer number of companies-developers of these information systems appeared on the market.

As for Russia, medical information systems are also rapidly developing in our country. There are thirty-seven existing medical information systems (Such as InfoMed, "Computer Science in Siberia" AIS "Polyclinic", "Hospital" "Tonlayn" Medic + "Infinity" "Hospital" "TORINS" and many others) Seventy five percent of them are actively working and developing. Modern Medical Automated Information System is software and hardware, data and knowledge bases, designated for various processes automatization at preventive institutions. Introduction of information systems in health care institution suggests solution for some difficult tasks such as creating a single information space and as

a result the quality improvement of keeping medical documentation, monitoring and quality control of medical care and as a consequence reducing the probability of medical error, increasing the transparency of activity the health care institution, and economic aspects analysis of delivering medical care, it is necessary for commercial health care institutions.

As for MIS prospects development, we can say that the development is moving in several directions. The Internet is one of the directions for the development. Using Internet technology staff will not need a special network for applications, and customers can get information about their medical records or general health information, irrespective of place where they are. Wireless technology is another direction for the development of MIS. It can be used for dropping the research results, serving as notebooks for patients' admission, providing access to different directories. The speech recognition and handwriting technologies are also successfully developing in our days. They are necessary in the conditions when it's impossible to make notes but writing at dictation is required (for example, in the operation room or radiology reports). Modern THPP- products convert speech to text files, these products include a new module - a dictionary of medical terms (more than 25000 words), improving the quality of speech recognition, comprising medical terms. "Interin" is one of the promising and established medical information systems on the Russian market.

In 1994, the Program Systems Institute and the Medical Center of the Bank of Russia decided to develop an integrated distributed medical information system.

Development of MIS became the basis for the new scientific field formation that is medical informatics. The laboratory was called INTERIN.

Theoretical research and practical developments have led to the construction of MIS technology, that includes a set of tools, technology and techniques for creating of integrated information systems of preventive institution called "INTERIN technology."

The first MIS created using the INTERIN technology, known as automated control systems of treatment and diagnostic process (INTERIN), was installed in the medical center of the Bank of Russia in 1996. Since that time, the system has been in production operation. All this time MIS development has been tracking in different modes. At the same time the methods and techniques of integration systems based on technology Interin with the third-party software were practiced.

One of the areas of application systems development based on technology Interin is an extension of their functionality. A basic version of MIS technology has been expanded by the following subsystems inclusion :

- Hospital;
- Clinic;
- Laboratory;
- Dentistry;
- HealthFood;
- PACS;
- Economics;
- PersonnelDepartment;
- Library.

The major MIS "Interin" subsystems are presented in this article. The scope of the subsystem "hospital" is all the stages of treatment and diagnostic process in the hospital: taking care of patients in the hospital and their moving in it, as well as the maintenance of the diagnostic and treatment processes in the department of the hospital ward. Functionality of the subsystem "clinic" is to implement mechanisms for automating outpatient registration staff and clients of preventive institution, including maintenance of ambulatory patient records, appointments to being examined in the diagnostic units, creating a single patient database of preventive institution with a hospital.

The subsystem "Dentistry" provides information support to the specialists of dental offices (for an outpatient and inpatient facilities).

Scope of the subsystem "Personnel Department" - all under accounting staff (reception and dismissal, transfer of employees, making the calculation of staffing and employment, registration of sick leave and vacation), and the use of employee data in other sub-systems (MIS administrator, medical staff at the organization diagnostic and treatment process, as well as the management of medical records staff MPI).

All sorts of information bits arisen in the process of medical institutions in the system INTERIN are presented in the form of special components. These are information objects with methods ('create', 'show', 'edit' etc.). The mechanism of information objects is the basis for the functioning of a unified interface "desktop" (Fig. 1) and for the formation of typical workplace.

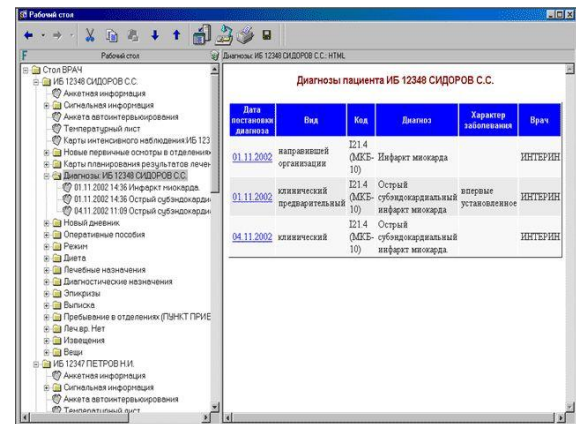


Fig. 1. The physician's desktop in ISI INTERIN.

"Desktop" is an organized set of objects the user is entitled to have access to. We can say

about these objects that they lie on the user's desktop. Not all objects are available to the user at this desktop. The interface based on the concept of "desktop" implements the regular analogy with paper documents work.

Medical card on the desktop has a definite structure. It is a folder, sections of which are sets of documents of any type. Every document or folder is submitted in a form convenient for viewing. Medical card can also include some specialized medical records (dental, gynecological, health book, etc.) as well as journal entries Outpatient Clinics conducted on the patient ambulatory procedures. The subsystem provides the ability to view and analyze patient information in different views.

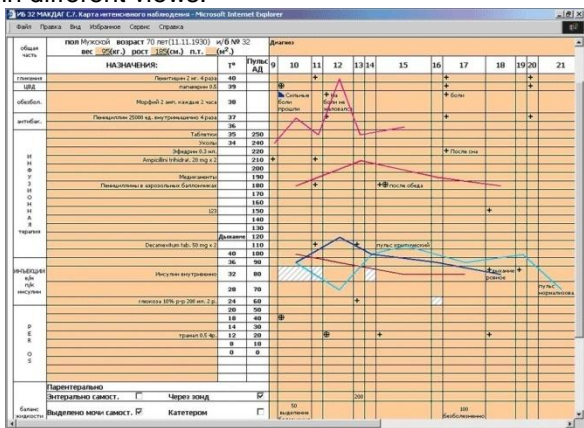


Fig. 2. The intensive care map of the patient in MIS INTERIN

Properties of the MIS Interin allow to solve all medical application tasks. Currently the following products were developed: Interin PROMIS 2012 is open and integrated medical information system, Integration Gateway, Internet Registry, mobile workplace of doctor.

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| Section VI | |
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**MATERIAL
SCIENCE**

INFLUENCE OF MECHANICAL ACTIVATION CONDITIONS ON CERAMIC POWDERS AND SINTERED PRODUCTS PROPERTIES

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Introduction

Powder metallurgy is a promising technological method that allows to obtain metal and ceramic products of various forms and purposes, to create entirely new materials, which are difficult to produce in other ways, and, in some cases, even impossible [1]. Urgent problem of powder technology is the activation of sintering process.

Mechanical activation is a process of change energy state, physical and chemical properties of matter under the influence of mechanical forces during grinding. The application of powder mechanical activation of can significantly improve the efficiency of powder technology that is expected to increase the density of products, improve their physical and mechanical properties [2, 3].

The aim was to investigate the influence of mechanical activation of metal and ceramic powders on their physical and technological properties, sintering behavior and properties of sintered samples.

Experiment

We used ultrafine powders of 80 % Al_2O_3 – 19 % ZrO_2 – 1 % Y_2O_3 , 95 % ZrO_2 – 5 % Y_2O_3 (mol. %). Mechanical activation of source powders was performed in energy-intensive planetary ball mill «Activator 2SL». We determined bulk density, flowability, and particle size distribution of initial and treated powders. The powders were pressed in a rigid mold at a pressure of 200, 400, 600, 800 MPa.

Compacts were sintered at 1600°C in the high-temperature resistance furnace. We determined the density, shrinkage of the samples after sintering, the investigated the microstructure, determined microhardness and elastic modulus by nanoindentation.

Results

Figure 1 shows the dependence of the compacted ceramic samples density on the processing mode in the activator and the compaction pressure.

It is evident that the greater the frequency of grinding and compacting pressure of powders, the greater the density of the compacted ceramic samples.

Figure 2 shows the dependence of the sintered ceramic samples density on the processing mode in the activator and the compaction pressure.

Ceramic compacts sintering of activated powders resulted in a significant in density

increase. Compacting pressure has little effect on the density.

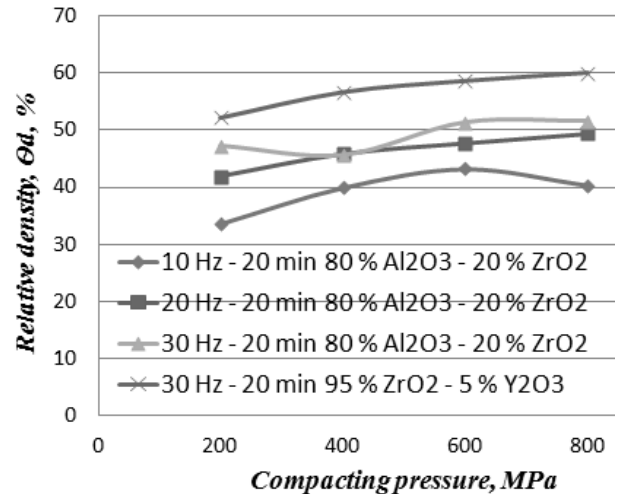


Fig. 1. The dependence of the compacted ceramic samples density on the compacting pressure

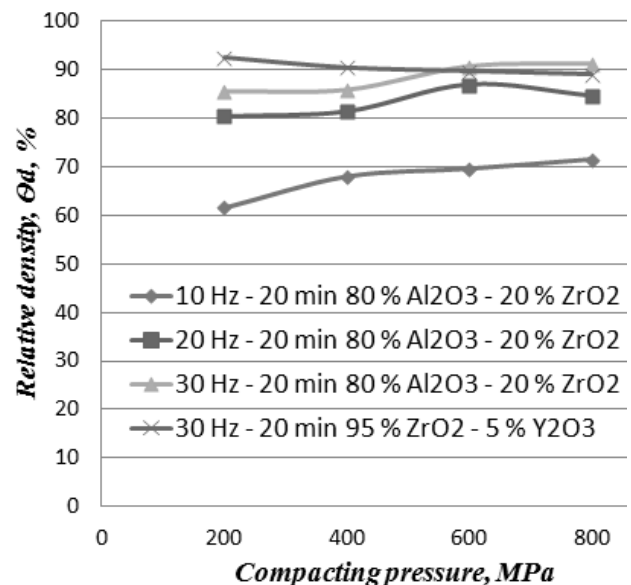


Fig. 2. The dependence of the sintered ceramic samples density on the compacting pressure

Figure 3 shows the microhardness dependence of ceramic samples on the mode of processing and compaction pressure.

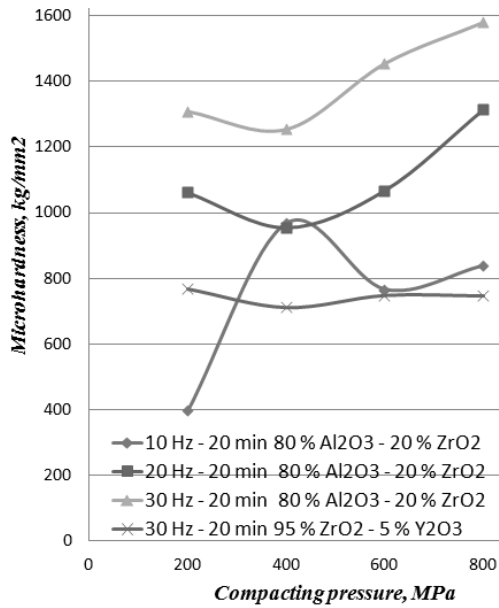


Fig. 3. The dependence of ceramic samples microhardness on the compacting pressure

One can see that microhardness of sintered ceramic samples is greater, if the frequency of grinding and the pressure of powder pressing. This is due, primarily, to the increase in of sintered samples density.

Figure 4 shows microstructure of ceramic samples.

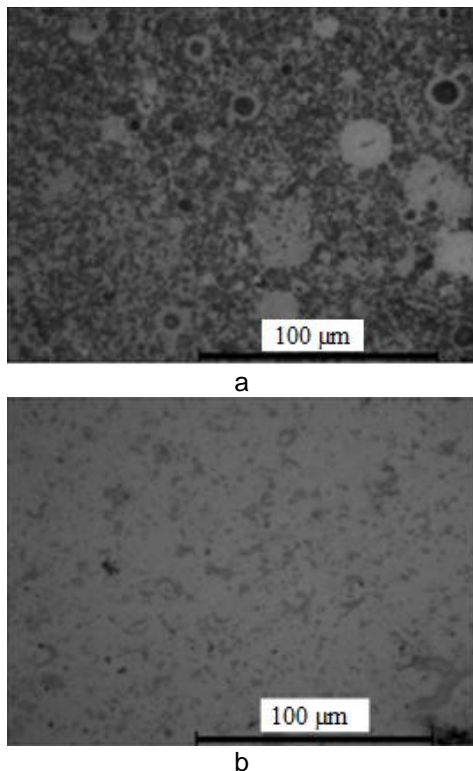


Fig. 4. Photographs of ceramic samples microstructure sintered from ultrafine powders processed at 30 Hz for 20 min: a - of 80 % Al₂O₃ – 19 % ZrO₂ – 1 % Y₂O₃, b - of 95 % ZrO₂ – 5 % Y₂O₃

The samples on the basis of Al₂O₃ have a pronounced two-phase structure in accordance with the phase diagram of Al₂O₃ - ZrO₂. The dark component corresponds to the α-Al₂O₃, the color is due to partial recovery of aluminum from corundum and its subsequent evaporation. The light phase is represented by partially stabilized ZrO₂. The uneven distribution of ZrO₂ around the corundum particles is due to locally inhomogeneous compaction. Such a mechanism of compaction is often observed during submicron powders sintering.

Ceramics structure with the composition of 95 % ZrO₂ – 5 % Y₂O₃ is also a two-phase: a light phase is represented by a-ZrO₂; dark inclusions are t-ZrO₂.

Conclusion

The processes of mechanical activation, molding and activated sintering of ceramic powders have been investigated. Particle size distribution of powders, bulk density, flowability, density of the compacts, the density of sintered samples, shrinkage, elastic modulus and microhardness of sintered samples were determined. The positive effect of mechanical activation on technological properties of powders was found. Mechanical activation of ceramic powders has resulted in a significant increase in the density and microhardness of sintered samples (up to 16 GPa).

Работа выполнена в рамках реализации ФЦП «Научные и научно-педагогические кадры инновационной России» на 2009 – 2013 годы, проект НК – 616П(8), ГК № П-920.

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“SMART” MATERIALS

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Introduction

A “smart” structure is a system that comprises of multifunctional parts that can sense, control, and actuate. It is a primeval analogue of a biological body. “Smart” materials are the ones used for constructing these “smart” structures that can perform sensing as well as actuation functions. [1]

Historically, in the first half of the twentieth century was the struggle of scientists to improve the quality of materials (for example, to improve the characteristics of metallic materials by 20-30% through achievement). We can see that the role of metals and alloys in the middle of the twentieth century, reaching a maximum. When this resource was exhausted? Scientists and researchers have turned to other materials whose properties could be successfully replaced by metals –ceramics, polymers, composite materials, the role of which increases during the last quarter of the twentieth century to the present day.

It should be noted the emergence in the late twentieth century a large number of new materials. Materials science begins to use functional materials. We can assume that the functional materials are all materials that have certain properties and are intended to use under certain circumstance. These materials are nontraditional classical or structural. They included all the latest materials developed over the last ten – twenty years.

There is a definite classification of materials:

- construction material;
- composite material;
- functional material;
- intellectual material;

The first three species studied in detail, and intellectual materials are new to science and engineering. Thus, the smart materials are considered the materials of the 21 –st century. These materials are capable of responding to external stimuli, perform three functions: sensor, processor, and the executive. They perceive the environmental conditions, analyze their impact on the material and react accordingly. But now there is still no fully intelligent materials, there are only material capable of performing some functions prescribed to them.

Types of “smart” materials

The commonly encountered “smart” structures and materials can be categorized into three types:

- “Smart” Structures: This type is an integration of actuators, sensors, and a control system that imitates the biological body in doing several

sought-after functions like self-repair of damages, synchronization with environmental variations, etc.

- Single Phase Materials: This category includes several ferrous materials along with those with one or more huge anomalies related to phase-transition phenomena. [2].

Composite Materials: Functional composites are normally designed to make use of non-functional materials to improve functional materials or to blend many functional materials to develop a multifunctional composite.

Some natural materials are born to be “smart,” such as piezoelectric, electrostrictive, and magnetostrictive materials, but they are far from satisfying the diversified needs of “smart” structures. Most natural materials also have limited amplitude in response and must be operated in a limited temperature range. One could, however, use chemical and mechanical engineering to create “smarter” materials and to tailor their properties for a particular “smart” structure design.

Applications of “Smart” Materials

There are many possibilities for such materials and structures in the manmade world. Engineering structures could operate at the very limit of their performance envelopes and to their structural limits without fear of exceeding either. These structures could also give maintenance engineers a full report on performance history, as well as the location of defects, whilst having the ability to counteract unwanted or potentially dangerous conditions such as excessive vibration, and affect self repair. [3].

“Smart” Materials in Aerospace

Some materials and structures can be termed ‘sensual’ devices. These are structures that can sense their environment and generate data for use in health and usage monitoring systems (HUMS). To date the most well established application of HUMS are in the field of aerospace, in areas such as aircraft checking.

An aircraft constructed from a ‘sensual structure’ could self-monitor its performance to a level beyond that of current data recording, and provide ground crews with enhanced health and usage monitoring. This would minimize the overheads associated with HUMS and allow such aircraft to fly for more hours before human intervention is required.

Design principles and methods for creating smart materials

“Smart” materials can change their characteristics and the shape and regulate the response to new conditions, in accordance with their level of change. As a result of a “smart” materials in materials science emerged the

concept of "learning" materials and "feel" of limiting situations.

For the "smart" behavior of the material should be non-linearly varying properties.

'Smart' materials based on:

- Control of basic functions;
- Optimization of properties by learning;
- The presence of these sensors, which control the change of environmental factors;
- Ability of material to analyze the situation that has arisen due to changes in the environment;
- Ability to respond to the results of its own analysis of the environment.
- 'Smart' ability provides composite materials to make up the components of shape memory alloys with magnetic properties, fiber-optic sensors, piezoelectric sensors, electro rheological fluids and other elements that have multiple non-linear variable characteristics. The production technology of "smart" materials based on the embedding of the above components in a polymer matrix. One of the technology, to create "smart" materials by embedding them in the structure of the fiber-optic sensors. Such sensors can monitor the processes occurring during the formation of products from "smart" materials, as well as to monitor their condition during the operation and respond to changes occurring in them due to environmental influences.

The presence of fiber-optic sensors in real-time information about the behavior of the product of "smart" material, and at an early stage to detect changes in its structure long before the appearance of irreversible deformation.

However, the incorporation of these sensors is not lost on the structure and properties of the

composite material, because the diameter of optical fibers on the order of magnitude or more greater than the diameter of the main reinforcing fibers in the material, giving rise to internal stresses in it.

Conclusion.

The field of "smart" materials and structures is interdisciplinary between science and technology and combines the knowledge of physics, mathematics, chemistry, computer science, and material, electrical, and mechanical engineering. It implements human creativity and innovative ideas to serve human society for such tasks as making a safer car, a more comfortable airplane, a self-repair water pipe, etc. "Smart" structures can help us to control the environment better and to increase the energy efficiency of devices. In the future, with the help of miniaturized devices such as electromechanical devices, we expect to see structures that can be "smart" enough to communicate directly with the human brain. The development of supersensitive noses, ears, and eyes would enable us to smell more scents, hear beyond our frequency range, and see what we cannot normally see, such as the infrared spectrum. There are a lot of demands on "smart" structures, and the imagination of scientists is unlimited. We can expect to see smarter materials and structures being developed in the near future.

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THERMOPLASTIC ELASTOMERS AND THEIR APPLICATION IN CABLE INSULATION

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The development of modern technology and new synthetic materials enhances the range of cable products and the application of new materials in the manufacture of cable insulation. In order to meet the increasing reliability requirements to insulation new thermoplastic materials have been developed. The application of these thermoplastic materials covers the wide range of cables used in different branches of industry such as medicine, power, civil

engineering, defence and automotive industries. Novel insulating materials have to provide such properties as durability, flexibility, wear, mechanical, and chemical resistance. Besides this materials must be weatherproof, not very expensive, having a higher level of flame retardance without significant degradation of physical and mechanical properties when compared to other compounds. Thus, these materials provide the benefits of traditional

materials without the tradeoffs commonly associated with use of the conventional materials.

Materials used in different spheres influence virtually every segment of our everyday lives. Historically, materials have played a major role in the development of societies and the advancement of human life depends on the access to materials and the ability to produce and manipulate them. With time new techniques for producing materials that had properties superior were discovered. Furthermore, it was proved that the properties of a material could be altered by heat treatment and by adding other substances to produce a new material. Until recently, selecting a material involved choosing from number of familiar materials the one most appropriate for the intended application by virtue of its characteristic but without knowing much about its structure. Modern techniques such as x-ray diffraction, cone calorimetry, electron microscopy and scanning electron microscopy make possible to see further into the structure, which leads to improvement of materials properties. Thermoplastic elastomers have been developed as new generation materials that have replaced many materials in use. Recent global trends have significantly impacted the availability and pricing of these materials.

A true insulator is a material that does not respond to an electric field and completely resists the flow of electric charge. Insulators used for high-voltage power transmission are made from glass, porcelain, or composite polymer materials.

Composite insulators are less costly, lighter in weight, and have excellent hydrophobic capability. This combination makes them ideal for service in polluted areas. However, these materials do not yet have the long-term proven service life of glass and porcelain. Thermoplastic elastomers (TPE) are the most promising class of insulating materials in the modern cable industry. Elastomer is a substance having to some extent the elastic properties of natural rubber. The term is sometimes used technically to distinguish synthetic rubbers and rubberlike plastics from natural rubber.

The most important consideration is that of economics. TPEs have the ideal set of properties and are relatively cheap. The benefits of these materials have been well documented in the literature and demonstrated practically. Wide application of TPE is based on the number of advantages such as softness at a wide temperature range, elasticity and recoverability in comparison with other plastics. Polyurethane elastomers possessing unique physical-mechanical properties play a vital role both in world industry and agriculture. Polyurethane

elastomers are used instead of rubber, plastic and even some metals, that do not have such operational characteristics as this developed new material. Typical products range from tiny grommets to large sealing elements that withstand the most extreme environments where for instance high temperatures, pressures and aggressive chemicals combine to create a demanding environment.

The properties of thermoplastic elastomers can be shown by the example of two trademarks that are the market leaders in cable insulation production: COGEGUM® GFR/365 (Solvay, Belgium) and Elastollan LP 9276 (BASF, Germany).

Cogegum® AFR series consists of polyolefin-based halogen free flame retardant (HFFR) silane crosslinkable compounds (LSOH-FR) for wire and cable sheathing and insulation, improved by addition of a catalyst (Sioplas method). These materials contain a fire retardant system that contributes to give the cable self-extinguish properties without halogenidric acids evolution together with low smoke emission. Special series COGEGUM® GFR/365 is mainly intended for oil and fuel resistant insulation and sheathing. Main applications refer to railway, oil industry, power cables, as well as photovoltaic and solar panel cables.

The wide area of application is determined by the improved material properties, such as

- wide working temperature rating (−40 °C to 125 °C);
- high wear and tear resistance;
- high fire resistance;
- resistance to hostile environments (such as weather impact, UV, alkaline and acid fluids);
- good electrical properties (excellent electric conduction in hostile environments);
- low toxicity (compound without halogen fire retardants);
- high extrusion speed.

Identical properties have thermoplastic polyurethanes (TPU) made on the basis of simple and complex polyesters. TPU are formed by the reaction of: (1) diisocyanates with short-chain diols (so-called chain extenders) and (2) diisocyanates with long-chain bifunctional diols (known as polyols). The practically unlimited amount of possible combinations producible by varying the structure and/or molecular weight of the three reaction compounds allows for an enormous variety of different TPU. This allows urethane chemists to fine-tune the polymer's structure to the desired final properties of the material. The currently available TPUs can be divided mainly in two groups, based on soft segment chemistry:

- polyester-based TPUs (mainly derived from adipic acid esters);

- polyether-based TPUs (mainly based on tetrahydrofuran (THF) ethers).

TPU is known under the trade name Elastollan®. Elastollan®, as well as Cogegum®. These materials are used for cable operation at high and low temperatures in hostile environments under mechanical stress. However, there are some specific properties that distinguish these materials from similar materials. They offer such advantages as

- resistance to hydrolysis;
- resistance to microorganisms;
- excellent abrasion resistance;
- outstanding low-temperature performance;
- excellent mechanical properties, combined with a rubber-like elasticity;
- high shear strength;
- good oil and grease resistance.

In other words, polyether-based TPU is used only in cases where excellent hydrolysis and microbial resistance is required, as well as in cases where extreme low temperature flexibility is important.

In this regard, Elastollan® finds wide application in cable production for medical equipment, control systems, trailing and conducting cables for industrial robots and manipulators. Cable sheath made by Elastollan satisfy the highest requirements applicable to the protection of sensitive and expensive wire lines and control circuits. Because of this, it significantly increases their efficiency and reliability. Thus, downtime is reduced and equipment failure is minimized.

At present, the domestic market of cable products is represented mainly by the following insulating materials as polyvinyl chloride (PVC) plastic, rubber, polyethylene, polypropylene and various compounds. Unfortunately, these materials do not possess the full range of properties inherent in thermoplastics. In most cases, each of them is mostly good only at certain application. For example, the rubber has a high flexibility, moisture resistance and oil resistance, but at high temperatures, sunlight and UV rays loses its properties. Although PVC plastic has high resistance to weathering, alkalis and acids it has low degree of elasticity and insulation.

Currently thermoplastic elastomers attract the increased interest among world cable manufacturers, including the Russian

manufacturers. It is caused by the material properties, as well as some technological aspects and the advantages that these materials offer to industry. On the one hand, these materials possess simplicity and high speed of engineering procedure for applying TPE vein, excellent performance and full utilization by recycling. On the other hand most Russian cable factories are not equipped with modern production lines of continuous vulcanization, preferring equipment for extrusion. It is to be noticed that, the production process of rubber compounds is difficult and environmentally-unfriendly in terms of ecology.

Thus, the best solution in terms of reliability, ecology, cost and wear resistance are thermoplastic elastomers. They are gradually gaining favour over traditional materials used for cable insulation as they can be soften and moulded into useful articles. Their flexibility, durability and high impact strength make it possible to use them in applications such as cable insulation where sudden loads can occur.

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PECULIARITIES OF MODIFYING CARBON STEEL GRADE 20 IN PETROLEUM PITCH ENVIRONMENT

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The problem of free surface effect on the ductility and fracture strength have received much attention nowadays. The free surface compared to the intergranular and interphase surfaces has the highest excess energy due to larger deviations of the constituent atoms from their position in the ideal lattice. The resulting surface tension creates special conditions for origination, motion and interaction of structural defects.

In this paper we studied microhardness distribution over the sample surface of steel grade 20 before and after carburization.

Modifiable surface should be able to deform at a microscale level in order to delay origination of stress mesoconcentrators [1]. This is provided by origination of a cellular dislocation structure in the surface layers.

The modified metal–fullerene layer thickness was adjusted by changing carburization time of steel grade 20 samples in the environment of petroleum pitch, according to the method developed in [2]. To determine the effect of the carburized layer thickness on the mechanical properties of steel grade 20, micro– and macroindentation parameters were used.

To determine stress points across the sample surface the microhardness measurement was made before and after chemical and heat treatment. To measure the microhardness five samples of the same thermochemical treatment were used. The results of microhardness measurement of steel grade 20 before and after chemical and heat treatment are listed in Table 1 and shown in Figure 1.

Hardness measurements were made as well all over the sample surface before and after carburization. The results of hardness measurements are shown in Figure 2.

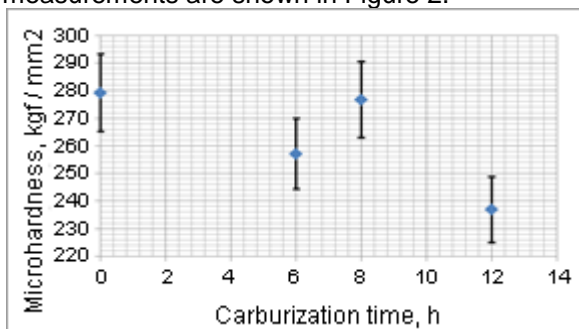


Figure 1 — Change of microhardness vs. change of carburization time

Table 1 — The results of microhardness measurements

| Exposure time, hours | Sample state | Microhardness, H _v |
|----------------------|--------------------|-------------------------------|
| 6 | No carburization | 266,9 |
| | With carburization | 241,9 |
| 8 | No carburization | 287,1 |
| | With carburization | 276,7 |
| 12 | No carburization | 283,5 |
| | With carburization | 236,9 |

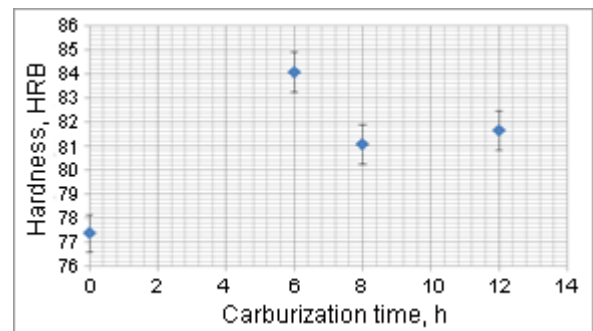


Figure 2 — Change of hardness vs. change of carburization time

The graphs presented in Figures 1 and 2 show that microhardness and hardness of the samples obtained at different carburization times behave oppositely, thus pointing to the decisive role of the carburized layer in mechanical properties formation. From the graphs we can conclude that the optimum carburization time is 12 hours. Carburized layer obtained under these conditions possess greater ability to deform at a microscale level. It may be connected with formation of a cellular dislocation structure.

It has been found earlier that metal–fullerene layer on the steel grade 20 surface obtained in petroleum pitch environment affects the corrosive characteristics [2]. Fullerene molecules have a closed π -shell with abundance of multiple bonds. They are able to accept electrons easily and reversibly without molecule denaturation. At the same time, Zakirnichnaya M.M. [3] has shown that fullerenes are mainly accumulated at the points of microdefects and dislocations, which may cause smoothing of stress microconcentrators all over the

surface sample during formation of fullerenes in the surface layer. This also results in decreasing corrosion activity.

Dark areas on the diagrams obtained correspond to a local microhardness improvement. Stress distribution over the surface of steel grade 20 can be inferred by the number of dark spots. From these diagrams it is clear that stress concentrators after carburization are smoothed resulting in increased corrosion resistance.

The results are shown in Figures 3–5.

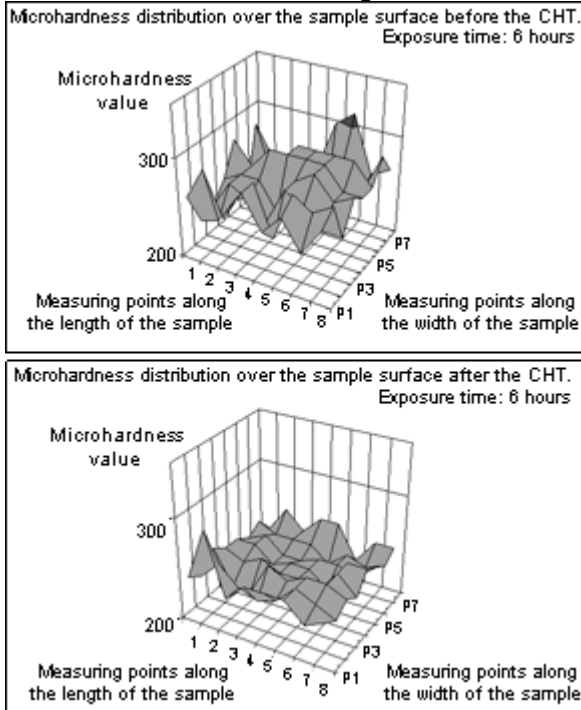


Figure 3 — Microhardness distribution over the sample surface before and after chemical and heat treatment. Exposure time: 6 hours.

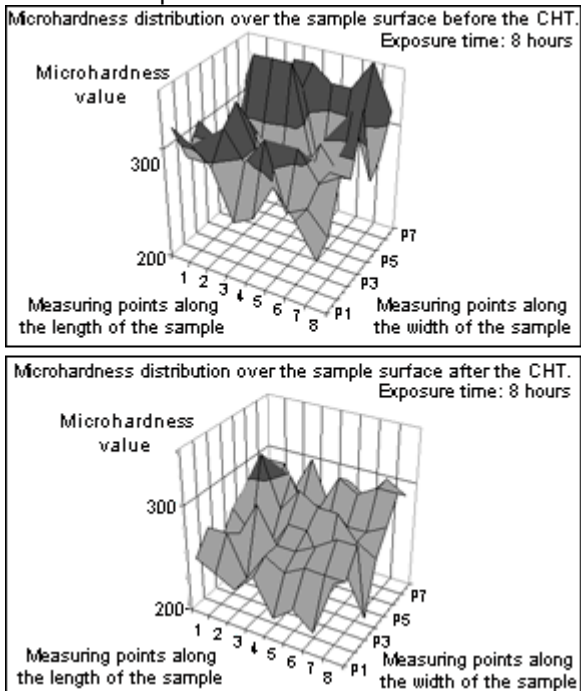


Figure 4 — Microhardness distribution over the sample surface before and after chemical and heat treatment. Exposure time: 8 hours.

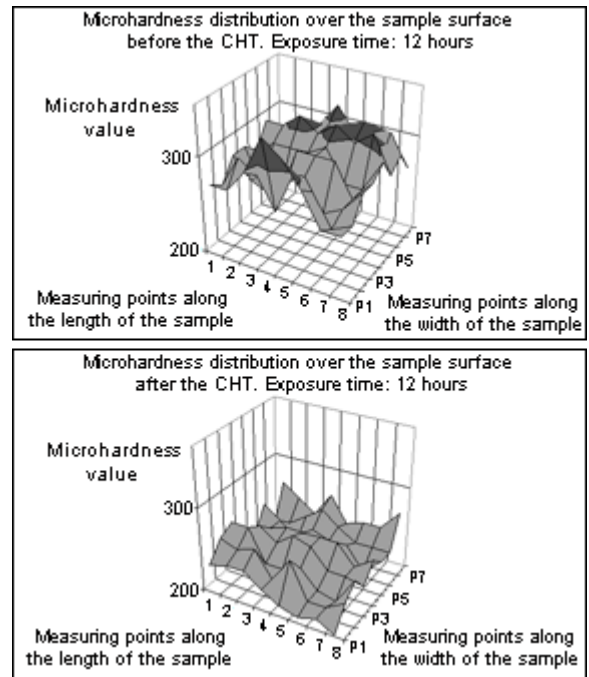


Figure 5 — Microhardness distribution over the sample surface before and after chemical and heat treatment. Exposure time: 12 hours.

The data obtained testify that this method is promising for industrial applications at the final stage of processing to improve operating characteristics of special-purpose products.

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DETERMINATION OF YOUNG'S MODULUS MATERIAL ON THIS SMALL SAMPLE ELASTIC LOADING WITH CHEVRON NOTCH

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1. Introduction

We know that when testing mechanical properties of materials with ultrafine-grained (UFG) structure small-sized samples are used [1]. Fracture toughness is usually measured on samples with a chevron notch [2-5]. For UFG structure different methods of intensive plastic deformation are applied [6]. As experience shows, mechanical properties of the material significantly change. The main characteristic of elastic properties of the material is the Young's modulus E . However, there is little information about the value of Young's modulus for the materials in the state of UMP. In this connection, the problem of determining the Young's modulus of metals and alloys with UFG structure, the resulting deformation of the IPD is very important. In ISPMS RAS in the laboratory of physical mesomechanics and non-destructive methods of control (LFM and DCC) a method of determining Young's modulus directly in the fracture toughness tests on specimens with chevron notch in the UFG state has been developed. This paper describes the use of this method to determine the Young's modulus for technical titanium VT1-0 and VT6 alloy in the UFG state.

2. Methodology of investigate and materials.

Chevron notch is a narrow slit, located symmetrically of the axis of the sample (Fig. 1). The boundary of a cut is given by a broken line with an angle α . When loading each half of the sample bends a certain value λ . In other words, half of the sample can be considered as a rectangular beam, one end of which is fixed, but on the other end a certain load P is attached (Fig. 2). It is known that for a rectangular rod of length l , width b and thickness a , the relationship between the deflection force F and the magnitude of λ is given by [6-8]

$$\lambda = \frac{4 \cdot P}{E \cdot a} \cdot \left(\frac{l_0}{b} \right)^3 \quad (1)$$

where E – is Young's modulus of the material.

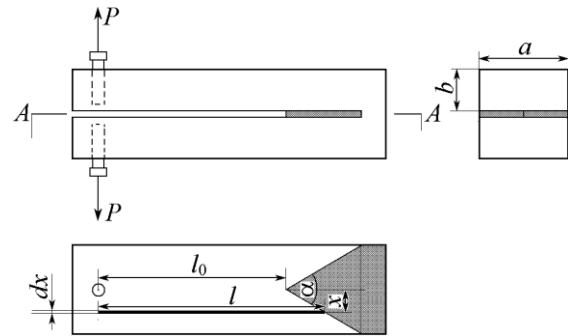


Fig.1. Scheme of the sample with the chevron notch. The cross section of the sample in the plane of the chevron notch is shown below.

Equation (1) is often used to determine the Young's modulus of structural materials [9,10]. From equation (1) that

$$E = \frac{4 \cdot P}{\lambda \cdot a} \cdot \left(\frac{l_0}{b} \right)^3 \quad (2)$$

However, it is impossible to use the formula (2) for the sample with a chevron notch, since the length l (Fig. 1) from the border of the notch to the point of application of the load varies, increasing as we move to the sample edge. The equation (1) shows that the change of l affects the results of the calculations. In the experiments, it is obvious that all points in the cross section of the sample at the place of the load shift to the same value of λ . Therefore, the formula (1) can be conveniently represented as follows:

$$\lambda = \frac{4 \cdot P}{E \cdot a} \cdot \left(\frac{l_0}{b} \right)^3 k, \quad \text{or} \quad E = \frac{4 \cdot P}{\lambda \cdot a} \cdot \left(\frac{l_0}{b} \right)^3 k, \quad (3)$$

where l_0 – is the distance from the tip of the angle chevron to the point of the load application (Fig. 1) and k – is correction factor to be determined. In ISPMS SB RAS and the NMC LFM this problem was solved using the theory of elasticity and strength of materials. For the coefficient k determination the equation is used:

$$k = \frac{\left[2 + \frac{a}{l_0} \cdot \cot \frac{\alpha}{2} \right]^2}{4 + \frac{a}{l_0} \cdot \cot \frac{\alpha}{2}} \quad (4)$$

Thus, the value of Young's modulus according to

the deflection of the sample with a half chevron notch is

$$E = \frac{4 \cdot P}{\lambda \cdot a} \cdot \left(\frac{l_0}{b}\right)^3 \cdot k = \frac{4 \cdot P}{\lambda \cdot a} \cdot \left(\frac{l_0}{b}\right)^3 \frac{\left[2 + \frac{a}{l_0} \cdot \cot \frac{\alpha}{2}\right]^2}{4 + \frac{a}{l_0} \cdot \cot \frac{\alpha}{2}} \quad (5)$$

The materials for the determination of Young's modulus were technical titanium and ultrafine-grained high-strength condition and VT6 titanium alloy with UFG structure. Tests were performed on the machine type strain IME. Thus loading curves "load displacement" are observed. From the slope of the curve in the elastic stage of the loading a certain value corresponded to a certain load P offset points of load application to the ends of the sample with a chevron notch (see Fig. 1). It is obvious that the value of λ is half the displacement of the ends of the sample with a chevron notch. The samples had the following geometrical characteristics: $a = 6$ mm, $b = 1,9$ mm, $l_0 = 8$ mm, $\alpha / 2 = 30^\circ$, $(\cot(\alpha / 2) = 31/2)$. For a given geometry, the value of the coefficient k in equations (4) and (5) was found to be $k = 2,054$. Excluding the factor of k , by calculating, for example, by (2) and $l = l_0$, we would get an incorrect value of Young's modulus, which turned out to be a factor of 2 smaller.

For ultrafine state for titanium, VT1-0 was used in the developed ISPMS RAS method of intensive plastic deformation, including abc-compression and multi-pass rolling [9]. UFG VT6 state obtained using the full forging.

3. Results

By formula (5), we calculated the Young's modulus for technical titanium VT1-0 and VT6 alloy in the UFG state. Previously developed method was tested on the example of the technical state of titanium in the supply, for which Young's modulus is known from the data sheet $E = 110$ GPa [10]. Microstructure of technical titanium VT1-0 consisted of equiaxed grains of α -phase with an average size of 15 microns. Calculation by formula (5) gave a value of $E = 110.99$ GPa, which indicates the effectiveness of this method to determine the elastic modulus.

For technical titanium VT1-0 according to the load chart calculations by formula (5) give values in the range of $E = 90$ GPa.

Young's modulus of titanium VT6 in the initial state is approximately $E_{in} = 115$ GPa [11].

According to the equation (5) we obtain the value of $E = 98.6$ GPa.

4. Conclusion

The calculations showed that the values of E for UFG materials are less than for the coarse material. The difference seems to be due to the fact that in the defective material, which is the material after intensive plastic deformation, Young's modulus of the general considerations must always be less than in defect-free material, that is, in a more stable thermodynamic state.

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COMPOSITIONAL AND IRRADIATION EFFECTS ON THE SPECTROSCOPIC PROPERTIES OF RARE EARTH DOPED PHOSPHATE GLASSES

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Abstract

A series of glass samples with different glass compositions doped with 5wt% Dy₂O₃ were prepared. Excitation and cathode-luminescence spectra were measured, for which the observed peaks are attributed to the *f-f* transitions of the rare earth ions. The variation in the spectroscopic properties of the obtained glass was correlated to the variation in glass composition. Effects of high energy electron irradiation on the emission intensity and decay time were investigated.

Introduction

Rare earth ions find wide applications in sensitizing solid state and glass lasers, infrared quantum counters as well as infrared to visible converters. Energy transfer between ions in solids can be accomplished either radiatively or nonradiatively and the mechanism and kinetics involved have been extensively addressed [1, 2]. Many workers have treated the compositional and structural effects on the spectroscopic properties of the doped crystals and glasses [3–6]. Irradiation of the host matrix also results in modifications of the host structure and creates color centers that affect its emission properties [7–10].

Experimental

For the current work, a glass system of composition-50P₂O₅-xLi₂O - (50-x)ZnO :5wt%Dy₂O₃ is prepared from high purity chemicals (Aldrich chemicals), using the melt-quench technique, where *X* changes in steps of 10, and ranging from 0 to 50 mol%. Excitation spectra were recorded at room temperature using a Jasco spectrophotometer FP-777. Cathode-luminescence intensity and decay kinetics were recorded using a photomultiplier FU 106, system of monochromator MDR-3 and GW-Instec GDS-2204 oscilloscope for signal detection.

Results and discussion

Cathode-luminescence spectrum of the samples, (as shown in Fig.1.) consists of blue and yellow emission lines which can be assigned to the *f-f* transitions of the Dy³⁺ ion as follows (from ⁴F_{9/2} to ⁶H_{15/2} at 481 nm) and (from ⁴F_{9/2} to ⁶H_{13/2} at 575 nm).

The excitation spectrum of the Dy³⁺ doped glasses given in figure 1 shows that the excitation of the Dy³⁺ ions is accomplished by the excitation of the ⁶H_{15/2}, ⁴P_{7/2} states which then relaxes non-radiatively to the ⁴F_{9/2} state, part of this excitation energy depleted through non-radiative cross relaxation [11]

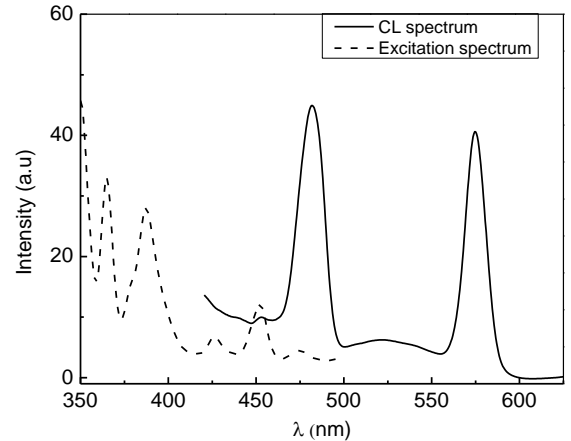


Fig. 1. Excitation and emission spectra of the Dy³⁺ - doped phosphate glass

The CL emission intensity is found to increase with increasing the composition factor *X* as shown in figure 2. Lifetimes of the ⁴F_{9/2} level are found to increase from 350μs to 200μs with the increase in the composition factor *X*, suggesting that the consequent replacement of ZnO by Li₂O minimizes the possibility of energy depletion from the excited state via energy transfer between the rare earth ions. It is stated that, energy transfer between Dy³⁺ ions plays important role in the emission properties of Dy³⁺ ions because of its closely spaced energy level diagram.

P₂O₅ based glasses consists of PO₄ tetrahedra connected via bridging oxygen ions with P-O bonds, and one dangling double bonded oxygen ion (non-bridging oxygen). Using IR investigation of similar glass composition [12] it was found that the presence of ZnO in glass composition creates non-bridging oxygens. So we could conclude that the replacement of Li₂O in the glass systems under study, by ZnO results in an increase of non-bridging oxygens. The existence of which increases the covalency of RE-O bonds, and enhance the RE site symmetry which may lead to enhancement of energy transfer. Because minimizing the possibility of Non-radiative energy transfer results in an increase in the emission intensity.

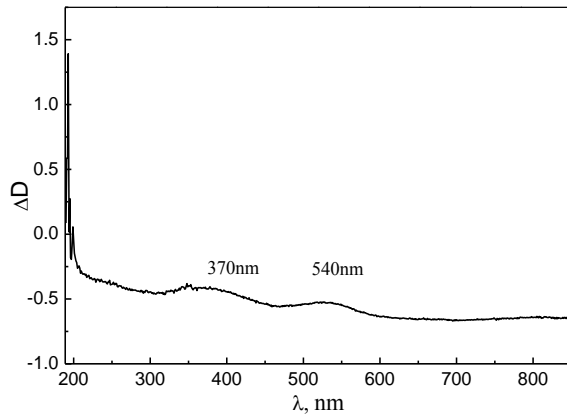


Fig. 3. Absorption spectrum of the color centers.

The irradiation of the phosphate glass matrix has similar effects to that of changing the glass composition. Where the bombardment of the glass matrix with high energy electrons results in the creation of color centers. Examined by the measurement of optical absorption of the sample before and after irradiation, the difference in absorbance is plotted as a function of wavelength (fig.3). The resulted color centers creates paths for energy transfer through which higher levels of excitations can be achieved during the excitation process while during the emission process this color centers offer pathway for cross relaxation and nonradiative energy transfer. The mentioned effects of the color centers lead to increase the emission intensity while decreasing the emission decay time from 360 to 220 μ s.

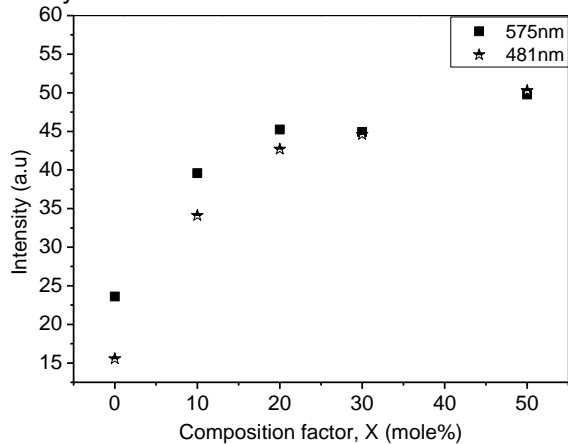


Fig. 2. Variation of the emission intensity with the composition factor, X

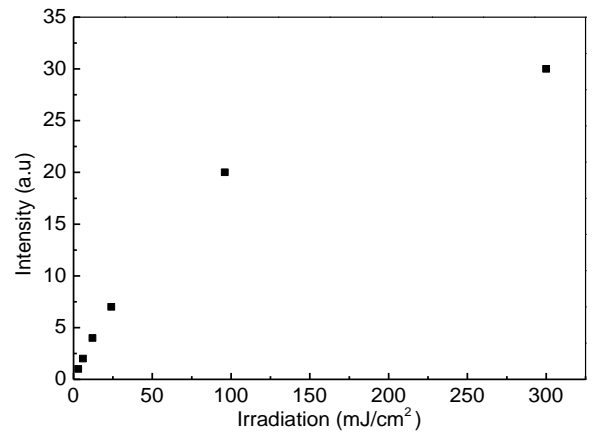


Fig. 4. Dependence of the emission intensity on the radiation dose

Conclusion

The irradiation of glass matrices with a high electron beam has the effect of creating color centers that playing similar role of changing the glass composition. These color centers efficiently increase the emission intensity while decrease the emission decay times.

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INVESTIGATION OF THE DEPENDENCE OF SILUMIN FLUIDITY ON THE TEMPERATURE OF THE ALLOY AND PROPERTIES OF POLYSTYRENE FOAM

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This article focuses on the method of lost foam casting (LFC) which is gaining popularity among the established technologies in recent decades in the foundry business. The most important feature of the method is to obtain a pattern; the quality of the pattern impacts the quality of a casting. Casting pattern is made of polystyrene foam.

The patterns used in the LFC technology, in order to obtain good castings, must meet certain requirements:

- the pattern's surface should be smooth, without roughness and external defects;
- density of the models must not exceed 0.027 - 0.032 g/cm³.

Based on these requirements there are certain requirements to polystyrene:

- grain-size composition of the material should be even;
- the content of the foaming agent (pentane) should not be less than 5.5%;
- the material should be evenly baked, be resistant to pressure and temperature [1].

The formation of the casting is the result of interaction of the form, metal and pattern. A pattern even from light porous foam significantly alters heat-mass-exchange processes of the system metal - form. This is confirmed by the practice of this method, for example, the formation of such defects as sandbuckle on the surface of the casting [2].

As any other method of casting the LFC has a lot of technological features. In this paper we consider the dependence of casting quality on thermal degradation of polystyrene foam as an example of the alloy of silumin and three brands of polystyrene foam (PRP-C-50 and extruded polystyrene foam, Penoplex 35 Penoplex 31).

The dependence of the casting quality depends on the thermal degradation of polystyrene foam. Polystyrene foam pattern destroys, and the products of this process are removed from the pattern by gas flow. The process of destruction of the pattern is complex. It would be wrong if we characterize it only as gasification, though the term "lost foam" has firmly established in the terminology of foundry.

In practice, for the production of artistic articles we use an easily accessible polystyrene foam such as packaging for a TV, or a plate for a single usage, which are made for mass production on machines, as well as blocks of polystyrene foam are used to make coldproof exterior walls of high

buildings. The given work investigates which ready-made polystyrene foam is better to use for casting practice. We also try to identify the minimum cross-section and sizes of the pattern, as well as the recommended temperature of the casting of the alloy silumin for each of the samples.

The test samples were 100 × 100 × 20 mm, each of polystyrene foam was accurately measured with a caliper. The obtained data allowed to find the density of each brand of the samples (Table 1).

| | PS B-S-25 | Pe noplex 35 | Pen oplex 31 |
|------------------------------|--------------|--------------------|--------------------|
| Density kg/m ³ | 15- 16 | 28- 37 | 28- 30,5 |

Table 1 Density

To determine the minimum possible cross-section castings, samples of length 150 mm and sections 5x5mm, 10x10mm, 15x15mm were cut (Fig.1) [4]. Then three samples of different cross sections of polystyrene foam were collected in the pattern blocks (Fig. 2). The alloy of silumin AK 12 was used casting. To carry the research we used four temperatures of castings 600, 700, 800, 900 ° C.



Fig. 1 The samples of various sections



Fig.2 The pattern block

The obtained samples were measured from the gating system. The data were written down in the table and presented in the diagram 1. The best polystyrene foam was polystyrene foam PSB-S-25, in practice it was the only material which filled the test sample of 15×15 at 700 °C and showed good results when filling sections 10×10. The rest of the samples with the

section of 15×15 also showed excellent results at the temperature of the alloy above 800 °C (Fig. 3).

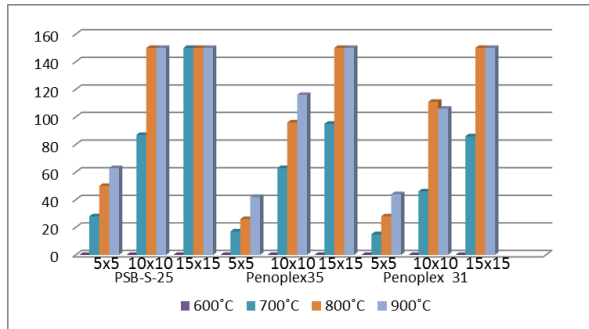


Fig. 3 The results of the research

Based on the results we can see that the small cross-section patterns are allowed with the limit of the length of the item 50mm. It should be noted the difference of surface quality when creating different patterns of polystyrene foam. PSB-S-25 is less dense, with large granules, it proved to be better in terms of fluidity of the metal, but the surface quality is much worse than that of more dense and fine-grained Penoplex 35 or Penoplex 31. Consequently, it is better to use Penoplex, it will reduce the cost of subsequent machining of the item. If the cross section and length of the pattern do not allow the use of Penoplex, the surface pattern of polystyrene PSB-S should be treated with paraffin.



Fig.4 The results at 900 ° C

From this work we can conclude that the temperature above 800 °C (Fig. 4) with a pattern from polystyrene foam PSB-S-25 has the best casting properties for LFC among the four presented temperatures of alloy casting.

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TUNGSTEN CARBIDE. RESEARCH AND MANUFACTURING

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Tungsten Carbides have a wide range of application in many industry sectors such as metal machining, wear parts for mining and oil industries, metal forming tools, cutting tips for saw blades and have now expanded to include consumer items such as wedding rings and watch cases, plus the ball that is in many ball point pens.

Cutting tools must be able to resist high temperature and severe temperature gradients, thermal shock, fatigue, abrasion, attrition, and chemical induced wear [1, 2]. Thus materials for cutting tools and dies must have high hardness to combat wear, hot strength to overcome the heat involved, and sufficient toughness to withstand interrupted cuts or

vibrations occurring during the machining process. Cutting tools are a two billion-dollar industry worldwide and form the backbone of manufacturing operations for metals, polymers, and advanced materials such as intermetallics and composites of all types [1, 2].

Tungsten carbide (WC) is an inorganic chemical compound) containing equal parts of tungsten and carbon atoms.

Tungsten Carbide is often referred to as a Hard Metal due to its very high hardness in relation to other metals. Typically a Tungsten Carbide Hard Metal can have a hardness value of 1600 HV, whereas mild steel would be in the region of 160

HV a factor of 10 lower. Although called a hard metal, Tungsten Carbide is actually a composite material with hard particles of Tungsten Carbide embedded in a softer matrix of metallic Cobalt. The high solubility of WC in cobalt at high temperatures and a very good wetting of WC by the liquid cobalt binder result in an excellent densification during liquid phase sintering and in a pore-free structure.

Important properties of WC-Co are hardness, strength, high breaking and beating ductility as well as high electrical and thermal conductivity. By varying the metallic cobalt content and the tungsten carbide grain size, important properties of the alloy can be specifically adapted. This fact is illustrated in Figure 1 with respect to hardness.

Tungsten Carbide are primarily produced using a Powder Metallurgy process, whereby the powdered forms of tungsten carbide and cobalt are mixed using ball mills, a binder material is added to hold the powders together during the next stage of the process which is compaction or pressing.

During the compaction processes, hydraulic presses or isostatic presses are used to compact the powders into a shape which approximates the design of the finished product. The sintering process causes the tungsten carbide and cobalt matrix to fuse together to produce a dense "Hard Metal". After sintering the material is so hard that it can only be machined by diamond grinding, a specialised form of micro machining that is relatively expensive as it is not possible to remove large amounts of materials by this process.

The primary requirement is the availability of nanosized starting powders (~ 100 nm). Preliminary attempts to produce nanosized WC-Co powders were based on mechanical crushing and grinding of the coarser powders.

The development of nanosized WC-Co powders in larger scale received a major impetus with the development of a chemical synthesis technique, called 'spray conversion process' (SCP). Such a process involves rapid spray drying of aqueous solutions of water soluble precursors, followed by thermochemical conversion to nanostructured WC-Co powders in a fluidized bed reactor. Such process is now routinely used to commercially produce nanocrystalline carbides, which are used for fabricating bulk nanostructured cemented carbides [5].

Liquid phase sintering is widely used for consolidation of conventional WC-Co powder. After cold compaction of WC/Co containing a lubricant - binder such as paraffin in a high-pressure hydraulic press, the powder compact is heated in vacuum or hydrogen to a temperature above the pseudo-binary WC-Co eutectic where liquid phase sintering occurs. Theoretically dense

structures are routinely produced by this method. However, sintering usually causes grains to grow larger. One of the challenges in the quest for nanostructured materials, including WC-Co, has been controlling the grain growth during sintering [3, 4]. This problem and other problems related with the effective synthesis composite materials based on tungsten carbide is successfully are solved.

In all these applications, there has been a continuous expansion in the consumption of cemented carbide from an annual world total of 10 tons in 1930; to 100 tons around 1935; 1,000 tons in the early 1940's; through 10,000 tons in the early 1960's and up to nearly 30,000 tons at present.

The development and improvement of cemented carbide cutting tools have supported the exponential increases in metal cutting productivity (measured by cutting speeds) in this century. Materials of the future will have to satisfy the requirements imposed by high-speed machining, such as high-temperature strength, chemical stability, and oxidation resistance. Currently, research is aimed at developing grades having improved wear, corrosion, and oxidation resistance [2,3]. Nano-grained WC/Co composites have the potential to become the new materials for tools and dies, and wear parts. Benefits of nano-grained WC/Co approach include shorter sintering time, high purity, and precise control of composition. These materials have superior properties and more homogeneous microstructure than those of conventional WC/Co composites do.

The research results over the last decade have unambiguously established the superiority of bulk nanocrystalline WC-Co cemented carbides, with respect to their room temperature hardness, strength and wear resistance. It is believed that usage of WC-Co nanocomposites are likely to result in improved performance in demanding applications and also increase in tool.

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| Section VII | |
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INFORMATICS AND CONTROL IN ENGINEERING SYSTEMS

A FAST GENETIC ALGORITHM FOR SOLVING BOOLEAN EQUATIONS EXPRESSED AS AND/OR TREES

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1. Introduction

The problem of solving Boolean equation can be always deduced to satisfying some Boolean formula.

The satisfiability problem (SAT) is of central importance in various areas of computer science including hardware and computer-aided design, artificial intelligence, algorithms, software verification, operations research and automation [1].

The Cook–Levin theorem [2] proves that the Boolean satisfiability belongs to NP-complete class. According to this theorem [2], any other NP-complete problem can be reduced by a bijective function to SAT. That is why SAT deserves a special interest.

Lots of works have studied SAT and proposed various heuristic solvers. In particular, application of genetic algorithms to SAT has become popular. The majority of these algorithms require deducing the general SAT problem to a normalized form – CNF, 3-SAT or k-SAT, leading to an exponential growth of the Boolean formula. Some works [3] suggest using real-valued fitness functions, or even switching from zeros and ones to a continuous domain – fuzzy logic approach [1]. This inevitably causes precision problems and increases computation time.

The algorithm proposed in this paper is very universal and operates with integers exclusively. The only requirement is that Boolean formula should be expressed using AND (\wedge), OR (\vee) and NOT (\neg) operations. Since $\{\wedge, \vee, \neg\}$ constitute a complete basis for Boolean algebra this constraint is very mild. At the core of our algorithm AND/OR tree formula representation lies.

2. Problem statement

The problem of solving a Boolean equation can be stated as follows: given a Boolean formula F , find a truth assignment for a set of variables $X = \{x_1, x_2, \dots, x_n\}$, with $x_i \in F$ for $i = \overline{1, n}$, such that $F(X) = c$, where $c = const$, $c \in \{0, 1\}$.

If c equals 1 then this problem is an instance of SAT. Only this case will be considered, since $F(X) = c$ and $\overline{F(X)} = \overline{c}$ have the same solutions.

AND/OR tree is a compact, visual and efficient in handling way of representing Boolean formulas over a $\{\wedge, \vee, \neg\}$ basis. Moreover, it can be shown that any combinational circuit can be expressed as

a system of AND/OR trees [4]. An AND/OR tree corresponding to the formula $a \vee ((\overline{b} \vee c) \wedge d)$ can be seen in Fig. 1. Leaves of the tree correspond to variables, internal vertices are marked with symbols \wedge or \vee . All the negations in the formula should be dropped to variables. Note that the tree is not necessarily binary.



Figure 2. AND/OR tree

The satisfiability of F is equivalent to obtaining the value 1 in the root of the corresponding AND/OR tree by assigning values 0 and 1 to the leaves.

3. Solving SAT problem with genetic algorithm

A genetic algorithm (GA) is a search heuristic based on the simulation of natural mechanisms and Darwin's "Survival of the Fittest" [5].

The classic scheme of GA comprises a population of chromosomes whose genotype is encoded in binary strings, a fitness function that evaluates a "goodness" of each individual and a sequence of generations – an evolution that leads the chromosomes to the optimum of some objective function [5].

In the context of our problem, chromosomes are represented as binary strings – the i^{th} symbol of such string corresponds to the variable x_i in the solution.

Let's consider a partial solution – a truth assignment setting some of the internal vertices but not the root to 1. The value 1 will climb up the tree satisfying node after node. So it would be natural to think of a "goodness" of a solution in a following manner: the better the partial solution is, the higher the value 1 will climb, the less the distance from the root to the nearest true value will be.

The first thought would be to define the objective function as the minimum of the distances from the root to the nodes satisfied by the partial solution. This function should be minimized as its zero value obviously corresponds to an exact solution. But this approach proves to be less than effective. If there are multiple vertices on the same layer of the tree, then a huge number of solutions will be indistinguishable and potentially good sets of variables will be lost. For example, when satisfying a formula in CNF partial solutions that

satisfy only one clause will be as “good” as the ones that satisfy several clauses.

Let’s design an objective function that doesn’t have this kind of flaws. A “good” solution climbs up to the root and satisfies as many nodes as possible. While the ascent of the tree will eventually lead us to an exact solution, the increase in satisfied nodes will improve the chances of several truth values 1 meeting in the internal node. The objective function with these properties can be defined as a sum of distances from the root to the 0-valued leaves reachable from the root without visiting any satisfied node. This definition comes from the observation that if some node doesn’t lie on any of these unsatisfied paths from the root to the leaves than this node is satisfied. The distance is there because the leaves that are closer to the root are easier to cut from it by the satisfied node, thus we give a higher priority to the solutions that cut away the deepest leaves. Zero value of the objective function still corresponds to an exact solution. In the context of GA, the fitter individuals correspond to the smaller values of the objective function.

Having the objective function defined we select the genetic operators and the parameters of the GA by trial and error strategy. The summary of the parameters of the GA can be seen in table 1.

Table 1. Overview of the GA parameters

| Parameter | Value |
|------------------------|----------------------|
| Size of the population | 200 |
| Number of generations | 10000 |
| Number of clones | 10 |
| Mutation rate | 1/(number of loci) |
| Crossover rate | 1 |
| Type of crossover | uniform |
| Type of selection | tournament, size = 4 |

Increasing the size of the population can radically speed up the evolution. But this also increases the number of objective function evaluations, thus slowing down the computations.

Mitosis (clones the fittest individuals) warrants that useful alleles won’t be lost through generations.

As the fittest chromosomes are preserved by mitosis the crossover rate should be as high as 1. The uniform crossover (genes are inherited separately) is superior over the cutting the bit string in two pieces. Chromosomes in SAT problems have no structure, so the uniform crossover doesn’t destroy more patterns than a simple cut. On the contrary, it provides a more powerful way to search the solution space.

The somewhat classical mutation rate proves to be effective. Higher values result in random search.

Roulette selection degrades to random picking with population that large. Tournament selection is superior. Size of the tournament is set to 4 – raising the selection pressure results in slower convergence.

Summary of the parameters: destructive crossover type, large population, low selection pressure, medium mutation rate – proves that diversity in genotype is vital when looking for an exact solution.

4. Experimental results

The GA was implemented in C++ and tested on Intel Core2DuoE8500@3.16GHz and 4GB RAM. As in [1] one randomly generated minterm is chosen as a Boolean expression to be satisfied. It is a rather hard test for a stochastic solver – it has a unique solution. Besides, increasing the number of variables in the minterm demonstrates the scaling of the algorithm.

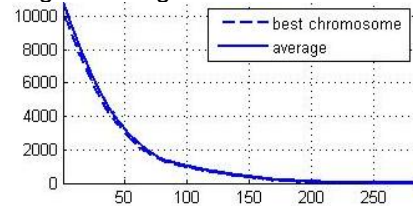


Figure 3. Best and average objective function per generation

Fig. 2 illustrates the behavior of the fittest individual and an average value of objective function per generation for the binary AND/OR tree representing the minterm of 2000 variables. We can observe that objective function drops almost exponentially and successfully converges to a solution after an average (of 100 runs) of 249 generations.

The computation time grows slowly with the number of variables N in minterm (Fig. 3). For each N the time is averaged from 50 runs. It is worth noting that the algorithm in [1] took 1.5 hours to solve 2400 variables minterm, while our approach took only 22 seconds in average of 50 runs.

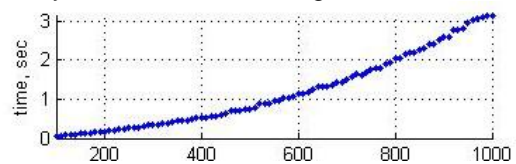


Figure 4. Correlation between the number of variables and algorithm execution time

Besides from satisfying minterms the developed GA was able to solve various SAT problems from [6].

5. Conclusion

In this paper we studied the application of AND/OR tree representation of Boolean expression to solving SAT problems using GA. We developed an effective objective function and optimized the parameters of the GA. The experimental results demonstrate advantages of our algorithm in terms of convergence and computational time. The developed algorithm can be applied to various practical problems – testing combinational circuits [4], for example. The future work includes the study of dependence between AND/OR tree structure and execution time; further development of the objective function.

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CREATION OF SOFTWARE TO AUTOMATE THE CALCULATION OF TARIFFS IN THE ELECTRICITY SUPPLY COMPANIES

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The main problem for urban lighting ventures is the annual change of tariff plans and the schedule of urban lighting, which leads to the problem of information updating, the correct calculation and routine actions. To solve these problems, the streetLightDB program was created.

To reduce possible errors, as well as to automate the data calculation, the software development was started.

Since the target audience - users of this software - works with operating systems of Windows family, Microsoft Visual Studio environment with the programming language C # was chosen as a means of development. The main reason for the choice of C # is its versatility, broad functional and the ability to solve various engineering problems.

• The users have an opportunity to view the information in the database. This feature is implemented by the creation of different directories (figure.1).

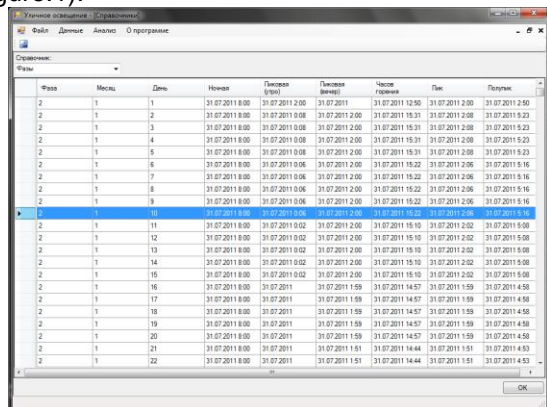


Figure.1. Fragment of the program interface (information view in a database)

• The ability to change the type of load is automated (figure.2).

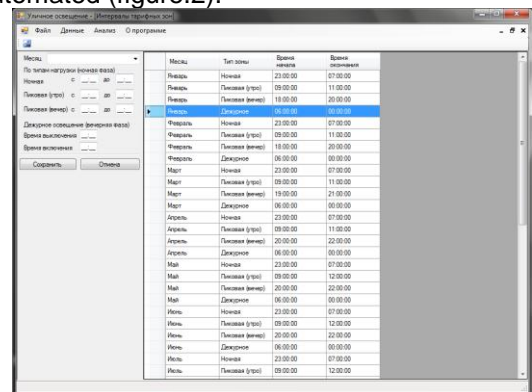


Figure.2. Fragment of the program interface (the type of load by month)

• There is also the possibility of the changing of data - time supply of electricity to the cascades (figure.3).

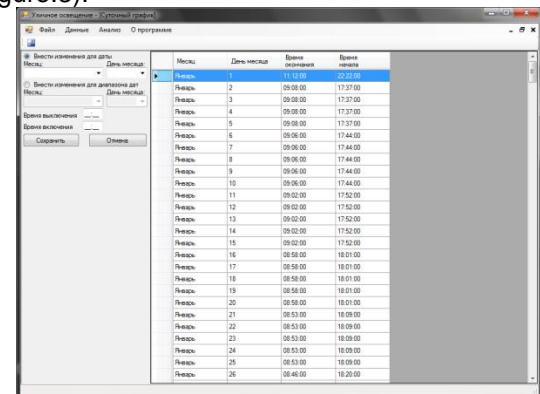


Figure.3. Fragment of the program interface (switching on and off cascades)

• The program also contains the information about the placed lighting units in the cascades (figure.4).

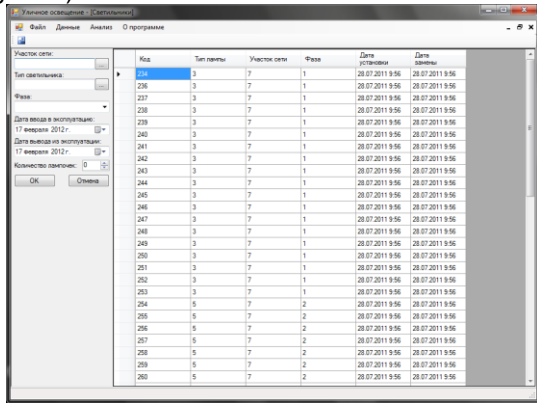


Figure.4 Fragment of the program interface (interface of adding of lighting units)

The main objects of the GUI are: TextBox, ComboBox, Button, Radiobutton, Label and DataGridView, are used to display the information from database tables.

The program has the following features:

1. Different methods of source data input by using TextBox, ComboBox and RadioButton.
2. A data validation occurs. This feature is created to except the transfer of incorrect data such as the symbolic information and the incorrect time intervals. The screening of the symbolic information occurs by using a special type TextBox, which does not pass the symbols (figure.5). Numerical values are checked by a special method.

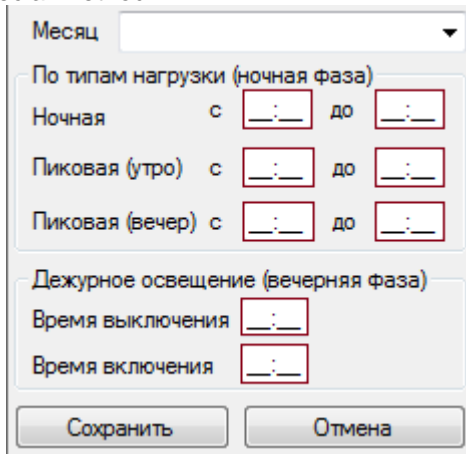


Figure.5 Fragment of the program interface (data validation)

3. In the program there is the ability to analyze both the data from the database and the data entered from the keyboard. To select the method of calculation there is required to note CheckBox (figure.6).

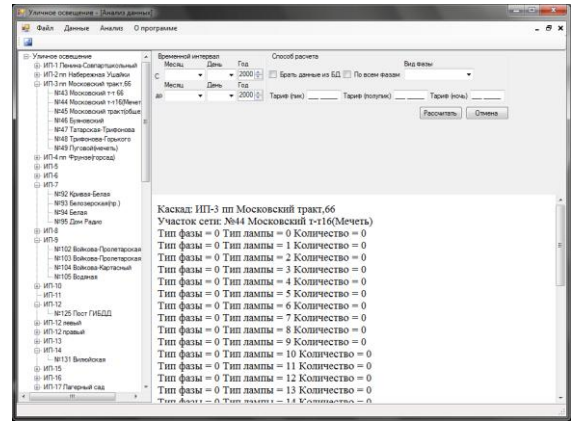


Figure.6 Fragment of the program interface (data processing and analysis)

4. The database for the program is implemented on MySQL (figure.7). It is an obvious advantage, since it allows to work in a local network to multiple users simultaneously. But the availability of the local network is not a mandatory requirement. All operations can occur on the local computer or even a laptop, because the program does not consume many resources. The sample from the database is executed by SQL queries.

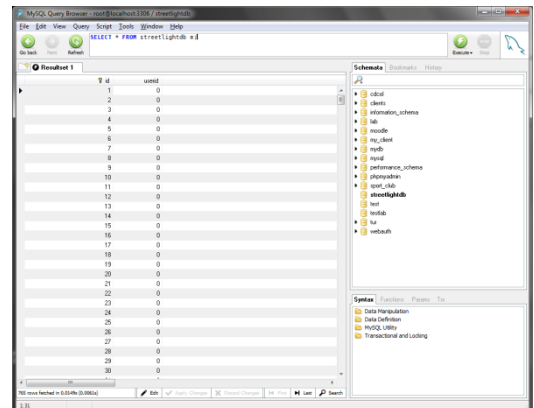


Figure.7 Fragment of the program interface (MySQL database)

The program is error-tolerant, because the database is uploaded by each workstation; and the connection break with the database will not bring fatal consequences of data loss. The exchange of the information with the database emerges only when there is required to update the database or complement it.

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INDEPENDENT SEMANTIC WEB APPLICATION

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Abstract

This paper presents new software architecture of semantic internet applications. The author analyzes existing approaches of development semantic applications and benefits of semantic technologies. New architecture proposed by the author uses the concepts of semantic user profile and client-side semantic analyzer. The problems of semantic data mining and implementation of sample application are also considered.

Introduction

The use of semantic information is a popular trend in the area of internet and service-oriented applications. The use of semantic information makes sense if the purpose and the value of sent or received information are dynamic and change in conjunction with user profile data, search queries and other variables. One of the core purposes of semantic technologies is to provide more relevant information to users. Many software developers and internet companies take attempts to implement concept "Semantic Web"[1] in their solutions. Each of these implementations cannot be used natively in the process of developing a generic internet application because they are tightly connected to their domain.

Internet search engines (Google and Yandex) detect vocabulary based markup of HTML document. Usually HTML tags which have specific semantic attributes are organized in a determined sequence presenting an article, user's review or another common entity. This type of sequence is called a micro-format. This way of presenting semantic information is convenient for search engines robots. The use of micro-formats is reasonable if a particular internet application is trustful. Otherwise, search SPAM and other unwanted content manipulation could cheat results of a search request.

Perhaps, a dynamic optimization of structure of a HTML document for each user of an application is much better strategy. In this paper dynamic optimization of HTML document structure for each user is proposed. This approach could decrease a number of turndowns and increase level of users' satisfaction. The turndown in terms of search engine optimization and internet analytics is a case when a user is not satisfied and immediately goes away from a web-site. If a user spends less than 5 seconds on a web-site this behavior is considered as a turndown. It is confirmed that modern tools for traffic analysis provided by Yandex, Google and other search engines are able to detect users' turndowns[2]. It is also confirmed that the ratio of turndowns influences on the position of the site in

search results[3]. We propose an approach to lower a total number of turndowns. It seems to us more efficient to rebuild dynamically structure of HTML document depending on needs and presets of each user of application than show only the information which the user wants. In most cases, it is unacceptable to show only relevant information to a user because of the following reasons:

1. Showing only relevant parts of a HTML document maybe unprofitable.
2. There is a possibility of an error of semantic analysis. As result, irrelevant information could be displayed and a user could be frustrated.

The concept of independent semantic application presented in the paper rather aims to satisfy users showing them the most useful information in appealing way than to optimize a page for a search engine.

Architecture

It is expected that the proposed semantic platform will have the following features:

1. Cross-platform except for the generator of semantic markup
2. Flexibility. Convenient and smooth integration with existing internet applications
3. Scalability. Distributed architecture could lower noticeably consumption of server-side computing resources. Semantic user profiles could be stored without central relational database.
4. Security and privacy. User information must be collected in a nameless manner. All private data is mined from open sources and surveys after user's permission.

All these qualities could be archived by the proposed semantic architecture, main processes and external entities of which are depicted on the figure 1. All processes except for the semantic markup generating are executed on the client side.

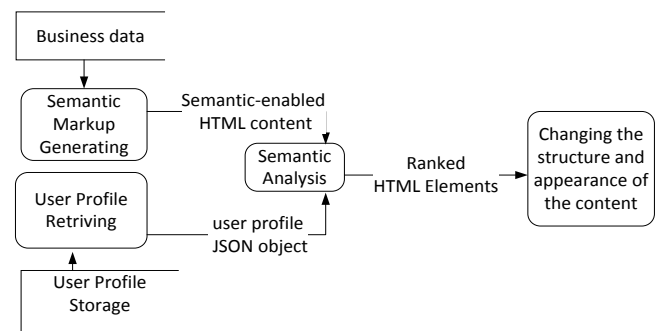


Figure 1. Semantic web application architecture

According to the processes mentioned above it is possible to distinguish three main parts of the architecture:

1. The semantic markup generator
2. The provider of semantic users' profiles
3. The semantic analyzer

Semantic markup generator

The semantic markup generator is a component which is responsible for adding semantic attributes to HTML elements, created on the server-side. The component is platform-dependent and has to be implemented as a part of a whole web-application. The semantic attribute has the format similar to a string of CSS-attributes.

Semantic user profile

The concept of Independent Semantic Web Application introduces a term Semantic profile. A semantic profile is an object with a set of properties describing preferences, interests, tastes and parameters of a particular user. In case of internet application a semantic profile should be presented as a JSON-string.

The provider of semantic user-profiles is responsible for generating a semantic profile. The most popular social networks like Facebook, VK.COM, Twitter can be considered as a source for retrieving user-specific semantic data, but the range of user's presets is very limited and is usually presented by the following fields: gender, age, education, address. Also this information can be collected by various surveys integrated with an internet application and stored in a local user profile.

Semantic analyzer

A semantic analyzer could be implemented as a JavaScript application. This way of implementation simplifies integration of semantic analyzer into existing web application.

As soon as HTML document is fully loaded JavaScript plug-in starts analysis of page content. The plugin requests a semantic profile and processes DOM elements which have semantic attributes. This process consists of the following operations:

1. The process of generation of semantic objects

2. The process of ranking each HTML element according to the values of a particular user profile.

3. The execution of callback function which changes the position of each analyzed HTML element and modifies CSS-properties in conjunction with it's semantic rating

Two general types of call-back functions are introduced:

1. Highlighting function. This function just changes opacity of analyzed HTML elements in a determined range

2. Reordering function. This function changes the order of analyzed HTML elements.

Developers are able to use their own callbacks instead of introduced above. The reordering function is more appropriate for mobile internet applications, because mobile user expects the most relevant information on the top of the screen. The highlighting of relevant information is appropriate for desktop users because those users have easier instruments to scroll large web-pages.

The semantic object is an entity with the following fields: a reference to a DOM node, arrays of semantic attributes and their values.

Conclusion

Proposed solution could be an alternative to existing methods of search engine optimization. JavaScript libraries developed for testing purposes could be easily applied to existing internet applications to add semantic functionality and increase users' satisfaction ratio.

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IMPLEMENTING REGION OF INTEREST ALGORITHM IN BIT PLANE ENCODER

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Introduction

Because of the explosive growth of the amount of multimedia data for transmission and storage, data compression has become very important in order to save bandwidth, increase storage capacity and at the same time provide sufficient quality of

compressed data. It has great actuality especially for application data compression in industrial sphere. In this way, variety of powerful and sophisticated wavelet based image compression schemes have been proposed and standardized. One of them is the BPE coder, which is wavelet

based image coder that was standardized by CCSDS in 2007. Furthermore, to increase an efficiency of using resources, the regions of image that are required more visual quality can be compressed with more details and transmitted with a higher priority than the other regions. This method is called region-of-interest (ROI) processing.

The proposal of this work is to implement in BPE coder an ROI-algorithm and compare the results with simple BPE coder.

Bit Plane Encoder Algorithm (BPE)

In the BPE coder, an image is first decomposed using a 3-level DWT. The recommendation specifies two types of DWT: integer and floating point 9/7 DWT. The resulting wavelet coefficients are processed in groups of 64 coefficients referred to as a block. A block loosely corresponds to a localized region in the original image. A block consists of a single coefficient from the lowest spatial frequency subband, referred to as the DC coefficient, and 63 AC coefficients as showed in a Figures 1 and 2.

Blocks are processed in raster scan order, i.e., rows of blocks are processed from top to bottom, and proceeding from left to right horizontally within a row.

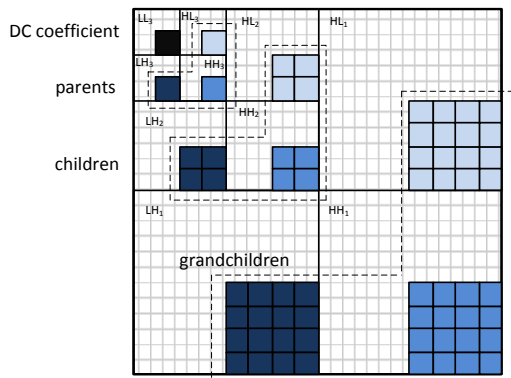


Figure 1. Wavelet-transformed image

A segment is defined as a group of consecutive blocks. Coding of DWT coefficients proceeds segment-by-segment and each segment is coded independently of the others. The number of blocks in a segment can be assigned by the user.

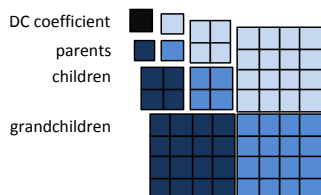


Figure 2. Structure of single block

Every segment has a header to specify coding parameters used for the current segment. The header can have up to four parts. The first part is mandatory and contains information such as segment counter, maximum number of bits required to represent DC value over all DC coefficients and maximum number of bits required to represent the magnitude of any AC coefficient. The remaining three parts are optional and the last

three bits of the first part of the header indicate whether the optional header parts are included. The second part specifies the number of bytes allocated for current segment, which could be used for rate control. The third and fourth part of the header specify parameters that are generally fixed for an entire image, such as the DWT type, image width, transform weighting factors, and bit depth of the original image.

Within a segment, the BPE first encodes a quantized version of the DC coefficients for the segment by applying the Rice coding algorithm to differences between successive quantized coefficients. Bits, providing further DC coefficient resolution, are included as part of the subsequent bit-plane coding process.

Next, the BPE successively encodes bit planes of coefficient magnitudes in a segment, proceeding from most-significant to least-significant bit plane, inserting AC coefficient sign bit values at appropriate points in the encoded data stream.

The resulting encoded bitstream constitutes an embedded data format that provides progressive transmission within a segment; DWT coefficient resolution is effectively improved by the factor of 2 as encoding proceeds from one bit plane to the next.

Coefficients within a block are arranged in groups, each with at most 4 coefficients. Conceptually, at a given bit plane, a binary word can be used to describe an update to each coefficient in the group for which all more significant magnitude bits are zero. These words are entropy coded using one of a handful of variable-length binary codes; the specific code is selected adaptively. The entropy coded data are arranged so that all parent coefficients in the segment are updated first, followed by children, and then grandchildren coefficients. Finally, the segment includes update bits for the coefficients in the segment for which more significant magnitude bits are not all zero.

The tradeoff between reconstructed image quality and compressed data volume for each segment can be controlled by specifying the maximum number of bytes in each compressed segment, and a "quality" limit that constrains the amount of DWT coefficient information to be encoded. Compressed output for a segment is produced until the byte limit or quality limit is reached, whichever comes first. The encoded bitstream for a segment can be further truncated at any point to further reduce the data rate, at the price of reduced image quality for the corresponding segment.

Region-of-Interest (ROI)

The regions that contain more details are supposed to take relatively more bits. These regions are called regions of interest (ROI). While the regions that contain homogenous or consistent backgrounds are regarded as regions of non-interest (Non-ROI). Relatively fewer bits are

allocated to the non-ROI and they also have a lower transmission priority compared with the bits from the ROI.

To find the ROI, region growing method will be used by reason of its simplicity. According to this method, a number of 8x8 blocks with similar properties are grouped together as follows.

1. The block that has the maximum sum of the absolute values of AC coefficients is picked up as the seed block. The statistical properties of this block are taken as the initial properties of the region.

2. Iterative region growing: Firstly, the current block is chosen and all its neighboring blocks are checked if they are in the region of current block. If it is in the region, the region information is updated.

To determine if a block belongs to the ROI, several properties and statistical parameters could be examined to see if they match each other. To produce good grouping results the mean average error ΔMAE should be found. It is calculating as follows:

$$\Delta MAE = \sum_{i=1}^8 \sum_{j=1}^8 |p[i][j] - p_r[i][j]|,$$

where $|a|$ represent the absolute value of a, $p[i][j]$ is the coefficient at $[i,j]$ in candidate block, and $p_r[i][j]$ is the average of the pixels at $[i,j]$ of all blocks, i.e.

$$p_r[i][j] = \frac{\sum_{k=1}^r p_k[i][j]}{r}.$$

If ΔMAE is below a threshold, this block is grouped into the region. Otherwise, it is regarded as a block in region of non-interest.

BPE Coder with ROI (BPE-ROI)

To use ROI in the BPE coder special syntax to handle different regions is required. In the BPE coder, the basic coding unit consists of up to 16 8x8 blocks, and a number of units are grouped to produce a segment. In the BPE coder, blocks in units and units in segments have to be consecutive. However, shape of the ROI may be arbitrary and blocks in the ROI may not be consecutive. To accommodate these changes, the header structure of the BPE coder needs to be modified and masking bits are needed. The

encoder needs to reorder the blocks in such a way that the blocks in the ROI are encoded first. The decoder then reorganizes the decoded blocks to their original order for reconstruction. These modifications, however, do not affect the main coding structure of the BPE coder.

To indicate whether blocks are in the ROI or not a Significance Block Map (SBM) is used as side information. One masking bit is sent out for each block. The bits in SBM are sent in raster order and immediately after part 4 of the header of the first segment and before coding of the blocks.

In natural images the homogenous regions are more likely connected, and it is expected that 1s and 0s in SBM occur consecutively, and therefore, the overhead can be lowered with run-length coding or other advanced methods of entropy coding. As coding bit rates increase, the cost of coding those overhead bits becomes relatively low and the coding penalty is negligible.

In the segment's header some new information will be included. In part 1 of the header, one bit is defined as a switch. If it is set to 1, the region based coding is initiated. Otherwise it is in regular coding mode. ROIWeight was added in header 5 as an optional weighting factor for the ROI. The pixels in the ROI can be shifted up by ROIWeight number of bits and the ROI can be encoded with higher priority for bit scanning.

Conclusion

In the article the concept of ROI is applied to the BPE coder and the corresponding syntax modification is developed. Further work at BPE-ROI algorithm will consist in creating hardware coder.

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JITTER IN DIGITAL SIGNAL

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Since the time integrated circuits were created there is a need to work and transfer with data in digital form. Also there is a problem with converting from analog signal to digital and back again.

The main differences between analog and digital signal are:

- a signal which has continuously changing voltage or current in analog form, is represented by digital form as a fixed number of discrete numerical values;

- these numeric values don't represent signal constantly during the whole time, but only at a certain moment which is called a moment of quantization.

Usually moments of quantization are determined by analog-digital converter (ADC) and digital-analog converter (DAC), that are used for signal transformation from analog to digital form and back again. These devices often have a master clock to control sampling rate (sampling frequency).

Digital signal is insensible to many disadvantages of analog recording and signal transferring: distortion, noises on the line, noises of the film, detonation and mutual influence of the channels. Even if the signal in the digital form is not completely free from disadvantages, it is certainly very resistant to most of these effects. But in practice a digital signal encounters new problems: the instability of clock generator, the drop of transfer characteristics of cable, parasitic noises. All of these lead to changes in waveform with small shifts in the time domain. These shifts are named jitters. [1]

Jitter is defined as short-term, significant changes of the digital signal from the ideal value of the signal at a given moment.

Jitter directly connected with problems in the synchronization digital stream leads to two problems of sending digital data:

- restored signal may be irregularly discretized. It could lead to significant distortions in the structure of an analog signal. As a result the noise threshold level decreases. It can lead to bit errors.

- jitter at the output of asynchronous multiplexers (i.e. at the input of the switching station) may result in elastic buffers' overflows and slippage with losses of frame alignment. As a result there is significant degradation of communication quality. [2]

Sometimes too much jitter causes additional errors in digital signal or even violates its timing. Possible reasons are:

- parasitic phase modulation in a clock generator;
- effect of noises and interferences on the clock in the receiver circuit;
- modification of the transmission path length;
- changes in the speed propagation;
- the Doppler shift of moving objects
- irregular receipt of timing information etc.

Causes of wide variety of jitter generate many types of jitter.[2]

The jitter model most commonly used is based on the hierarchy shown in Figure 1. In this hierarchy, the total jitter (TJ) is first separated into two categories, random jitter (RJ) and deterministic jitter (DJ).

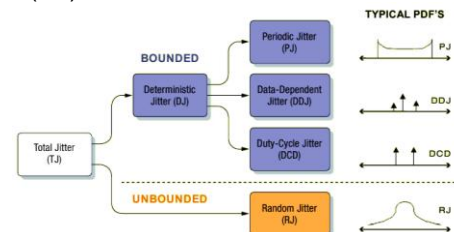


Figure 1. Jitter hierarchy.

Random jitter is timing noise that cannot be predicted, because it has no discernible pattern. While a random process can have any probability distribution in theory, random jitter is assumed to have a Gaussian distribution for the purpose of the jitter model. One reason for this is that the primary source of random noise in many electrical circuits is thermal noise (also called Johnson noise or shot noise), which is known to have a Gaussian distribution. Another, more fundamental reason is that the composite effect of many uncorrelated noise sources, no matter what the distributions of the individual sources approaches a Gaussian distribution according to the central limit theorem.

The deterministic jitter is further subdivided into several categories:

- periodic jitter (PJ, also sometimes called sinusoidal jitter or SJ),
- duty-cycle dependent jitter (DCD),
- data-dependent jitter (DDJ, also known as inter-symbol interference, ISI).

An additional category (bounded, uncorrelated jitter, or BUJ) is sometimes used.[3].

Periodic jitter is typically caused by external deterministic noise sources coupling into a system, such as switching power-supply noise or a strong local RF carrier. It may also be caused by an unstable clock-recovery PLL.

Any periodic waveform can be decomposed into a Fourier series of harmonically related sinusoids, this kind of jitter is sometimes called sinusoidal jitter. By convention, periodic jitter is uncorrelated with any periodically repeating patterns in a data stream. This fact differs Periodic jitter from Data-dependent jitter.

Any jitter that is correlated with the bit sequence in a data stream is termed Data-Dependent Jitter, or DDJ. DDJ is often caused by the frequency response of a cable or device. Another common name of this jitter is Inter-Symbol Interference or ISI because adjacent bits can affect each other. DDJ depends on a concrete sequence of bits.

Jitter that may be predicted based on whether the associated edge is rising or falling is called Duty-Cycle Jitter (DCD). There are two common causes of DCD:

1. The slew rate for the rising edges differs from that of the falling edges.
2. The decision threshold for a waveform is higher or lower than it should be. [3]

There are several ways in which jitter may be measured on a single waveform. These are period jitter, cycle-cycle jitter, and time interval error (TIE). It is important to understand how these measurements relate to each other and what they reveal.

Figure 2 shows a clock-like signal with timing jitter. The dotted lines show the ideal edge locations, corresponding to a jitter-free version of the clock.

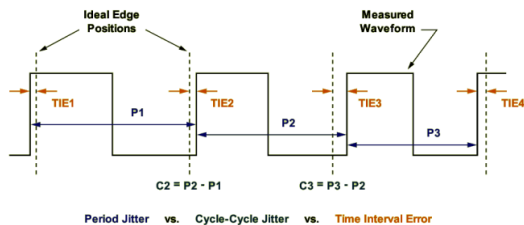


Figure 2. Measurement jitter.

The period jitter, indicated by the measurements P1, P2 and P3, simply measures the period of each clock cycle in the waveform. This is the easiest and most direct measurement to make. Its peak-to-peak value may be estimated by adjusting an oscilloscope to display a little more than one complete clock cycle with the display set for infinite persistence. If the scope triggers on the first edge, the period jitter can be seen on the second edge.

The cycle-cycle jitter, indicated by C2 and C3 in Figure 2, measures how much the clock period is changed between any two adjacent cycles. As shown, the cycle-cycle jitter can be found by applying a first-order difference operation to the period jitter. This measurement shows the instantaneous dynamics a clock-recovery PLL might be subjected to. It can be noted that no knowledge of the ideal edge locations of the reference clock was required in order to calculate either the period jitter or the cycle-cycle jitter.

The TIE measures how far each active edge of the clock varies from its ideal position. For this measurement to be performed, the ideal edges must be known or estimated. For this reason, it is difficult to observe TIE directly with an oscilloscope, unless some means of clock recovery or post-processing is available.

The TIE may also be obtained by integrating the period jitter, after first subtracting the nominal (ideal) clock period from each measured period. TIE is important because it shows the cumulative effect that even a small amount of period jitter can have over time.

Figure 3 gives an example of how these three jitter measurements compare to each other for a specific waveform.

[3]

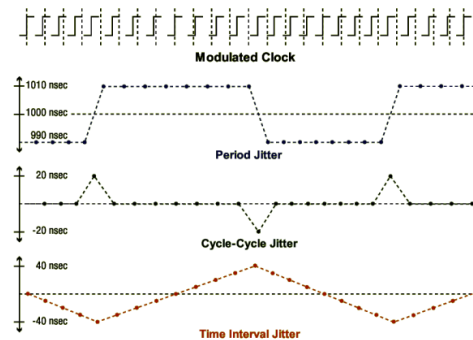


Figure 3. Relations between jitter parameters

Timing jitter has always degraded electrical systems, but the drive to higher data rates and lower logic swings has focused increasing interest and concern on its characterization. Characterization is needed to identify sources of jitter for reduction by redesign. It also serves to define, identify or measure jitter for compliance standards and design specifications.

All jitter has random and deterministic components. Because of its random nature, care must be used in specifying acceptable limits for jitter. To enable working with random components of jitter, a method that has found favor in jitter analysis and prediction is to use a mathematical model, the parameters of which are adjusted based on observed measurements like a period, cycle-cycle and TIE of jitter. The model can then be used to predict performance in other situations. The model can also give insight into the specific causes of the jitter, and therefore aid in understanding how to reduce it.

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MECHANISMS FOR COLLECTING INFORMATION ABOUT DEVICE CONFIGURATION IN MONITORING SYSTEMS

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Network management is a critical function that supports modern network in working order. Network management allows operators to maintain network services, to track changes in hardware configuration, and to store the history of these changes. The obvious solution is to store configurations in a database. To be successful in the competitive environment it is necessary to allocate resources for services quickly in order to provide these services on demand. Besides, it requires preventive support which allows to prevent failures and to achieve availability of systems at high level. These purposes cannot be achieved without good network management tools which can monitor and register all actions that may affect the network performance. The main tool for network management and configurations collection is a networks monitoring system. Monitoring system is a system that constantly monitors a computer network for slow or failing components.[1]

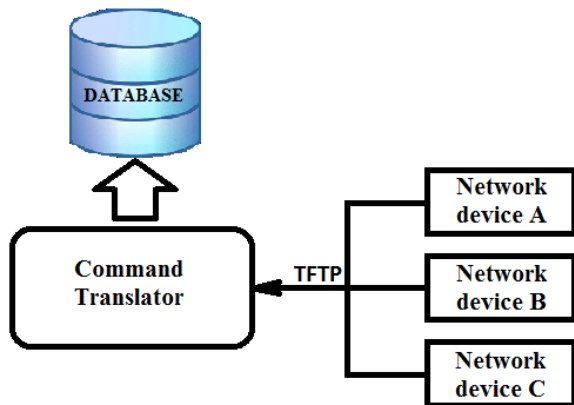


Fig. 1 The standard scheme for collecting data about the configuration

The main mechanism for saving working configurations in monitoring systems is Trivial File Transfer Protocol (TFTP). TFTP (Trivial FTP, RFC-1350, -783, RFC-906, STD0033) is a simple protocol to transfer files. It is a simplified version of FTP. TFTP has no security and identification; unlike FTP it is based on User Datagram Protocol

(UDP) using port number 69, instead of TCP. Usually, transferring is made in blocks of 512 bytes and it waits for an acknowledgment of each packet (protocol "stop-and-wait"). TFTP is used when booting the operating system in a diskless workstation (such as X-terminals). It is possible to execute TFTP command directly (TFTP name_computer). However, this procedure does not provide any serious advantages over FTP (except the exchange rate). Through this protocol, the process of file configurations transfers from and to network devices.[2] There are five types of TFTP messages:

- Read Request (RRQ, #1) — Request about file reading.
- Write Request (WRQ, #2) — Request about file writing.
- Data (DATA, #3) — the data transferred through TFTP.
- Acknowledgment (ACK, #4) — packet acknowledgement.
- Error (ERR, #5) — error.

The received files are used as back-up options on which we can return at error detection on the device. The configuration files received through TFTP protocol get into the data combination step. In order to make the database not overloaded by configurations files of different devices there is dynamic data recombination with templates used, which have notes about company types and device vendors.

One of the programs intended for collecting configurations of network devices is WinAgents HyperConf. One of the main features of this program is an automated backup of device configurations. WinAgents HyperConf supports single database configurations, tracking all the changes in the network settings. Availability of backup configuration will allow to reduce network downtime in case of failure of network devices. WinAgents can accept messages SYSLOG generated by the devices reporting about configuration change, with the integrated SYSLOG server. In addition, there is a possibility to create configuration backup copies manually.[3]

Another program for collecting network device configurations is the Remote management Services which is part of the CiscoWorks LMS (LAN Management Solution).

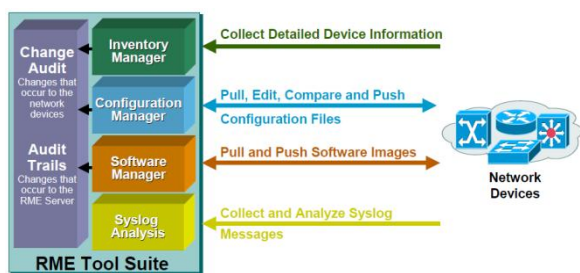


Fig. 2 Remote Management services (RMS)

In RMS a mechanism for controlling configurations (Configuration Manager) is built in. It performs three functions:

- Archiving: it serves the archive of hardware configurations, which is managed by RME, and provides the following tasks:
 - receiving, archiving and restoring device configurations,
 - receiving the configuration file on the basis of Syslog messages to synchronize the information stored in the database with the new configuration of the device,
 - ability to generate reports from data in the archive,
 - ability to compare versions, configurations, and to test for compliance with accepted standards and rules.
- Config Editor: it is used to change the device configuration, stored in the archive, and download the new configuration to the device.
- NetConfig: it provides an opportunity to change configuration of one device or group of devices with the help of templates. Using templates allows you to considerably reduce the time for applying changes on network devices in the case of global changes in the network. Templates contain rollback commands to a previous version of the configuration, which can be useful if some error occurs. To work with configurations there are some protocols used. The system contains an algorithm of using protocols in a particular order. The order can be changed by LMS administrators for each application separately.[4] There are such available protocols as:

- Telnet
- TFTP (Trivial File Transport Protocol)
- RCP (Remote copy protocol)
- SSH (Secure Shell)
- SCP (Secure Copy Protocol)
- HTTPS (Hyper Text Transfer Protocol Secured)

Despite a large number of positive aspects of the system, there is also a drawback – the system can only be used on the Cisco equipment, whereas different equipment by other vendors is used more often in a network. To work with such networks there is a system called Orion SolarWinds.

Orion SolarWinds includes mechanism for working with device configurations. This mechanism is called Network Configuration Manager. It is based on scripts that simplify network configuration management in environments consisting of equipment by different vendors. It works with the help of regular monitoring of the device configuration by using SNMP and notification of configuration changes for fixing problems quickly before users face them. Combining these scripts with the Windows Task Scheduler allows you to plan OrionNCM nightly backups, configuration changes, inventory of network devices. All changes in the configuration and users' activities are stored in Orion NCM database and they are available from the Orion NCM console application and Orion NCM Web-interface. [5]The ease of use of the product is specified by the fact that the data access can be received using the Web-interface that provides access from any devices and at any time. Based on the information received diagrams are built and statistics is carried out. They can also be used in scripts, for example, we can back up or upgrade an older version of the configuration if the number of errors increased dramatically for the last hour. Due to the graphs it is possible to trace cyclicity of collecting configurations or restorations, to assess the system possibilities and to influence on them.

Having considered some different mechanisms for collecting configurations it is possible to conclude that Orion SolarWinds Network Configuration Manager is the most appropriate mechanism for collecting information about the configurations of the most network devices, as the collection of information is possible with devices by different vendors. In this respect, it is also possible to use WinAgents HyperConf but it is intended only for small networks of up to 500 nodes. Cisco LMS is suitable for networks consisting only of the Cisco devices, but the quality of such networks is high.

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VIRTUAL OILFIELD

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Introduction

In recent years, major oil and gas companies have been making extensive use of software information systems. Such companies are "Gazprom", "Rosneft", "Lukoil" and others. Informatization considerably facilitated activities of large companies. It has allowed to connect distant offices of companies and store large amounts of information in databases.

"Virtual oilfield" provides an opportunity to obtain all the necessary skills in field development and well drilling.

The idea of creating a «Virtual oilfield» was not accidental. According to employers, students that arrive for internship have no idea of the real field operation. In universities they receive theoretical knowledge, while practical tasks remain in the background. So the idea of combining information technology and oil and gas industry had appeared and was received with enthusiasm. For example, «Virtual oilfield» development is carried out at Tomsk Polytechnic University and Gubkin Russian State University of Oil and Gas.

What is a «Virtual oilfield»? An accurate definition of a virtual oilfield hardly exists. All of the proposed definitions include the following: «Virtual oilfield» is:

- Subject of activity: a 3D computer model of a given section of oil or gas deposit, a virtual deposit;
- A multitude of virtually managed oilfield processing facilities, i.e. computer models of injection and production wells, power equipment of an oilfield;
- Virtual automated process control system for oil and gas production;
- A real management information system and computer-aided decision support systems used in modern oil and gas production enterprises;
- Automated workplaces for specialists: geologists, geophysicists, technologists, drillers, mechanics, power engineers, ecologists, economists, and managers whose teamwork ensures oilfield operation;
- Oilfield development control center combining the functions of a monitoring center equipped with facilities for visualizing 3D deposit models with those of a situation center for oilfield operation analysis and a decision making center;

- Telecommunications center allowing to simulate telephonic and video conferences;
- Training and research laboratories and centers;
- Production field equipment polygon for research and training (a mini-oilfield with operational production equipment for training purposes);
- Dataprocessing center;
- Local high-speed information network linking the basic components.

«Virtual oilfield» operation is very often compared to the work of a flight control center. Using «Virtual oilfield» allows to monitor the work performed by each expert at a workstation, receiving not only sound, but also video.

For creating the project «Virtual oilfield» focused specialists not only information and profile of the oil, as well as highly skilled mathematical methods, the developers of 3D modeling, geophysics, geology, and many others.

Many people might have a question: what is the overall purpose of creating a «Virtual oilfield»? First, it is the lack of places where students can obtain real practical experience. The system of academic and practical internships, as one of the pillars that underpin the national education system, has largely been destroyed. Higher education institutions can't guarantee that students receive practical experience, in turn depriving them of the opportunity to acquire the necessary professional expertise. The economy is replenished by specialists that know theory well but are not ready to solve practical tasks. From the industrial perspective the problems are much more serious: training programs simply do not catch up with the technologically advanced industries. Second reason is the opportunity to acquire practical skills on the job. Imagine that using computer technologies you are able to take part in virtual well drilling, installing the necessary equipment, and field development.

The idea of creating a «Virtual oilfield» has been implemented in Moscow at Gubkin Russian State University of Oil and Gas. For this university the gist of the innovation consists in the following:

- The principle of systematicity: activities of oil and gas companies are simulated as a whole;

- Creation of jobs that give students the opportunity to perform the work made by specialists of the given profile on an everyday basis;
- Simulation of a working environment that includes such things as "smart" wells, "electronic fields", the network, etc.

This project is also being implemented at Tomsk Polytechnic University's Institute of Cybernetics, Department of Optimization of Control Systems. For 10 years the department and the research laboratories and centers working under its scientific and methodical supervision have performed more than 15 research efforts on oil and gas field modeling, building and visualizing 3D geological and hydrodynamic models by subsurface users' orders, creation of an automated control system for an oil-producing association, etc. The total amount of research efforts performed in this area exceeds 25 million rubles. The virtual oilfield here is interpreted as follows. The virtual oilfield is a set of technology-oriented automated workstations and hardware and software stands connected via telecommunications to the oilfield situation control center and data and knowledge bases located at a supercomputer cluster, providing broad opportunities to study the processes of oil and gas field modeling, design and development.

Within the framework of this project work is being done to create 2 types of virtual field: oil and gas. Scenarios being created include:

- Field development design;
 - Oil production shop situation control;
 - Reservoir pressure maintenance situation control;
- The «Virtual oilfield» is located at:
- The Institute of Cybernetics (Cybernetics Center, building 10);
 - The Institute of Natural Resources (building 20);

The main products and services of the project are:

- system integration hardware and software solutions for constructing the "Virtual Oilfield" situation center;
- algorithmic and software systems that provide 3D modeling, design, and situation control of virtual departments;
- scientific and methodological support (monographs, textbooks, and laboratory courses in the core subjects);

- academic staff possessing the technology of training students and conducting refresher

Conclusion

This topic was developed a short time ago. Probably the reason for the development of this direction was the general informatization. Information technologies have become an integral part of our lives, being used in such industries as mathematics, medicine, geophysics, ecology, and oil industry. Computerized information channels connect petroleum specialists with colleagues and partners allowing them to interact with each other. University students of different majors will be interacting and cooperatively monitoring and managing field development while sitting at their computers, and in case of an emergency try to determine who is responsible for its removal: the driller, the technologist, the mechanic, or the transportation engineer. Within the framework of this project I have developed a website titled "well maintenance", which allows obtaining the necessary information on this topic. A visual representation of the main page is shown below:

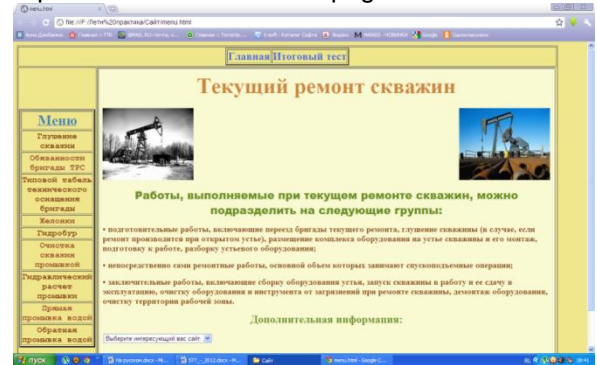


Fig. 1. Home page

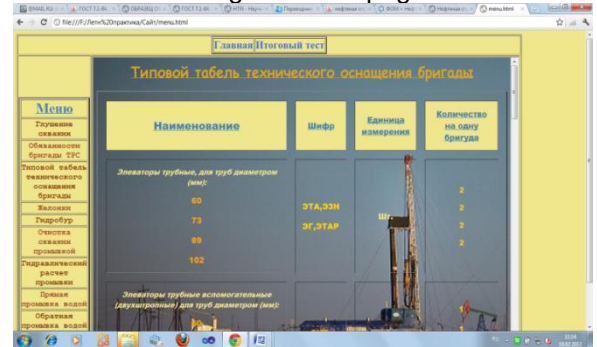


Fig. 2. Tables

Website will be embedded in this project.

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- 1) Website: http://portal.tpu.ru/departments/institut/ik/Projects/Virtual_field, «Виртуальный промысел»
- 2) Website: http://www.gubkin.ru/general/innov_pr/info/reklama/buklet.pdf

CLLOUD TECHNOLOGY: OVERVIEW OF DATABASES AS SERVICE PROVIDING SYSTEMS ON THE BASE OF XEROUND, AMAZON RDS AND SQL AZURE

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Cloud computing is the delivery of computing as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a metered service over a network (typically the Internet). [1] Cloud computing is a model for delivering information technology services where resources are retrieved from the Internet through web-based tools and applications, rather than a direct connection to a server. Data and software packages are stored in servers. However, cloud computing structure allows access to information as long as an electronic device has access to the web. This type of system allows employees to work remotely. [2] There is a more common definition. Cloud computing is a general term for anything that involves delivering hosted services over the Internet. The problem is that everyone has different definition of cloud computing. This is caused by high functionality of this technology. But the most accurate definition is given by Peter Melland Timothy Grance from National Institute of Standards and Technology (USA): 'Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction'.

General Director of Ltd "EMC Information Systems CIS" Sergey Karpov said: 'Cloud computing is in one sense the evolution of entire IT industry in general'. He identifies five characteristics of cloud computing.

1. Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer's demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but he may be able to specify location at a higher level of abstraction (e.g., country, state, datacenter). Resources include storage, processing, memory, network bandwidth.

2. Dynamics and flexibility. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for

provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

3. On-demand self-service. A consumer can unilaterally get computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.

4. Broad network access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

5. Economy of the process. Measured service is used in cloud technology. Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

There are four deployment models of cloud computing.

1. Private cloud is infrastructure operated solely for a single organization, whether managed internally or by a third-party and hosted internally or externally. [1] Private cloud functions on a private network. It is highly secure

2. Public cloud is one based on the standard cloud computing model, in which a service provider makes resources, such as applications and storage, available to the general public over the Internet. Public cloud services may be free or offered on a pay-per-usage model. [4] It may be owned, managed, and operated by an academic, government, or business organization. It exists on the premises of the cloud provider. This type of deployment model offers the highest level of efficiency.

3. Community cloud shares infrastructure between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party and hosted internally or externally. The costs are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realized. [1]

4. Hybrid cloud is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together, offering the benefits of multiple deployment models. It can also

be defined as multiple cloud systems that are connected in a way that allows programs and data to be moved easily from one deployment system to another. [1] This deployment model provides increased efficiency.

There are three service models of cloud computing: IaaS, PaaS, SaaS.[3]

1. By using IaaS model organizations get infrastructure components: storage capacity, computing power networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software which can include operating systems and applications. The consumer has control over operating systems, storage, and deployed applications and possibly limited control of select networking components but he does not control the underlying cloud infrastructure. However, consumer organizations need to hire the addition staff to manage and maintain the infrastructure and applications.

2. PaaS model provides organizations with platforms or runtime environment to create and deploy applications. Consumer organization is only responsible for management, maintenance and development of the applications, but it does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage.

3. SaaS model. The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings. [1]

As cloud computing is achieving increased popularity, concerns are being voiced about the security issues introduced through adoption of this new model. The effectiveness and efficiency of traditional protection mechanisms are being reconsidered as the characteristics of this innovative deployment model that is widely different from those of traditional architectures.

Microsoft Security trusted Advisor Bezmaly V.F. who in his presentation on the subject of cloud security said that more than 3.500 virus signatures were made and more than 30.000 threats appeared every day. He stressed the fact that use of cloud computing is much more secure.

One of the ways of using Cloud Technology is to put your database in cloud. This is called Database As a Service (DaaS). DaaS solves a lot of problems of applications which work with database for example transplantability of this application and scalability of database (DB) especially for web applications.

DaaS is a managed service, offered on a pay-per-usage basis that provides on-demand access to a database for the storage of application data.

The most popular DaaS today are SQL Azure, Amazon RDS and Xeround. All of them are highly available and scalable cloud database services built on SQL Server technologies.

SQL Azure is a product of Microsoft. It supports up to a 150 GB maximum size T-SQL-based relational database. Customers are billed based on the peak database size in a day. SQL Azure Database is charged as a monthly fee for each database, but that database fee is amortized over the month and charged on a daily basis. For databases greater than 1 GB, you will be billed in the next whole gigabyte increment. But it is very expensive to use SQL Azure (1GB≈10\$ per month) and there are problems with transferability of DB in cloud from local host.

Key differentiators between Xeround and Amazon RDS are as following:

1. Rule-based Auto Scale up & down with no downtime vs. Amazon RDS manual scaling with down time;
2. Pay per actual usage vs. pay per instance size, resulting in over subscription;
3. Xeround never fails – even when Amazon's instance fails. Xeround offers a highly available, self-healing, database, with no downtime. Amazon RDS cannot guarantee downtime, both planned (4 hour / week maintenance) and unplanned
4. Unlimited database size vs. limited to Amazon RDS instance sizes;
5. Database configuration does not require code changes to your application (replication, etc.);
6. Xeround offers up to 700% higher throughput and less than 1/10 the latency of RDS for heavy-duty MySQL applications. [5]

When considering all the benefits of a true cloud database, coupled with competitive pricing, Xeround is the preferred choice of developers and businesses for their database application requirements in the cloud.

Summing up, it is possible to say that IT stops being a brake on business development due to cloud technology. By purchasing cloud services by Pay-As-You-Go basis companies can avoid capital expenditures on additional infrastructure resources and instantly scale up or scale down according to their business requirements.

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FEATURES OF THE NEURAL CONTROL SYSTEMS DESIGNING IN A NEURAL NETWORK TOOLBOX PACKAGE (MATLAB)

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Modern industrial processes connected with producing or machining material, energetic and information flows have high demands on reliability and quality characteristics of control system built in technical environment of these processes. The absence of certainty in characteristics of control object often has an impact on the quality of controlling the technological processes that can lead to consumer properties deterioration that is unacceptable. That's why at present the important task is ensuring the stability in characteristics of controlling processes, especially under conditions of certainty induced by causes of various natures. Ordinary types of controllers (like proportional (P), proportional – integral (PI), proportional – integral – derivative (PID)) are not usually efficient for solving this problem. On the contrary using of intellectual adaptive or optimal controllers potentially can satisfy the requirements for control processes quality [1]. To implement intellectual controllers fundamentally different algorithmic methods can be used that usually allow "transmitting" knowledge and experience in process control from operating specialist to control unit. Range of methods can be the basis for the functioning of intellectual controller. For example, it can be fuzzy logic methods, methods of using neural networks, application of genetic algorithms or various combinations of these methods. Using of listed methods in programming controllers are often "soft – computing". In opposite – stiff adjustment with using ordinary control algorithms called "hard – computing". These designations highlight the difference between ways of tuning controller – ability of operating with partial, inaccurate data [2].

One of the widespread ways of building intellectual controllers is using of neural networks. This is explained by the fact that the multi-layer neural networks are almost universal instrument for control signals generating [3]. Artificial neural network is a structure that consists of simple computing units called artificial neurons. It was invented in the 20th century during the nervous

tissue research. Neurons in artificial network are located in different layers and can be connected with neurons in other layers as in biological prototype (Fig.1). Layers situated between input and output ones are usually called hidden. The artificial neuron has bias (that determines activation threshold) and any number of connections. Each connection has a coefficient (weight). Due to the huge number of connections (for example networks with 20 neurons located in 3 layers can have thousand connections) selecting right weights and biases allows network to simulate a wide range of mathematical functions [1].

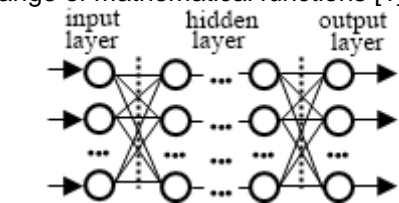


Fig. 1. Multi-layer neural network

Modern controllers have enough memory and computing power to implement the neural network control. However, they are not equipped with software (algorithmic blocks, procedures, etc.) focused on working with neural networks. This fact complicates the implementation and configuration of the controller greatly. In order to save time during design, controller training and evaluation of neural network control system efficiency the modeling of the control system with computer-aided design system is used [4]. One of the most widespread instruments for neural networks and neural network controllers design is a Neural Network Toolbox application in Matlab.

Working with neural networks in Neural Network Toolbox has several features distinguishing it from working with structural schemes of conventional control systems and from working in specialized multidomain modeling packages (SimPowerSystems, SimMechanics, etc.). There are three features of working with Neural Network Toolbox:

1) direct access and object parameters editing of Network class is more simple and less time-consuming way of working with neural network than building a model in Simulink and editing elements of this model;

2) the process of neural network training is reduced to the execution of sequence of actions, and abilities of package does not include an indication of the effect of retraining and indication of choice an adequate count of the neurons in hidden layers;

3) using neural network controllers included in the components library of Simulink - Neural Network Toolbox is possible for the problems solving of automatic control tasks.

That's why it is rational to solve the problem with the help of controllers provided by standard library previously to the original controller design [5, 6].

The first feature is caused by complex structure of neural net model that consists of input blocks, output blocks, submodels of layers, delay units defined by a number of parameters and interconnections. This leads to a huge number of elements in the model, its complexity and large size. To make visual image of model more intuitive some parts of it (performing a particular function) are combined under "the mask". That makes the network tuning more difficult. On the contrary, addressing directly to parameters of Network object through the Command Window allows user to change the network structure quickly, to correct weight coefficients and biases, to set properties of network training (the most difficult thing to do using Simulink model). A number of methods for objects of Network class is provided. Some of them are: "**view(Network)**", useful for the diagram drawing that displays graphically the structure of the network, dimension of input and output vectors, delays on connections between layers and inputs; "**gensim(Network)**", used to generate automatically the Simulink model. Using of these methods makes the task of constructing neural control systems easier (view allows to see clearly the current structure of the network while building it; **gensim** is useful for connecting a model of neural network (or neural controller) with the control system for further researching) [5,6].

It is essential to determine the initial values of weights and biases for automatic training of neural networks. For this purpose the network initialization can be used (method "**init (Network)**"). The principle that determines the initial values may be different for each layer (if required, for each neuron in layer) and depends of the parameter "**initFcn**" of layer, or, depends of the matrix of weights separately for each neuron.). The network training procedure is similar to the initialization procedure. The "**adapt(Network)**" methods are used to adapt the network in operation, and the "**train(Network)**" to train the network for using samples. The way and speed of the network parameters optimization

are defined by the following parameters "**learnParam**", "**trainParam**", "**adaptParam**" (may refer to a layer of a single neuron) and "**adaptFcn**", "**trainFcn**", "**learnFcn**" defined for the whole network. Training a network, one should be aware that if the number of neurons do not match the task the effect of overtraining with a large number of samples may appear (downgrade of regulating characteristics of network for any input values which are not represented in the sample). To identify the effect of overtraining a mechanism for the control test is used. It consists of the following: part of the training controls (about 25%) is reserved and is used to control the network quality. If the accuracy required can't be reached during the process of training, it is necessary to change the number of neurons involved in the network. That's why in the design process it is advisable to start with a small number of hidden layers and neurons and increase their number if it's necessary [5].

There are three types of neural controllers in the section of blocks of Control Systems: Neural Net Predictive Controller – a controller with a prediction of future process reactions to the random process control actions. Implementation of this controller requires a large amount of calculations because calculations for optimization are performed on each cycle of control;

Nonlinear Autoregressive - Moving Average Controller - implements a mathematical model designed for the analysis of stationary time series. only the calculations connected with implementation of a neural network are performed at each step of the computation;

Model Reference Controller - the controller based on the reference model. It requires training of a neural network based on backpropagation. It is suitable for a wide class of problems. A neural model in all three cases is a two-layer network with a direct signal transmission and lines of delays at each layer [5].

Due to fact that today (according to the experts) significant technological growth in the area of projecting neural networks and neural computers is expected (it is connected with the expansions of neural technologies applications, especially in areas that are quite important for the economy), an increase of demands to systems and tools for developing neural networks occurs [4]. Currently Neural Network Toolbox is one of the most suitable one for solving automatic control tasks, designing pattern recognition systems task and some other problems. In this case awareness of features connected with using Neural Network Toolbox, knowledge of its contents and structure of Network class allows a developer to use the resources of Matlab more efficiently and to solve successfully the tasks of neural control systems synthesis.

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ANALYSIS OF «DATABASE FOR ENTRANTS TO THE UNIVERSITY» DATA

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Introduction

Database is a collection of information related to a particular topic or a problem, such as tracking customer orders or storage of music collection. If the database is not stored on a computer or computer stores only parts of it, it's necessary to keep tracks of information from a variety of other sources that the user must coordinate and organize on his own[1].

Formulation of the task

Vocational training is becoming today, first of all, the formation of personality developing in ability to work, in choosing the direction and sets of knowledge, which man considers to be necessary and appropriate.

Profession, being one of the means of realizing human potential, can manifest their preferences: what like to do, what is the inclination and ability, and largely determines the degree of satisfaction with life.

Choice of profession is the relationship of factors such as "I can", "I want" and "it is necessary" (or "one must"). "I want" is interests and inclinations of the individual (or person), such as propensity to work with technology or people. "I Can" is a person's ability to master and implement specific training activities. "It is necessary" (or "one must") is a kind of social order, society's need for people in certain occupations[2].

To choose the type of employment, a person must feel the coincidence between the demands of the profession and individual personal characteristics. For most young people entering higher education is urgent awareness of their purpose in life, who to be, what to do, because by choosing high school, specialty, many young

people do not know whether they perform a correct choice for future professional activities.

And, in order to help a candidate make a choice of his future specialty and faculty, we decided to develop a database for students[3].

Development of a database for applicants

In order to begin testing of applicants, they need to enter the initial data (Figure 1).

Fig. 1 Input of data.

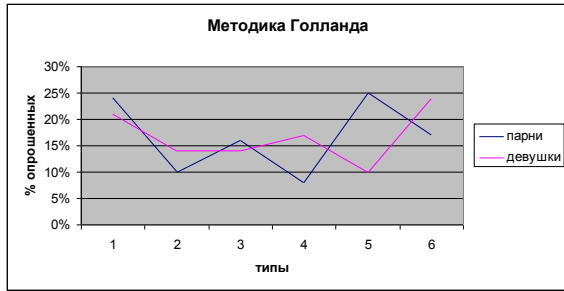
After you enter your name and the name of educational institution (if you're an applicant, you can write your educational institution to school) you go to the passage of the following tests:

- SUN (This test is designed for rapid assessment of health, activity and mood).
- Luscher color test
- Psychogeometrical tes
- Test of sociotipy
- Method of Holland
- Test type of temperament
- Test for spatial thinking
- Test for creative thinking

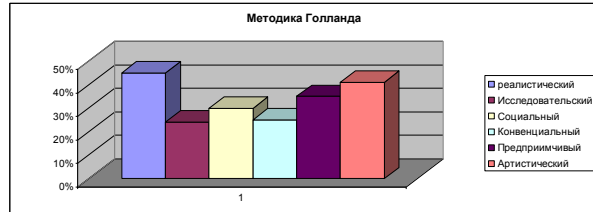
Analysis of the data

Databases are key components of the majority of WEB-appendices. They allow representing a dynamic content on sites. Our database is also widely used at present by entrants to the university. 12 young men and 13 girls have tested "Database for entrants to the university".

The received results are presented on graphics 1-2 and table 1.



Graph.1. Method of Holland for young men and girls



Graph.2. Method of Holland. 6 type.
Table 1. Method of Holland

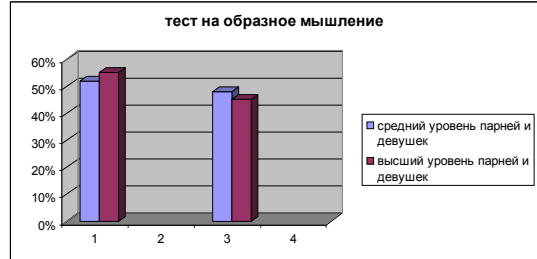
| Method of Holland | Young men | Girls | All |
|-------------------|-----------|-------|-----|
| Realistic | 24% | 21% | 45% |
| Research | 10% | 14% | 24% |
| Social | 16% | 14% | 30% |
| Convensual | 8% | 17% | 25% |
| Enterprising | 25% | 10% | 35% |
| Artistic | 17% | 24% | 41% |

Graphics 1 and 2 are rather similar. As it is seen from schedules, among girls realistic, artistic and convensual type prevails. Most of young men are of realistic type, enterprising and artistic. It is possible to confirm it, after all it is valid, and girls often lean against emotions, imagination, and intuition; like to listen to music, to watch films. And young men select the purposes which allow showing energy, enthusiasm, impulsiveness, like to order.

Images «Test for spatial thinking» and « Test creative thinking » have been received. See graphics 3-4.



Graph.3. Test for spatial thinking.



Graph.4. Test for creative thinking.
The general results are presented in table 2.

Table 2. General results of tests for thinking

| | Test for spatial thinking | | Test creative thinking | |
|-----------|---------------------------|---------------|------------------------|---------------|
| | Average level | Highest level | Average level | Highest level |
| Young men | 64% | 36% | 52% | 48% |
| Girls | 58% | 42% | 55% | 45% |

The graphics shows that spatial thinking is the most developed in girls, and test for creative thinking – in young men. Though, graphics are rather similar.

Conclusion

Thus, we have received the decision of an actual problem – visualization of the multidimensional data in the field of psychology.

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TECHNOLOGICAL ASPECTS OF SUPPORTING TOOLS IMPLEMENTATION FOR INNOVATIVE EDUCATIONAL PROCESS ORGANIZING AT UNIVERSITY

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At the moment, the Russian higher education system is going through fundamental changes in organizational structure, methods of assessment and educational methodologies [1]. These changes are caused by the globalization of education and demands of modern business and industry. In recent years harmonization of the national educational system with European standards is a very urgent goal [1]. We should note that the harmonization process of the educational systems into the bounds of the Bologna and Copenhagen Processes has already spread beyond the European community, encompassing a growing number of countries in different parts of the world [2].

Thus, the modernization of educational standards forces all the major world powers to implement reformation of higher education such as clear and internationally-recognized qualifications, two-tier system of education, credit system, academic mobility of students and professors, international co-operation, lifelong learning, etc. [1]

At present a great number of Russian institutes of higher education are in the process of transition to the above-mentioned principles of education. But they haven't succeeded in it yet because of variety of organizational problems. It becomes clear that the information system for management of the learning process and its control is absolutely necessary.

During the development of this information system, emphasis was placed on the implementation of fundamentally new systematic approach for organizing the educational process and its associated control processes. The special feature of this approach is the accent on individualized educational trajectories of students, support of modern educational concepts (such as CDIO, PBL, etc.) [3]. Furthermore, special attention was paid to the social elements of the system, such as student-professor or student-student communication and students and professors public ratings.

System features

First of all, this system is a repository of data about all aspects of educational and organizational activities in university. Obviously, the system should provide different features depending on the role of current user. That is why role management service was implemented during the early stages of development. This service allows every user to combine several roles. It's necessary for

implementation into a real university, because most of the employees have two or more roles.

Every role has its own front-end for access to all available features via web-interface. On the first stage of development we decided to make four basic types of front-ends: first, for student, second, for professor, third, for university administrators and the last, for free access (guest).

Students' front-end is linked to the students' profile. The profile is being created when a student enters the university or when the system is being implemented for those who are already studying.

Professors' front-end is linked to the professors' profile. We made a decision to include the unique feature into the system— allowing a professor to make strict and optional requirements for timetable making and checking in for his courses. When professor gets the access to the system, he can add his own courses into the courses' database (or he can register himself as a professor for existing course). Professor should add the course description, course work program, list of the lessons, learning materials, etc. After that he should define restrictions for signing up to the course such as maximum amount of students for this course, list of the necessary courses which students had already pass, etc. Furthermore, a professor can select the requirements for classrooms such as availability of interactive board, audio system, special laboratory equipment, classroom placement in a specific building etc.

Administrators' front-end is linked to the administrators' profile. The main purpose of those users is entering data about classrooms, students' and professors' profiles etc. At later stages of the development of the system we are going to add special roles for these purposes.

Guests' front-end is used only to view public information. One of the use cases of this front-end is sharing information about student progress with an employer.

Besides the usual way of accessing to the system features via web-browser we plan to implement Web API (Web Application Programming Interface) to allow other programs and widgets to use our system features and data [4]. This Web API will be used afterwards to develop applications for mobile devices and native applications for different operating systems.

Making of academic timetable is one of the most important functions of our information system. This timetable should satisfy many conditions, so the problem of its calculation without doubts is the most nontrivial and resource consuming [5] in the

bounds of this system. In comparison with other timetable making systems, which work only with learning groups (classes) and in most cases aren't taking into account any additional conditions, our information system works with a large amount of individual curricula and uses different conditions provided by students and professors.

Because of the high complexity of the timetable generation, we made a separate computation cluster for this purpose in the network architecture. This decision was made for unloading of the main server, because it's responsible for interaction with users. The timetable making is the fully independent task and doesn't require any interruptions in the process. Therefore, this problem is the ideal one to compute in the cloud computing services [6]. At the present time the choice of cloud computing is reasonable both economically and because of convenience of implementation [7].

Network architecture

The network architecture of the system (Figure 1) was developed based on declared earlier features.

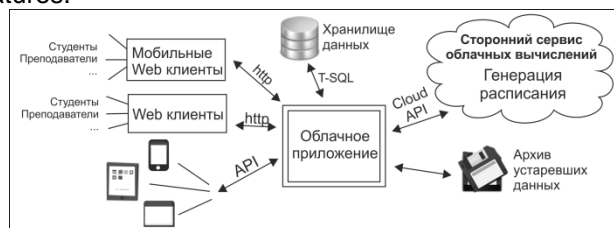


Figure 1. Network architecture

The core of the network architecture is the cloud applications and data storage. The main application is doing the important function of differentiating the roles, distributing the rights, sharing and processing data. The data storage does not have its own mechanism of rights distribution, so all interactions go through the main application. On the scheme, the data storage is designated like a network unit, but when it's necessary it can be scaled by adding replication system without any influence on the other parts of the system.

There are possible options of accessing to the system on the left part of the scheme, such as mobile and usual web-clients (via web-browser), native applications for mobile devices and different operating systems (via Web API). All those options are being realized through unified mechanisms of the main web-application. This method provides absolutely identical behavior for different parts of the system.

Special attention in the network architecture was paid to the scalability of every part of the system. It allows delivering this system using SaaS (Software as a Service) model. The SaaS model reduces the cost of implementing and completely excludes the costs of servers and infrastructure for

clients. Also it solves problems with software updating and backing-up [8, 9].

Conclusion

It should be noted that similar systems do exist, but generally overseas. Usage of these systems in the Russian universities is impossible, since they do not take into account the peculiarities of the current state of our education system and have a hard binding to the foreign educational standards and paperwork organization of the educational process.

The information system presented in this article is designed for future implementation in the major Russian universities, particularly in the national research universities.

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PROBLEMS AND METHODS OF MONITORING APPLICATIONS IN THE NETWORKS

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Nowadays information resources are becoming more available. As the cost of the IT resources goes down more enterprises gain access to them. Modern business completely depends on IT infrastructure serving its needs and more or less significant failure in its work may lead to significant losses or even bankruptcy. On the other hand, the issue of monitoring IT infrastructure is not considered thoroughly.

Application software (also known as application or 'app') is computer software designed to help the user to perform specific tasks. Local applications are applications designed to work locally on the user's machine or in local network. A web application is an application that is accessed via a network such as the Internet or an intranet. Web applications are popular due to the ubiquity of web browsers, and the convenience of using a web browser. The advantages of such applications are cross-platform and a small amount of traffic transmitted. Network applications are applications that run at large corporate networks. Terminal applications are used to work with the terminal servers [1]. It does not require network resources, e.g. the use of RGP technology for controlling machines remotely.

The use of modern information technology in enterprises is connected with the active application of the software which uses a local or wide area network for data transmission. Poorly-configured applications lead to loss of efficiency in network and enterprise work. In the long run, it influences on the final economic result. Therefore, the main problem for such applications is slow work in the enterprise network.

The performance of complex applications depends on many factors such as the system resources, database and application architecture, the effectiveness of the program code, the network infrastructure. Performance management of application is required at all stages of the application lifecycle from development and testing to deployment and operation. For example, when application is tested in high-speed corporate networks, we can get an acceptable result of its

work, but when we deploy and run applications on a real object, it can be completely unworkable. In order to define the problem, you must use network and application performance monitoring.

Network monitoring is the process describing the use of a system that constantly monitors a computer network for slow or failing components and that notifies the network administrator, for example, via email or other alarms in case of outages. Sometimes network monitoring means only the process of testing data transmission systems and finding out whether they meet the corresponding standards. But this definition is too narrow. Network equipment is often configured correctly and it provides maximum hardware performance. The basic parameters characterizing the network do not exceed certain thresholds. Such basic parameters are network communication channel loading, the total number of transmission errors, and the percentage of broadcast and multicast packets [2]. Effective analysis of network applications quality requires adequate statistical information about its individual software modules, the state of communication channels, nodes, etc. So, it is necessary to collect the required data, to do its analytical processing and represent the produced statistics in a graphic form. This problem cannot be solved without the use of network monitoring applications. Using the results of the network applications quality evaluation it is possible to optimize network performance by changing the order of application startup or by moving application modules between computational nodes in order to localize network traffic and reconfigure network resources. All these actions can improve the speed, reliability and performance of network without purchasing additional hardware or processing of the software. Such approach, from economic point of view, is more appropriate. The given analysis allows us to give answers to a number of questions such as: What component of the infrastructure is it necessary to update in order to reduce application response time? Is it possible to increase the load of the network infrastructure without significant loss

of applications productivity? How faster are user requests processed after upgrading the network? Is it possible to use the redistribution of the load on the servers or enter the prioritization of traffic instead of buying additional equipment?

However, each application has its own important parameter. The response time of some programs largely depends on the performance of the server (for example, a client-server applications), others - on the performance of the communication channel, the third - on the performance of workstations. For example, the time of the operation is distributed among the components in such a way: 70% - on the server, 15% - to transfer data over the network, 15% - on the client. Thus, even if the network operates at maximum speed, the operation will not accelerate more than 15%.

There are three principal methods of monitoring which use the approach of the application.

The first method is monitoring servers and applications availability by means of using periodic synthetic transactions to application servers from the client subnet. In a distributed infrastructure this scheme is ineffective. Due to the large number of remote nodes, the transaction can reduce not only the efficiency of network infrastructure but servers as well. Thus, it distorts the real picture. The most significant problem is that the generation of artificial requests may directly indicate only the availability of applications and can detect only a serious problem.

The next method is installing the software agents on the servers to monitor the performance of individual applications (agents can be built into the application itself, or installed separately). This method allows you to accurately display the technical parameters of a single application, but it does not allow to control the network infrastructure as a whole including individual users, data network and quality of individual modules interaction in a multi-level structure of applications. Such system is difficult to deploy and manage since it is necessary to install and maintain additional agents in each office.

Hardware collector APA (Application Performance Appliance) is installed in data centers [3]. When it works, it copies the incoming and outgoing traffic on all servers. Thus, the monitoring system can analyze all user requests to the system in a passive mode without making any changes in the work of the infrastructure. The passive mode of analyzing is extremely useful because the collector being configured does not require maintenance and administration. Analyzing all transactions within each session APA splits response time into the following components:

- query processing time by the server;
- time required for the application to transmit generated data;
- time required for packets to go through the network.

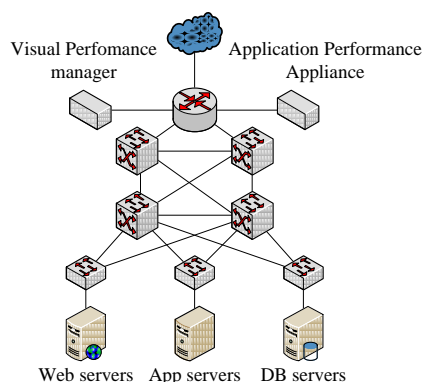


Fig.1. The scheme of APA Collector work

But this method is expensive as the equipment for this method is high-priced. If you want to collect data from a large number of routers, it is necessary to buy some additional devices, e.g. traffic couplers. That, in its turn, makes it more costly. And what should we do if there is no data center in the network? Despite its novelty this monitoring method is the most promising and cost-effective from the point of view of the network infrastructure work as traffic is not spent on the data about application work. Consequently, it is necessary to do a large amount of research on the optimal placement of the collectors and on mathematical methods for development of processing the incoming information about applications.

Thus, the main task of monitoring applications system is to collect information about its work. It includes:

- number of the application processes;
- CPU load;
- used memory;
- POP3/IMAP availability;
- FTP-server monitoring;
- SSH monitoring;
- DNS;
- DHCP;
- LDAP

Therefore, the approach which is called 'from application' is becoming more widespread. It differs from the traditional approach in measuring parameters. It measures not only parameters which characterize the network performance but also indicators that define the work of users' programs. Applications monitoring is the most promising method of the network monitoring from the point of view of economic benefits as it allows to analyze the efficiency of network applications, and it provides data and reports. It is used to achieve stable and fast application performance by reorganizing the network, transporting the modules and applications, as well as setting them up properly.

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APPLICATION OF FUZZY LOGIC FOR ENHANCED OIL RECOVERY METHODS SELECTION

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Planning of enhanced oil recovery methods (EOR) is a complex problem that requires an integrated approach for its solution.

The potential of EOR methods can not be fully realized without optimization of conditions to select the technology for its application at a certain field or its part. At this stage of development, selection of EOR technologies for specific geological objects is a significant but insufficiently explored problem. Methods and programs of EOR selection which are created for geological conditions of the object we are interested in are still poorly used in Russia [1]. Furthermore, this stage is considered to be complicated due to the ambiguity of the method selection criteria. Nowadays, to overcome these uncertainties expert systems and artificial intelligence technologies are increasingly used in international practice. The review shows that most of these programs are successfully developed and applied abroad. Methods and software for analytical modeling have been effectively used in numerous projects in such countries as USA, Mexico, Venezuela, Colombia, Egypt, and others [2].

To establish the boundaries for applicability criteria of EOR methods, the crisp boundaries are often used, which can lead to errors and risks in selection of optimal technology. Traditionally screening is based on the comparison of average reservoir properties with the table applicability criteria. Partially successful projects when the reservoir property values are beyond the boundaries of screening criteria are not commonly considered when EOR is to be chosen. The measurement error is not always taken into account when making intervals of applicability criteria. All of the mentioned above can result in erroneous decisions.

To overcome the problems related to the limits of applicability criteria of methods we can use Fuzzy Logic [3] to obtain more reasonable results. Fuzzy logic is used to analyze complex systems where human knowledge and experience play an important role, and it is difficult to use traditional quantitative methods.

Fuzzy logic is a form of many-valued logic; it deals with reasoning that is approximate rather than fixed and exact. In contrast with traditional logic theory, where binary sets have two-valued logic: true or false, fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. The membership function of the element to some set can take any value in the interval from 0 to 1; these types of sets are called fuzzy sets. Fuzzy logic is often used in expert and self-learning systems, systems for devices and processes control and in pattern recognition systems as well.

Fuzzy set A means a series of $A = \{(x, \mu_A(x)) | x \in X\}$, where X is the universal set, $\mu_A(x)$ is a membership function of x to the set A representing a degree or grade of membership of x in A .

The concept of a fuzzy set makes it possible to express uncertainty in a manner different from the classical probability theory, which is based on the concept of randomness. The fuzzy set can express uncertainty caused by imprecision or vagueness.

In fuzzy logic we also introduce the concept of linguistic variable which values are not numbers, but words called terms. Each term corresponds to a certain fuzzy set. For physical realization of the linguistic variable it is necessary to determine the precise physical values for the terms of this variable, which can be given by different functions. Figure 1 shows an example of the membership function of the fuzzy number (term) "about 10" using a triangular function.

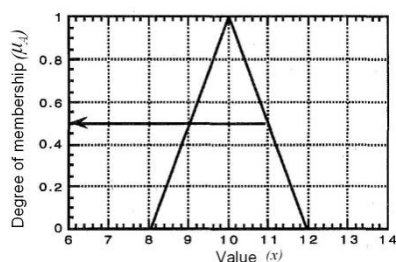


Fig. 1. Membership function of the fuzzy number "about 10"

Reservoir systems with fluids saturating them represent a classic example of a complex system in which the physical object uncertainty related to both stochastic uncertainty (situation of chance), and absolutely impossible precise definition of well-defined physical parameters of the environment measured by physical devices situation of fuzziness). Thus, the oil reservoirs can be referred to the class of fuzzy environments, and to choose EOR method means to make decision in fuzzy environment. With Fuzzy Logic it can be possible to quantify such terms as «very good» or «very bad» that is especially important in problems such as the choice of EOR method, when the reservoir parameters are different from the applicability criteria [4].

Thus, for the quick geological-and-physical data analysis in order to screen the oilfields an electronic applicability matrix able to calculate the applicability coefficient for EOR methods has been developed [6].

The applicability matrix is based on the applicability criteria, summarized according to Russian and world literature [5, 7]. Enhanced oil recovery methods used in the program are divided into several groups: hydrodynamic, thermal, chemical, polymer injection, alkalis, flow diverting technology, gas, water alternating gas and air injection. The input data for the matrix are a standard set of geological and physical information: the reservoir type, depth, permeability, porosity, temperature, oil viscosity, and others.

In the applicability matrix we use Fuzzy Logic to set critical boundary values (confidence interval) for screening criteria and calculate the applicability coefficients for methods. In the methods for each geological and physical parameter an individual applicability function is used. The score of each reservoir property computed by Fuzzy Logic varies from -1 to 1 .

For example, the applicability interval for one of the properties (e.g. viscosity) ranges from 5 to 8 cP, the values 4 and 9 cP are not be excluded from the evaluation due to small deviations since the error is to be found in any measurement of properties.

As a result, measurement error and experience of technologies application creates a confidence interval. Reservoirs which values of properties fall within the confidence interval are assigned a lower applicability coefficient according to function.

The program makes it possible to evaluate the EOR applicability and to perform plots "EOR method – applicability coefficients". Further procedure of detail screening can involve the construction of analytical plots, radar plots and use of integrated knowledge module. In this module we can view EOR criteria and limitations of the methods.

Furthermore, the program contains geological and physical properties and the summary of more than 300 projects of enhanced oil recovery application in Western Siberia and other Russian and foreign oilfields. Thus, it is possibly to search the reservoir analogs of applied EOR methods by software tool and to use the experience of previous reservoir development.

In comparison to logical and computational decision-making techniques, when we use Fuzzy Logic, no strict requirements for accuracy, completeness and consistency of source data for EOR methods screening are needed.

The criteria incorporated in the program and Fuzzy Logic for EOR evaluation provide more adequate assessment of the applicability of each method and reduce risks in optimal EOR method selection.

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DETERMINATION OF THE EMERGENCY PARAMETERS OF THE KTM PLANT

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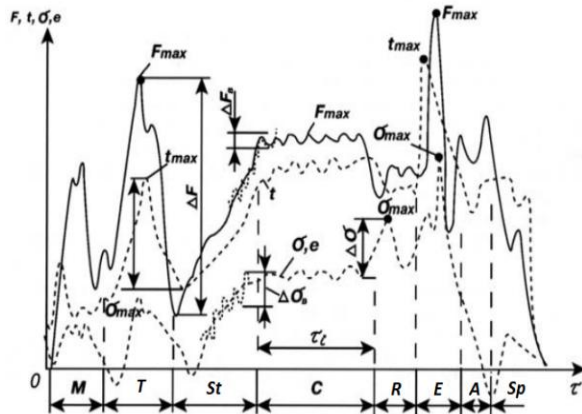
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The emergency accidents which can bring different negative effects are possible in every mode of the tokamak KTM operation.

The figure 1 shows the typical modes which were picked out for high-technology plant:

- M - mounting;
- T - test;
- St - startup;
- C - fixed mode with maintenance of parameters constant ;
- R – regulation of basic parameters;
- E - beginnings of emergency accidents;
- A – response of safety system;
- Sp - stop maintenance after planned or emergency modes.



Picture. 1 Modes of high-tech plant operation.

In general, 3 main loads act on technic system in usual and emergency accidents:

- 1) mechanic (from pressure, weight, inertial force);
- 2) electromagnetic (from act electromagnetic field);
- 3) thermal (from irregular spacing of temperature and (or) heterogeneity of thermo physical properties of materials.

From the mechanics accident standpoint the following types of limit states are appeared at the increasing of abovementioned loads:

- destruction (ductile and brittle);
- plastic deformation of the entire cross section element;
- loss of stability;
- beginnings harmful changes in the shape;
- beginnings of macrocracks in cyclic loaded;
- depressurization;
- wear, erosion;
- corrosion.

From a security perspective the first type of limit state is the destruction. It has fundamental importance, because it leads to the maximum possible damage. All anthropogenic accidents are happened due to it [1].

Therefore, there is a possibility of appearance of all above mentioned limited states in the tokamak KTM. In order to prevent an emergency situation, the controlled parameters should be picked out. The dynamics of these can help to explore the emergency accident at early stage of its development and the anti-damage system will make the control action.

Analyzing stage of work tokamak KTM:

Preparatory stag

High-vacuum is pumping of the vacuum chamber with heating. At this stage of the work the hermeticity of vacuum chamber was chosen as a controlled parameter. It is important to prevent different impurities at the moment of disruption in plasma-forming gas or to reduce their concentration to a minimum in relation to the concentration of working gas. The value of hermeticity should be in range $10^{-3} - 10^{-10}$ torr.

Also while heating a working chamber we should control temperature and discharge of water in cooling channels, the coil temperature, vacuum chamber and load-bearing element of power sources for prevention destruction.

Formative stage: pumping plasma-forming gas in vacuum chamber, switching on the toroidal magnetic field, powering of central solenoid-inductor with compensative coils which create necessary conditions for disruption of plasma-forming gas, solid ionization of gases and formation of plasma filament, with help consecutive overcoming of radiation and ionization barriers.

For steady formation of the cable it is necessary to input the microwave emission in the plasma. Its power should be more than necessary to facilitate the implementation and maintenance of the breakdown plasma. At this stage, several parameters, namely, the current in the winding of the EMC, the value of the rectifier current, supply voltage, output voltage of the power sources were identified. For each parameter, the range of variation in the safe mode installation KTM was defined.

The next stage:

The next stage is defined by the rise of plasma current to a predetermined value for a specific law, the maintenance of the plateau current in the plasma column. The controlled parameter is pinch current.

Also, controlling the dynamics of intensity change and rate of hard X-rays rise, the displacement velocity of the plasma vertical, loop voltage we can portend the failure of the plasma, taking control action, reducing or eliminating the consequences of an emergency.

The stopping stage:

The last stage is characterized by the controlling completion of the discharge in the plasma by a rapid change in the sign of the voltage across the inductor to an agreed off the RF heating and maintaining the equilibrium of the plasma during the all current output [2].

Table 1. Controlled parameters

| No | Name of parameter | Diapason of changes |
|----|---|---------------------------|
| 1 | Hermeticity of vacuum chamber | $10^{-3} - 10^{-10}$ torr |
| 2 | Temperature of water in cooling channel | 0-100° |
| 3 | Discharge of water in cooling channel | $(0-1.4)m^3/h$ |

| | | |
|----|---|-------------------------------|
| 4 | Temperature of windings, evacuated vessel and strong elements of sources power. | 0-300° |
| 5 | Output voltage | 0-600 V |
| 6 | Input voltage | 220 kV |
| 7 | Current in windings | 18-20 kA |
| 8 | Current in plasma | 0-750 kA |
| 9 | Intensity and rate of rise of hard X-rays | 104-107 ren/s sm ² |
| 10 | The displacement velocity of the plasma vertical | 0-20 sm |

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THE ADVANTAGES OF SAP OVER MS DYNAMICS AX FOR BUSINESS

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Today companies have the problem of selecting the ERP-system. This system is designed to manage the company's resources: money, production facilities and personnel.

Implementation of the ERP-system in the company provides a high level of data reliability, efficiency in obtaining the necessary information, the unity of the presentation of information to all departments. At the same time, customizable role-based access to the data system provides a reliable level of protection against unauthorized reception and leaks of information. ERP-system automates all basic and auxiliary business processes including financial accounting and distribution, manufacturing and logistics, personnel management and customer relationship management. An established system of control significantly increases the level of capitalization of the company and its attractiveness on the market.

The most recognized systems in the world are SAP, Oracle E-Business Suite, Microsoft Dynamics AX (Axapta), Microsoft Dynamics NAV. Belonging to a class of ERP-systems, each of them has its own specific features and price.

On the Russian market and CIS markets the most widespread are SAP and AXAPTA. Let's

consider advantages and disadvantages of each one.

Microsoft Dynamics AX is one of solutions for enterprise management, which comes from a division of Microsoft. The first version of AXAPTA was released in March 1998 on the Danish market and U.S. market. Today AXAPTA is sold and supported in 45 countries around the world. The current version is released June 1, 2009. AXAPTA has more than 11,000 customers.

SAP R / 3 is integrated and automated control system. It is the main product sold by the German firm SAP. This product has been improved over the past 30 years. Today, more than 38,000 companies use SAP software to manage the business.

AXAPTA was originally aimed at medium-sized businesses. This explains the lack of some features (especially in terms of production). Currently AXAPTA is a universal system. On the other hand SAP was targeted originally at geographically distributed large holdings, a wide range of activities and industries. Only recently this system has started to be considered as a system for medium-sized and big businesses.

The basic functionality of ERP-system should provide opportunities to automate all business processes. Even if at the moment the company does not need this or that feature, as the business grows, ERP-system must meet all the new and the new requirements. Because of this reason it is becoming especially important to purchase and implement the ERP-system in a modular form. If SAP has integrated functionality, the AXAPTA has limitations in terms of supply chain planning, production planning, enterprise asset management (repairs, maintenance).

In this case, the best industry solution is pre-tuned business model in the ERP-system, which implements the principles of business management based on the best Russian and international industry experience. Industry-specific solutions allow you to accomplish the project most effectively. Such industry solutions are available in SAP industry, but AXAPTA is incompatible with industry-specific solutions of a partner, which leads to the following additional costs.

Quite often structural units of an enterprise are geographically distributed. In these circumstances, it becomes critically important to create a centralized database and organize the work of the departments over the Internet. This problem is solved most effectively by the ERP-systems, which were originally designed to work over the Internet browser. In this case, the installation on the end users' computers is not required, which also facilitates maintenance. SAP uses modern development tools, which facilitate the recruitment of personnel to work with it. But AXAPTA uses its own language X++ (C++ and Java).

Today there are two main approaches to the design of ERP-systems. There are multiplatform and single-platform systems. SAP and AXAPTA are multi-platform systems. But SAP, in addition to Microsoft SQL Server, Oracle, supports DBII.

An important aspect of choosing the ERP-system is its cost. The cost of a project implementation consists of three main components: a license of a system, technical support and consulting services for implementation. Purchase and maintenance of SAP is several times greater than of AXAPTA.

Before-mentioned shows that Axapta is largely inferior to SAP.

These are also four reasons why you should choose SAP above any other software solution such as MS Dynamics:

1. SAP Business Suite is built for growth: SAP provides you with a single state-of-the-art platform on which all native SAP software (ERP, CRM, SRM...) is seamlessly integrated with each other. Being database and OS independent it provides the necessary flexibility to fit in any existing IT landscape (e.g. Linux). Whether you have one or multiple legal entities, SAP provides integrated intercompany processes and consolidation tools to support existing and growing businesses in one

system. SAP Business All-in-One provides pre-configured business process based on industry best practices gained over the last 40 years and as Gartner states SAP is still the most complete software solution on the market and will remain so. SAP's only business is to provide scalable business application software to small, medium sized and large enterprises.

2. One user interface does not fit all: SAP has recognized that there are different types of business users within a company. To enhance employee productivity SAP has launched a wide range of different ways to connect to the backbone applications. To name a few: the web-based Enterprise Portal, mobile applications, Adobe PDF interactive forms, NetWeaver Business Client, Duet for MS Office and SAP, Business Objects, ... and by doing so one can integrate SAP and non-SAP applications into one single interface where single-sign-on provides easy access to all applications for each employee. Furthermore SAP provides a platform and tools to develop your own web-based business applications without any programming (e.g. visual composer, floorplan manager).

3. Turning a predictable total cost of ownership into value: SAP can you provide you with numerous business transformation studies to provide the proof of a significant lower and predictable (what you see is what you get) TCO when implementing SAP software without any hidden costs. AXAPTA support costs can be very unpredictable. There is a risk to spend on system support more than the purchase. Where TCO provides you with the cost of implementation it does not give you any insight on the benefits or business value you will gain. SAP and its partners are able to pinpoint the most important value drivers and KPI's for your sector through value engineering with tools like 'Enterprise Health Check' and 'Value Lifecycle Manager'. Based on real life business experience SAP knows what is driving each industry sector and has made benchmarks to measure your performance against competition.

4. SAP channel partner and customer eco-system: In order to become a channel partner implementing Business All-in-One software, a stringent qualification process is in place to ensure local and global top quality. Instead of developing (local, partner specific) add-on software components, all vertical solutions are based on standard SAP software. Partners cooperate with SAP to define new solutions and processes which are certified by SAP for global roll-out. Partners work together to offer the best possible solution to you as a customer. The eco-system allows sharing information on events like the SAPIence.be user days and commission meetings that allow customers to share knowledge and experiences across all domains, or to talk to SAP experts on specific topics.

From the foregoing it is clear that SAP has a great advantage. SAP supports a lot of platforms. It works over Internet browser. The system is developed on well-known programming languages. SAP has integrated functionality. That is why many companies prefer this ERP-system. The main drawback of this system is high cost. However, as the experience of investments meet the expectations of buyers. Because implementation - is an investment in a business improvement with a rapid return of investment. According to research conducted among companies using the SAP solution, the following figures showing the average effect of the implementation were obtained:

- Reduction of the number of delays in the supply of products to customers by 90%;
- Reduction of the minimum balances of materials in the warehouses by 30%;
- Increased inventory turns by 20%;
- Reduction of the volume of work in-process by 17%;

- Increased productivity of equipment and personnel by 10%.

Let's consider a real example. The project of replacement AXAPTA by SAP was recently completed on the second largest in Russia and the first largest in Ukraine producer of dairy products "UNIMILK." All operating activities - from production to sales and business performance management has been integrated into a single platform. The company's management believes that the investment will pay off in 1-2 years, which is a good indicator for large businesses.

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ADAPTATION OF ELECTRONIC DOCUMENT MANAGEMENT SYSTEM TO BUSINESS PROCESSES

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1. Automation of document flow

Standard management methods in state and business enterprises, such as meetings, teleconferences, e-mail and paperwork for a long time have been proving their low efficiency in nowadays business world. Today electronic document management systems (EDMS) are coming to the market. Some of them, like Lotus Notes, have a long history, while others, such as, DIRECTUM, 1C and DocsVision are relatively recent and are still actively developed. [1]

None of the EDMS implementation is ending with off-the-shelf software product supplying. Management tasks performed in each particular organization may be different and can be reduced to the development of additional modules and integration with other systems. The success of the implementation of an information system depends largely on the capabilities of its adaptation to the business processes of your organization. In addition, the system must evolve with the business. Compliance with these requirements is the key to effective use of information systems.

The study that this paper is focused on is devoted to the choice of the variant of implementing the electronic document management system which is the most preferred

for the majority of users engaged in the business organization, in terms of realization of the best opportunities to adapt the system for a particular specificity.

2. EDMS realizations

Today the most popular EDMS systems in Russia are Lotus, 1C, DocsVision, DIRECTUM, Delo. They have a similar set of functions to handle the flow of documents and business process management, but different methods and settings interfaces. This is very important because not all the features of the data domain can be efficiently implemented using a standard graphical user interface.

For example, the IBM Lotus Notes / Domino platform (BOSS-Referent EDMS) uses a Lotus Designer special software as a developing tool, which allows you to create multiplatform applications with Lotus Script that is Visual Basic - like language. In many cases it is necessary to resort to the @-formulas or Java / Java Script languages. However, this is not enough to create an application for a relational database. Therefore, Borland Delphi 6.0 is used as an additional tool. [2]

The 1C approach for configuring the system for a specific customer uses a subject-oriented

development tool and special graphical user interface. [3, 4]

DocsVision company promises us to develop the functions of business processes modeling in future versions of its system to make the design of processes scheme and tasks more affordable for specialists in subject area. [5, 6]

Other embodiments of the EDMS software products are the Kancler, Delo and the Motiw. All of them offer their services for setting the system up to the specific needs of the custom organization without providing such an opportunity for programmers of the client company. [7, 8, 9]

The attractive point of DIRECTUM is the possibility for a customer company to use the advanced IS-Builder toolkit which main difference is simplicity. It allows you to adapt the system quickly, integrate it with other systems, as well as apply the own customer company efforts to modify the basic variant of the system according to the development of the organization. The advanced functionality, user-friendly documentation and the subject-oriented approach allow the IS-Builder to easily develop high-performance capabilities of the applied system with an abstraction from the specific technical details of their implementation. [10]

IS-Builder is an open language that enables to integrate DIRECTUM with other systems for exchanging of electronic documents with digital signature between different organizations even if they use different document management systems, or do not use them at all.

All these benefits determine the choice of DIRECTUM EDMS as the best system to automate workflow and interaction management. [11]

3. Documents movement realization

As an example, is represented by the development of standard route (SR) "Negotiation about the order of the basic activities" in DIRECTUM system with a choice of persons that negotiate and sign is represented. The script that is created with the help of a software developer's tool automates the following steps:

- forms the theme for each Executer, describing the essence of the job and sends the job within the specified period according to the developed scheme;

- performs registration of the document in the appropriate journal and automatically assigns a number that is configured in the Journal for the documents of this type;

- inputs registration number and date of the registration into details of the document. Registration card that is automatically created is automatically attached to the task that goes back to the Initiator with the document that was agreed and signed by signature; - At each stage of execution of the SR program the specified logical checks that ensure the correctness of the movement of a document over the SR are executed.

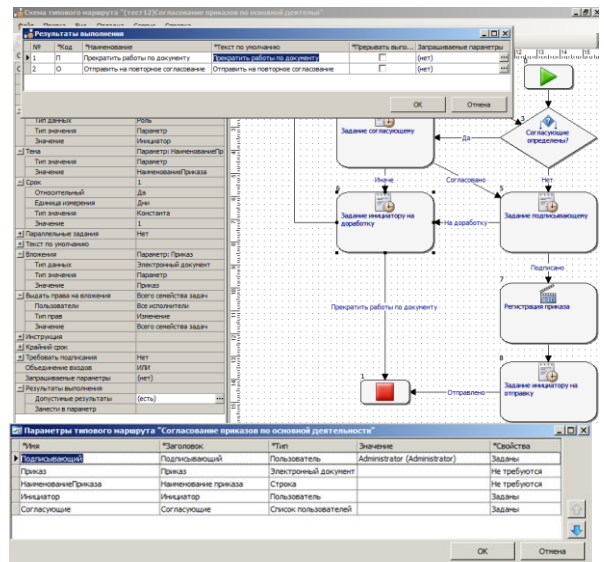


Fig. 1. The SR configuring process: scheme editor and configuration of the SR parameters

```

7 Code = 'Д000004'
8 Register = References.ГДЛ.GetObjectByCode(Code)
9
10 ИДДок = Work.GetAttachments(False).Values(0).ObjectInfo.ID
11 EDoc=EDocuments.GetObjectByID(ИДДок)
12 // Создает справочник "РКК" сразу - чтобы лишние запросы не возникли,
13 // если нет прав на справочник
14 SprPKK=CreateReference('РКК';;True;)
15
16 РККПредст=КНЦРККПредставление('Внутренний')
17 SprPKK.CreateView(РККПредст)
18 SprPKK.Params.Add("РКК_Регистрация";РККПредст)
19 SprPKK.Params.Add("РКК_РегистрацияИДДок";ИДДок)
20 // Контекст нашей организации не устанавливается при навигации от записи в
21 // которая по нашим организациям не делится
22 ТекОрг=НашаОргЕд()
23 // Дальнейшие вычисления выполняются
24 // если ранее была определена наша организация
25 Если ТекОрг <<> ""
26 ПредОрг=ТекОрг(ТекОрг)
27 // Запишем в карточку ЭД присвоенные рег.номер документа и рег.дату
28 SprPKK.DataSet.AddWhere('1=0')
29 SprPKK.DataSet.Open
30 // Добавляем новую запись
31 SprPKK.DataSet.Insert
32 SprPKK.ГруппаДел = Code
33 Параметры = Work.WorkFlowParams
34 SprPKK.Наименование = Параметры.ValueByName('НаименованиеПриказа').Value
35 КонецЕсли
36 SprPKK.Save
37 // Восстановление исходного состояния
38 ТекОрг(ПредОрг)

```

Fig. 2. A code fragment that demonstrates the registration of a document

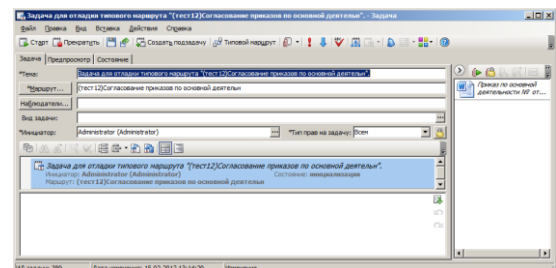


Fig. 3. The window of the job coming to the Executive

4. Results

As a result of development that has been carried out on the IS-Builder platform and complementing the basic version of DIRECTUM EDMS, potential employees are able to promptly negotiate and sign an electronic document stored in the DIRECTUM system, register it and control the execution of tasks. All participants of the interaction process get the job assigned to them at the right time. When employee opens a job there is

a text visible explaining the essence of the work that Initiator wants him to do and attachments that contain an electronic document which can be viewed by opening it in the Microsoft Word application and the register card put automatically after registration. If the member of interaction has some comments on the document he has the opportunity to leave his suggestions in the task. Then work with the document goes through the process until all of the comments are not corrected.

Thus as a result of work a software script that automates the process of negotiating documents taking into account the specifics of the application was created.

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THE WAY TO STORE FORESIGHT RESULTS

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Today's world is growing too rapidly: prediction the events in the next year is a very difficult task, moreover the 5 and 10-year-perspective are impossible to be predicted even for professional business-analyst. Year to year, long-term planning is becoming increasingly difficult, and decisions about the organization strategy much more expensive.

Often the future depends of the huge number of factors, which behavior also depends on various circumstances. Long-term planning becomes similar to the solving the equation with hundreds of variables and for successful decision we lack of computing power, or should take a large number of assumptions, which are dramatically reduce the reliability of the output.

In this regard, in the 1980s in the U.S.A. new method for long-term forecasting appears. Forming a coherent picture of the world, this technology called foresight, in literal understanding means - looking into the future.

For the initial, members of foresight project use statistical researches, forecasts and assumptions of the experts, and the result is a consistent picture of the future, the most likely scenario of the world. Based on the foresight result, enterprises, governments, corporations and other organizations can shape priorities for development and predict patterns of behavior that will be claimed after 20, 30 and 50 years.

Foresights, that already held were about the corporation plans for far future, the long-term forecast of technological industries, the risk

assessment of investment projects and even about the development of public policies in some areas.

Next definition corresponds to the classical foresight: "Foresight is - the process involved in systematically attempting to look into the longer-term

future of science, technology, the economy, environment and society with the aim of identifying the emerging generic technologies and the underpinning areas of strategic research likely to yield the greatest economic and social benefits (foresight is NOT the same as forecasting - a process not a technique)." Ben Martin (SPRU, University of Sussex). [1]

The technology has come to Russia about 7 years ago, but its practical application became only since 2010.

Foresight technology have adopted by different expert clubs (including the Industry and Energy experts club), analytical agencies, Kurchatov Institute, Metaver, various general-governmental organizations and even some ministries of the Russian Federation (the ministry of science and technology and the ministry of industry and trade). Besides, an international center of foresight was established based on the HSE and the magazine dedicated to the results of the foresight project produced since 2007. According to the official site of the Industry and Energy expert club [2] foresight - long-term forecast technology - the method of constructing a coherent, balanced and responsible way of the future. It is based on technology of working with large experts panels, where hundreds of expert transit their knowledge, opinions and assumptions. The results of the expert panels (lists of perspective technologies and scenarios) are talked over in a series of discussions with specialist in the sphere, which foresight is dedicated to. The result of foresight is a common vision of future that is clear and acceptable to all parties.

As a result, participants receive a foresight "road map" - a visual image of a common future, including key trends, events, technology, strategic crossroads and decision points, the plan of legislative and lobbying measures, the forecast for technologies development and key markets. [3] In fact, the roadmap is a huge scheme attached to the timeline, and containing two or three hundred items. For clarity elements with similar semantics are gathered in one next groups: text-boxes of different shapes and sizes, connections, dependencies, and branching. In some cases detailed text descriptions may be attached to the scheme.

Of course, the question about storing results of experts panels, brainstorming sessions, discussions, conclusions and projections.

Despite the popularity of technology, the majority of organizations conducting foresight, still building maps and diagrams on large sheets of paper, and much later redraw created a map of

schemas in one of the graphical editors and later publish only a screenshot.

Obviously, this process provides semantic errors in copying, the complexity of correlation of dates and events, moreover, the detailed scheme would be difficult to treat because of the huge number of small details and signatures.

In this regard, there is a need for a program product, which will help to keep foresight sessions achievements, organize materials and link them to each other.

Thus it's necessary to develop information system that will combines features of several programs and

- allows:
- to draw flowcharts, differentiated groups of items by color, shapes and size;
 - to save a scheme with all items in format, that supports editing in the graphical way;
 - to support the ability to work groups of experts remotely as well as a discussion in the real time;
 - to scale quickly and easily any item of the scheme and each of the text elements to be read;
 - to show the whole scheme and each level of the scheme separately;
 - to store text description, explanatory documents and bind them to the elements of the scheme.

For this task next solutions seem possible:

First way is using online editors, wiki-enabled technologies, such as mindmeister.com or gliffy.com. These technologies are very comfortable for common work of several expert groups and provide an opportunity to save an image or imported it into the common formats such as * vsd (MS Visio) for future edition.

But the hierarchy of schemas defined implicitly, and as a consequence, it is difficult to navigate in a large number of connected circuits (if it's necessary, the hierarchy can be organized manually, but there are no built-in templates). Furthermore, this method will require additional hyperlinks to text documents (such as docs.google.com), it is difficult to implement "live" discussion and it's necessary to choose an editor with opportunity to scale each item without scaling whole scheme.

The second way is to create a special site or web page for the foresight project, containing explanations and presentations materials. This approach will provide easy orientation in the materials: all documents and references will be collected in one place. Also, there is the opportunity to participate in foresight for an unlimited number of people by comment articles or schemes (this approach was partly implemented in a foresight project "Childhood 2030"). This method is suitable to publish the results when there are little adjustments and refinement only, but it's not such convenient for using it as a working tool. In addition, it is difficult in realization, so it makes sense only for large projects.

The third way is creating a process template, with a set of necessary tools, following which from

one to another, users go through all stages of foresight. The advantage of this approach is the comfortable using because the interface is the same for all projects. But it's complicated in implementation, thanks to necessity to formalize the process and to pick out the general phases of all foresight technologies. Besides, the user extensions in tools set is highly desirable.

So, selecting the best working tool for the foresight projects, way to store the results, application to create and preserve schemas and maps is a complex task that requires careful analysis and testing on projects. This search for optimal solutions will be found out in the further work.

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DESIGNING A CONTROL SYSTEM BY THE ELECTRIC MOTOR

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The electric drive has passed its way in the historical development from a simple source of mechanical energy for a car or group of cars to the 'intellectual device' which actuates car bodies and mechanisms and controls this movement.

Nowadays the electric drive is a constructive unity of an electro-mechanical converter of energy (engine), a power converter and a control device. It provides transformation of electric energy in mechanical one in accordance with the algorithm of work of technological installation. Application areas of the electric drive in industry, in transport and in everyday life are constantly expanding. At present, 60 % of all electric energy developed in the world is consumed by electric motors. Consequently, efficiency of energy-saving technologies is largely defined by efficiency of the electric drive. The development of high-productive, compact and economic systems of the drive is a priority direction of development in modern engineering.

The last decade of the past century was marked by considerable successes of power electronics — industrial production of bipolar transistors with the isolated shutter (IGBT), power modules on their basis (racks and the whole inverters), and also intellectual power modules (IPM) with the built in protection frames of keys

and interfaces for direct connection to microprocessor control systems. The growth of integration level in microprocessor technology and changing from microprocessors to microcontrollers with the built-in set of specialized remote terminal units have made a tendency of mass replacement of analog control systems drives with direct digital control systems irreversible [1].

The elementary block diagram of automatic control system of the electric drive is the opened system. However, the influence of *revolting influences* on such a system is great – perturbation error is too big. The most widespread block diagram of the automatic control system of the electric drive is the closed system with regulation by mistake. The given system has the following advantages:

- maintenance of constant value of speed in a static mode without depending on revolting influences, for example, at a loading sketch;
- monitoring a randomly changing signal entered into the system, for example, sinusoidal, change of entrance influence at a backspacing.

It is obvious that the system with regulation on a deviation is capable to provide all set-up technical parameters of the projected electric drive, therefore, in this article there will be a system with

model of 3-contour control with regulation by mistake.

We will use the microcontroller, the power module and sensors for designing a control system by the electric motor.

We will choose microcontroller ATmega 16 (ATMEL Co.) to control the given engine. Due to the number of input-output ports, as well as parameters of the computing capacity this microcontroller is suitable for controlling the engine.

The microcontroller choice was based on the following requirements:

1. It is necessary to provide switching on 2-3 phases on an exit with frequency not less than 20 kHz. In the case of 3-phase engines the quantity of references to power keys will be in 3 times more and equal to 45-60 kHz (45-60 thousand operations per second).
2. The controller should process 5-7 entrance signals and execute some mathematical operations.
3. Digitization frequency of the pulse-width converter is about 15-20 kHz.

Clock frequency of the internal clock generator is usually set by quartz; therefore, it is equal to the frequency written on quartz. Sometimes quartz isn't used. In that case the internal RC generator

which is not very accurate starts to work (it does not need any external components). The generator usually works on frequency of 1 MHz (it is possible to adjust it to frequency of 8 MHz or less). What mode to use is defined by internal options "fuses" (they are also called crosspieces). For example, for microcontroller ATmega16 by default (when the chip comes pure from the factory) crosspieces are adjusted to work without quartz, from internal RC generator on frequency of 1 MHz.

So, frequency of kernel F in Hertz is known. Now it is possible to get the time for one step: $T_{CLK} = 1 / F$ (in seconds). Each command is performed in definite number of steps (the quantity depends on the command). For example, commands ANDI and ORI (which are often used in control of port legs) are executed in 1 step. There is an example of calculating the duration of ANDI command execution:

$$F = 1 \text{ MHz};$$

$$T_{CLK} = 1/1000000 = 0.000001 \text{ sec} = 1 \text{ mksec.}$$

Command time execution: $1 \cdot 1 = 1$ micro second (command ANDI is executed in 1 step).

Thus, it is possible to make a conclusion that MC choice is correct, and it also meets the requirements specified above.

Drivers are intended for management of powerful transistors with field management on pressure to 6500V.

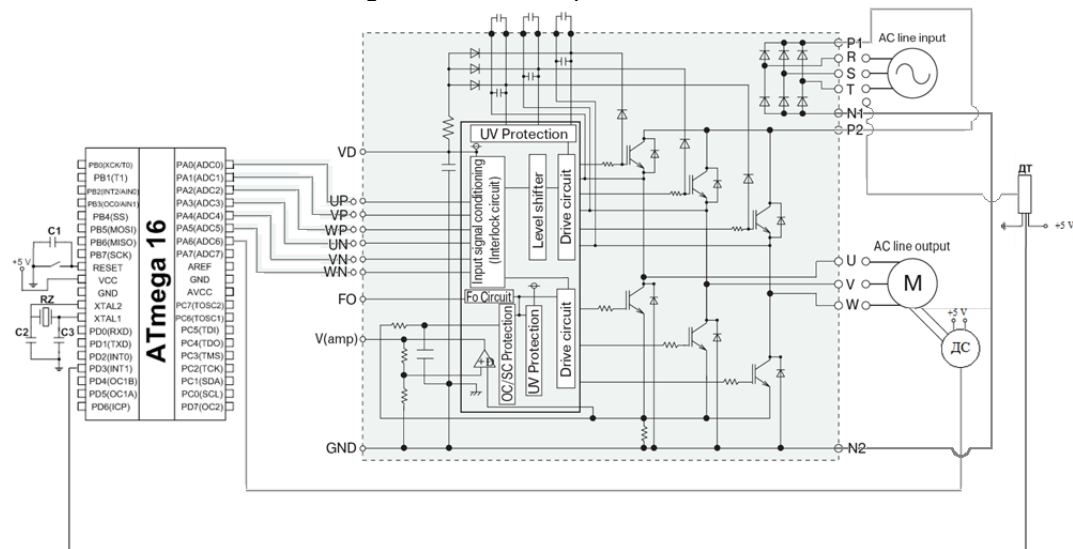


Fig. 1. The scheme of the coordination of automatic control system of the electric motor

Drivers have shown themselves to good advantage in many areas of the industry thanks to their simplicity and reliability.

Their structure includes the majority of the knots necessary for protecting operated transistors in emergencies. Modules of drivers which are also part of drivers allow to collect almost any control system with the minimum expenditure of time for development and the maximum flexibility in algorithms of work.

IGBT driver structure includes the logic scheme. The logic scheme is a circuitry decision aimed at an exception of probability of two power

keys opening in one shoulder of the bridge simultaneously.

We will choose driver CM15MD-12H for electric motor control which structure includes the power scheme of control [2].

As for sensors which are included in feedback for regulation realization on a deviation we will use the current sensor, the sensor of speed and position. The current sensor serves for fixing current value during each moment of time. As for the current sensor we take sensor ACS712 [3]. This sensor is applied for measuring direct and alternating current using Hall Effect. As for speed and position sensor we will choose an optical

encoder [4]. Optical encoders carry out various industrial problems: controlling angular position, measuring speed of a shaft, its position or displacement, controlling positioning.

Summing up, it is possible to say that this system has been successfully designed (fig. 1) and this is universal for any type of the electric motor.

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CONTOUR ANALISYS FOR SOLVING PROBLEMS OF AUTOMATIC CLASSIFICATION OF OBJECTS

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Introduction

Computer vision is the theory of creating algorithms, which can detect, track and produce segmentation of objects. Computer vision is a science discipline. It refers to technology of creating artificial systems, which get information from images and video.

If we get information from video stream, we should pay attention to high-speed performance, because video must processed in real time. That's why there is path of computer vision named contour analysis.

The object of research in this state is description and classification.

The subject of research is contour of moving object which is a binary image. Binary image is image which has two colors: black and white. Contour is described a set of white points, which located on a closed path on black background. Example of contour is shown in figure.

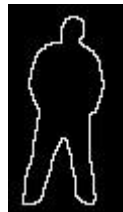


Fig. 1. Contour of object

The problem of research is a description given contour of array of numbers, named array of descriptors. Descriptor is a value which described object or it specific property. The next problem is a classification of given descriptor arrays and giving an array either group: person or car.

Description of contour

We have a matrix of a binary image $I_{M \times N}$.

After we create a descriptor array of this image. This operation can be done one of the three ways:

- Freeman chain code;
- Coefficients of Fourier transform;

Freeman chain code

With the help of chain code boundary is represented as a sequence of numbers, characterizing the points way in the contour. This representation is found of segments of 4-connected and 8-connected. The points is coding by number in line with scheme of numeration.

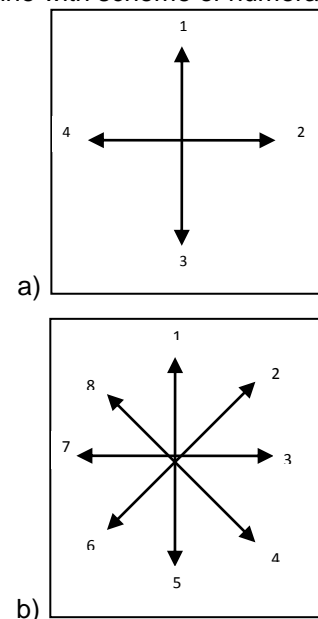


Fig. 2. Numeration of points ways for a) 4-connected code; b) 8-connected code

Coefficients of Fourier transform

The boundary of the object can be represented as a sequence of coordinate pairs:

$$f_k = [x_k, y_k], \quad (1)$$

where:

$[x_k, y_k]$ – coordinates of a point on the boundary;

$k = 1, 2, \dots, K$ – serial number of the coordinates.

Each pair of coordinates can be represented as a complex value:

$$f_k = x_k + j \cdot y_k \cdot (2)$$

The expression for the Fourier transform of a finite sequence given by the equation:

$$a_u = \sum_{k=1}^K f_k e^{-j2\pi u(k-1)/K}, \quad (3)$$

where:

a_u – coefficient of Fourier transform;

f_k – pair of coordinates, which represented as a complex value;

$k = 1, 2, \dots, K$ – serial number of the coordinates.

The coefficients a_u describe the boundary of contour and named descriptors of boundary.

The inverse Fourier transform, applied to these coefficients, can restore boundary of contour f_k :

$$f_k = \frac{1}{K} \sum_{u=1}^K a(u) e^{j2\pi u(k-1)/K}. \quad (4)$$

If for inverse Fourier transform we use not all K coefficients, but only part of them – R , then the result of recovery will be:

$$\hat{f}_k = \frac{1}{K} \sum_{u=1}^R a(u) e^{j2\pi u(k-1)/K}. \quad (5)$$

So, the result $\hat{f}(k)$ will be approximately described the original sequence $f(k)$. The accuracy of this approximation will depend on the number of Fourier coefficients used. In followed figure we can see it.

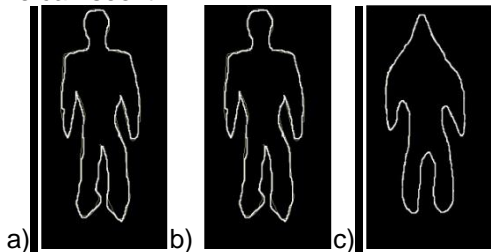


Fig. 3. a) original image; b) inverse Fourier transform for 100% of coefficients; c) inverse Fourier transform for 10% of coefficients

I have been chosen second method – Coefficients of Fourier transform, because testing has shown a high rate calculations.

Contour classification

The classification is based on a comparison of the input contour with the etalons. I was allocated 2 etalons of cars and 3 etalons of people. At this stage I have examined two ways of comparing arrays of descriptors:

- The correlation coefficient;
- Euclidean distance.

Vectors which compared is $q1$ and $q2$. The correlation coefficient between two vectors is:

$$koeff_{q1,q2} = \frac{\sum_k (q1_k - \bar{q1})(q2_k - \bar{q2})}{\sqrt{\sum_k (q1_k - \bar{q1})^2 \sum_k (q2_k - \bar{q2})^2}}. \quad (6)$$

Euclidean distance:

$$d = \sqrt{\sum_n (q1_n - q2_n)^2}. \quad (7)$$

Etalons

Allocated etalons of people and cars situated on next figure.

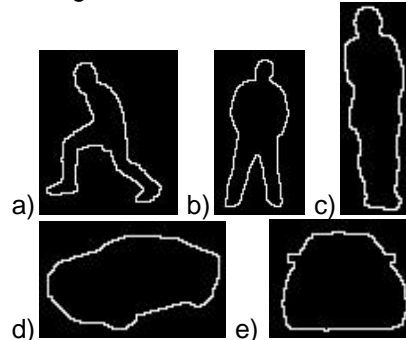


Fig. 4. a, b, c, d, e. Etalons of people and cars
When creating the etalons of people and cars, emphasis has been on a variety of poses (people) and changing the observation point (cars).

Results of research

It was made a comparison of two methods of classification: the correlation coefficient and Euclidean distance. I imported 653 images of contours. Correct results of classification are in the table.

Table 1. Results of classification descriptor arrays

| Method | Number of correct classified images, % |
|-----------------------------|--|
| The correlation coefficient | 78 |
| Euclidean distance | 89 |

We can see that method Euclidean distance is more correct.

Conclusion

For solution of problems, such as description and classification of contours, was analyzed some special books. It was books with a theoretical packs for this theme.

At result was created a model of classification of image with contour for either class: person or car. On the basis of this model was created a

computational algorithm. This algorithm was realized in Matlab.

Then was tasted ways of description and classification of contours for performance and quality.

In future I plan to realize the algorithm in C++ Visual. Also I plan describe the etalons of contours more accurately and expand a classification (trucks, plains, beasts, birds). After them it's necessary to solve a problem of allocation a contour of moving object from video.

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THE IMPLEMENTATION FEATURES OF IMAGE COMPRESSION ALGORITHMS WITH THE USE OF FAST DISCRETE TRANSFORMATIONS

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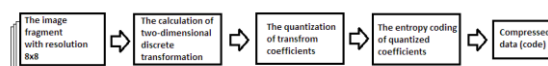
The subject matter of this work is JPEG-like image compression algorithms. At the present time the most common method of image compression with losses, called JPEG, is based on quantization and static coefficient coding of Discrete-Cosine Transformation (DCT). However for such aims, as image compression, we can use different orthogonal transformations. In this article the other types of orthogonal transformations such as Walsh function transformation and Discrete-Pseudocosine Transformation (DPCT) will be considered.

Introduction

JPEG (Joint Photographic Experts Group) is the most common image format used by digital cameras and other photographic image capture devices. JPEG is also the method of image compression which allows compressing data of multigradation images with reasonable speed and good efficiency. The JPEG algorithm uses Discrete-Cosine Transformation (DCT) [1] for compressing pictures. However for implementation of such kind of transformation it is necessary to execute large number of calculations with floating point. It is possible to say that calculation of Discrete-Cosine Transformation and reverse transformation form of DCT (called IDCT) are one of the most time-consuming and time-wasted procedures which should be executed until images compression and extraction procedures are done. It all means that such procedure as Discrete-Cosine Transformation is highly needed to be more optimized for improving the speed and efficiency of work of software and hardware which performs all compression and extraction operations.

Common scheme of image compression

For the aim of optimization and further manipulations, the original discrete image is divided into small scale square fragments or sequences of N elements and each of such separate parts of original image is processed independently with the use of transforming matrix F defined by chosen type of orthogonal transformation in process of compression and using the F^{-1} reverse transformation matrix in procedure of recovering. In the most general form the scheme of digital images compression with the use of orthogonal transformations looks like the scheme presented in pic.1.



Pic.1. The scheme of digital images compression with the use of orthogonal transformations

The two-dimensional orthogonal transformation is calculated by the formula: $Y = kXP^T$. Here X – the matrix of input values, Y – the matrix of output values (set of output coefficients), P – the matrix of transformations, k – a scalar scalable factor. Now, let's consider the matrix Y^T : $Y^T = kPX^T P^T$. Define the Z matrix as $Z = PX^T$. Then matrix Y^T will transform to $Y^T = kZP^T$ and matrix Y will transform to $Y = kPZ^T$. So then the calculation of matrix Y of output values can be reduced to just two consistently executed operations of two matrixes multiplications in which the first matrix is the same. That fact simplifies the creation of software and hardware realizations of such compression algorithm.

Discrete orthogonal transformation based on Walsh function

Discrete-Cosine Transformation is not the only orthogonal transformation which we can apply in image compression algorithms. Let's take a look on the Walsh orthogonal transformation [2]. Such orthogonal transformation is characterized by the fact that this transformation can be reduced to simplest addition and subtraction operations.

In the technical literature one can find several methods of how transformation matrix is formed. For discrete orthogonal transformation based on Walsh function with arranging by Adamar's method we can create the transformation matrix P by using recursive method of creation block matrix based on formula: $H_{2^n} = \begin{bmatrix} H_{2^{n-1}} & H_{2^{n-1}} \\ H_{2^{n-1}} & -H_{2^{n-1}} \end{bmatrix}$. Most often the original image is divided to blocks of 8x8 pixels resolution. For such case the matrix of orthogonal transformation will look like this:

$$P = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 & 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 & 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 & 1 & -1 & -1 & 1 \\ 1 & 1 & 1 & 1 & -1 & -1 & -1 & -1 \\ 1 & -1 & 1 & -1 & -1 & 1 & -1 & 1 \\ 1 & 1 & -1 & -1 & -1 & -1 & 1 & 1 \\ 1 & -1 & -1 & 1 & -1 & 1 & 1 & -1 \end{bmatrix}$$

The fast Walsh transformation use decomposition of matrix P by three matrixes which significantly reduces the number of necessary operations because existence of big amount of zero's in derivative matrixes:

$$P = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & -1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & -1 \end{bmatrix}$$

$$\times \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 \end{bmatrix}$$

For multiplication the matrix of transformation to one column vector of the original data it is necessary to carry out 24 addition operations. It means that to transform all input square matrix with resolution 8x8 we need to calculate just $2 \times 8 \times 24 = 384$ addition operations at all.

Discrete-Pseudocosine Transforming (DPCT)

In such method the transformation matrix P can be created from orthogonal transformation matrix DCT by replacing the values of the trigonometric functions with their approximate values which can help to present this matrix as a multiplication of two special viewed matrixes D and C. The C matrix permits factored representation in a form of poorly filed matrixes consisting of elements from a set of numbers {-2, -1, 0, 1, 2}.

So that transformation matrix $P = D \times C$, where $D = \left(\frac{1}{2\sqrt{2}} \frac{1}{2\sqrt{5}} \frac{1}{2\sqrt{2}} \frac{1}{2\sqrt{5}} \frac{1}{2\sqrt{2}} \frac{1}{2\sqrt{5}} \frac{1}{2\sqrt{2}} \frac{1}{2\sqrt{5}} \right)$ in case of eight dots (pixels),

$$C = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 2 & 1 & -1 & -2 & 0 & 0 & 0 & 0 \\ 1 & -1 & -1 & 1 & 0 & 0 & 0 & 0 \\ 1 & -2 & 2 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 2 & 1 & -1 & -2 \\ 0 & 0 & 0 & 0 & 1 & -1 & -1 & 1 \\ 0 & 0 & 0 & 0 & 1 & -2 & 2 & -1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & -1 \end{bmatrix}$$

Multiplication by matrix C requires calculating 24 addition operations and 4 bitwise shift operations. For converting the full square matrix with resolution 8x8 we need to carry out $2 \times 8 \times 24 = 384$ addition operations and $2 \times 8 \times 24 = 64$ bitwise shift operations.

Discrete-Pseudocosine Transformation is the simple approximation of Discrete-Cosine Transformation which saves orthogonal properties. Such algorithm allows avoiding multiplication operations in process of coefficients calculations which helps to increase speed of compression algorithm.

So far as such orthogonal transformation is actually the form of Discrete-Cosine Transformation the compression ratio of compression algorithm based on DPCT is almost the same as of JPEG [3].

Conclusion

The fast two-dimensional discrete transformations discussed here have low hardware requirements and high speed of work in addition to good enough quality of reconstructed images which are insignificantly inferior to JPEG quality. It makes such orthogonal transformations very effective while applying in software and low-cost hardware codecs (for example in digital cameras) and also in other spheres of human endeavor that

require fast algorithms to process and transition images.

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EVENT LOGGING IN NETWORK MONITORING SYSTEMS

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Logging is the process of storing critical information about the network events. The logs can be stored in simple text files as well as in a database. The log format can be defined by a user. Logging is very useful for analyzing the data for critical issues, application failures, hardware issues and finding other important information about the computer network. The logged information is used for the diagnostic purposes. Network logging provides the information like line, count, date, error message, application, protocol and actions.

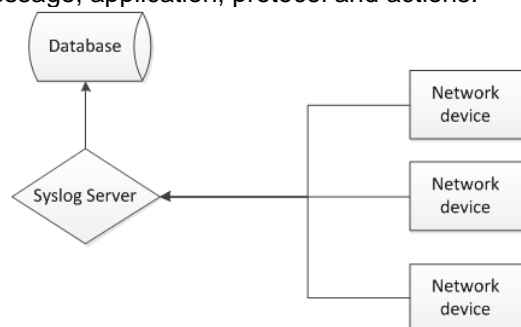


Figure 1. Collecting network messages

The logging provides improved security and ease of administration. In the computer network, the routers, servers, client computers, wireless access points and other network devices should be logged to get the detailed report about your network. With the log files, it is very easy to diagnose and troubleshoot the errors that are generated due to the software, hardware,

securities and network applications. There are different tools that are used to log the information on the networks.

In Windows-based computers, there is a utility known as Event View that is used to log the System, Applications, Security, Internet Explorer and other things.

In the Unix-based computers, there is a service called Syslog, which is also available in other systems. The Syslog protocol is used in some third-party systems for Windows. It has become an industry standard, so most of the modern devices, including Cisco systems, can send messages to Syslog server directly using built-in features.

Each Syslog message includes a priority value at the beginning of the text. The priority value ranges from 0 to 191 and it is made up of the Facility value and the Level value. The Facility value is a way of determining which process of the machine created the message. Since the Syslog protocol was originally written on BSD Unix, the Facilities reflect the names of Unix processes and Daemons. Message header also contains date and device hostname or IP address.

Message example:

```
<PRI> Jul 10 12:00:00 192.168.1.1 SyslogGen
MESSAGE TEXT
```

The priority value is calculated using the following formula:

$$\text{Priority} = \text{Facility} * 8 + \text{Level}$$

The list of Facilities available:

1. kernel messages;
2. user-level messages;
3. mail system;
4. system daemons;
5. security/authorization messages;
6. messages generated internally by syslogd;
7. line printer subsystem;
8. network news subsystem;
9. UUCP subsystem;
10. clock daemon;
11. security/authorization messages;
12. FTP daemon;
13. NTP subsystem;
14. log audit
15. log alert;
16. clock daemon;
17. local use 0 (local0);
18. local use 1 (local1);
19. local use 2 (local2);
20. local use 3 (local3);
21. local use 4 (local4);
22. local use 5 (local5);
23. local use 6 (local6);
24. local use 7 (local7).

If you are receiving messages from a Unix system, it is suggested that you use the 'User' Facility as your first choice. Local0 through to Local7 are not used by Unix and they are traditionally used by networking equipment. Cisco routers, for example, use Local6 or Local7.

The list of severity Levels:

1. Emergency: system is unusable;
2. Alert: action must be taken immediately;
3. Critical: critical conditions;
4. Error: error conditions;
5. Warning: warning conditions;
6. Notice: normal but significant condition;
7. Informational: informational messages;
8. Debug: debug-level messages.

Recommended practice is to use the Notice or Informational level for normal messages.

The Syslog server can listen for UDP messages and TCP messages. Normally Syslog messages are sent using UDP. Some networking devices such as the Cisco PIX firewall can send messages using TCP to ensure each packet is received and acknowledged by the Syslog Server.

Also, there are reliable message delivery mechanisms available in the Syslog protocol. They are described in RFC 3195 document.

Along with the simple collecting of messages, modern logging systems allow you to set rules for additional messages processing and have built-in tools for running a user written scripts to extend

functionality and perform some custom actions. Moreover, instant notifications to all the interested staff can be sent by using some available communication channels from e-mail to SMS and messages in social networks. As a reason for notification any message can be used, for example, a server failure or lack of disk space for logging. Sound notification on the workplace is also available.

Possible actions when a message is received:

- Display message on screen;
- Log to file;
- Forward to another host;
- Play a sound;
- Run external program;
- E-mail message;
- Send Syslog message;
- Log to ODBC database;
- Log to NT Event log;
- Send pager or SMS message;
- Send instant message;
- Send SNMP Trap;
- Run Script;
- Stop processing message (it causes server to stop processing the current message any further).

Archiving and backing up log in the system are automatic. Archiving is performed for old records which are not likely to be used. If you need this data, it can still be accessed by extracting from archives. Just as the archiving tasks are scheduled, any other task can be scheduled as well to be executed at specified time, once, periodically, or triggered by some event.

For easy log reading there are special tools allowing you to filter the required data by desired criteria of any complexity, highlight lines or mark them in some other way. Criteria can be things like time when message was received, its type, priority or source. Filtration, along with simple selection of lines containing selected words, can include features such as use of regular expressions, IP address range filter, subnet mask filter, priority and timeout filter, time of day and time interval filter. Also, the log itself can be stored in different files or database tables, depending on messages source and type, and divided into separate parts for different periods of time. For example, new log file can be started each day. Organizing the log in this way significantly decreases the time spent finding the piece of data you need.

Providing Web-interface for logging system, you can allow the access to log from any place and device including mobile devices like smartphones. Having instant log access, instructions for fixing network issues can also be given very fast, no matter where the information about failure has reached you.

Using messages forwarding software, you can reach seamless integration of several logging

systems in one network, for example, deliver Syslog messages to Windows Server based systems. Tools like SyslogAgent allow Windows EventLog events as well as other Windows applications logs to be sent to a syslog server. SyslogAgent is installed as a transparent service on Windows.

Based on the data received you can build graphs and statistics, which can also be used in scripts and notification system. For example, message can be sent if during the last hour the amount of messages has suddenly grown up to the cap of few thousand. Analyzing the graphs you can see how system activity changes over time in different periods or what influence some events have on your system and find its possible weaknesses and capabilities to take further actions in system support or improvement.

If you need to process log data in external application, there is usually no means in logging systems to export data in different formats, so you have to deal with database access mechanisms directly (if you have a log stored in a database) or work with plain text files, that is quite a simple task at most times.

One of the possible development directions for such systems is use of their logs inside the expert system built into the network monitoring solution. Based on log data received from network infrastructure, each message can be identified and classified to create a database of possible network issues, things that cause them and ways of solving these problems. Having such data, you can build processing algorithms for each issue case and provide recommendations for further actions to personnel maintaining your network.

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FEATURES OF PROGRAM IMPLEMENTATION OF CRC32 CHECK SUM COMPUTATION ON THE EXAMPLE OF PKZIP, WINZIP, ETHERNET

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This paper discusses the algorithms for calculating CRC32 checksum. The work is based mainly on the algorithms described in the literature. During the course of work an algorithm for computing the CRC32 checksum compiled and applied practically in PKZIP, WinZIP, ETHERNET. The example showed that the algorithms described in the literature and applied practically, produce different checksums.

Introduction

Methods of error detection are designed to detect damage to communications during transmission through a noisy channel (contributing errors). To do this, the sending device calculates a number called a checksum and is a function of the message, and adds it to this post. Checksum is a value calculated from the data set by applying an algorithm and used to validate data integrity during transfer. The receiver, using the same algorithm that calculates a checksum of the received message and compares it with the passed value.

Usually, the checksum is sent to (read) in the end of the message:

<original unaltered message> <checksum>

CRC - cyclic redundancy code (born Cyclic redundancy code) - an algorithm for computing the checksum, designed to verify the integrity of transmitted data. CRC algorithm detects all single errors, double faults and errors in an odd number of bits. CRC is commonly used in data transmission protocols (Ethernet, Bluetooth, ZigBee) and archivers of data (Pkzip, Winzip).

The paper discusses the direct and inverse table checksum algorithm CRC32. Both algorithms are based on calculating the byte CRC. However, direct table algorithm, described in the literature [1] and the inverse table algorithm used in practice [2] produce different checksums.

The classic algorithm for computing the checksum

The classical algorithm is based on polynomial arithmetic. Its implementation is a bitwise division of the polynomial representing the data (file) on a

generator polynomial, which is calculated depending on the application of the algorithm. In this case, it will be a polynomial 104C11DB7, used by PKZIP, Winzip, Ethernet [3].

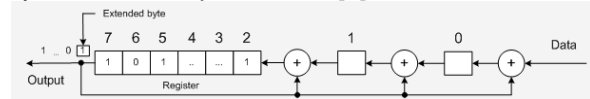


Fig. 1. Schematic representation of the classical algorithm.

Classical algorithm can be implemented using an iterative sequential shift of data in register by one bit [4]. As a result of this operation a checksum will be in the register (Fig. 1).

At the initial stage, the register contains a null value. The first step consists of shifting register data by one bit from the least significant bits to the most significant ones and adding data bits (files) to junior ranks of a register. In the second step is the advanced bit of significant bit register is checked. If the bit is equal to zero, then a transition to the fourth step is carried out. If the bit is set to 1, then a transition to the third step is made. On the third step the advanced bit is added to 1, 2 and 3 register bits, according to module 2 and the result is written into the appropriate register cells. The fourth step is to check whether all the bits have passed through the register. If the condition is false, then a transition to the first step is carried out. If the condition is true, the register contains a checksum. Thus the work of the algorithm is accomplished.

The main drawback of this algorithm is that the operations are performed bitwise, which significantly slows down its performance. Therefore we can apply the accelerated algorithms for computing the checksum, in terms of blocks of bits - bytes. Next to be considered different implementations of table algorithms.

Direct table algorithm

This algorithm is widely found in the literature [1] and based on the fact that in calculating the CRC32 checksum-byte offset can be used, as well as a table, calculated on the basis of forming the polynomial (Fig. 2).

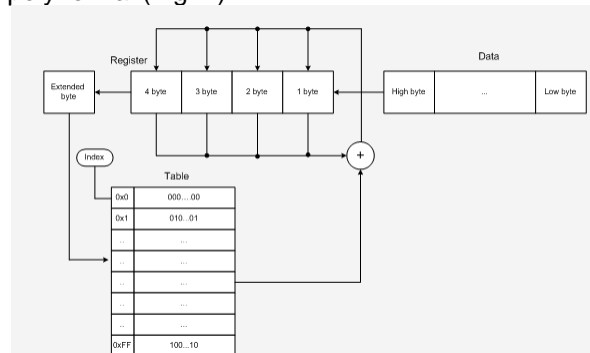


Fig. 2. Schematic representation of direct table algorithm

This algorithm uses 4-byte register, in which the checksum will be recorded. Let's consider the

direct table algorithm (Fig. 4) in details. At the initial stage the register contains a value of FFFFFFFF in hex.

In the first step a shift of register contents to a single byte to the left (from low to high bytes) and the addition of bytes from the file are carried out. Data from the file are read by sequential shift, starting with the highest byte and finishing with the lowest byte.

In the second step, the byte advanced from the register is used as an index inside a table of 32-bit values. In the third step the addition of 32-bit value in the table with the contents of the register is carried out according to module two. The result is written back into register. The fourth step is to verify whether all the bytes have passed through the register. If the condition is false, the transition to step 1 is carried out. In the case of this condition, the register will contain the checksum. Here the work of an algorithm is accomplished.

In practice (in archivers PKZIP, WinZIP and protocol ETHERNET) [2] uses a different table algorithm, characterized by the realization of this that, as will be shown later, leads to the incompatibility of the results of calculating the checksum.

Reverse table algorithm

The main difference between this algorithm and direct one is that the data is read from the lower byte of the file [2] and modified table of 32-bit values is used (Fig. 3). Changes in the table are due to the fact that 32-bit values in the table and their position are mirrored.

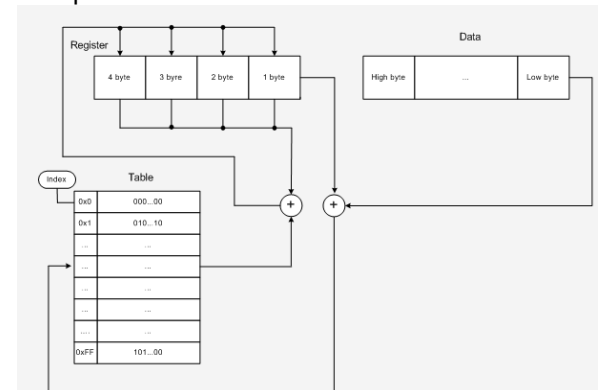


Fig. 3. Schematic representation of the reverse table algorithm

At the initial stage, as in the direct table algorithm, the register contains a value FFFFFFFFh. The first step is a shifting register contents to the right by one byte (byte from high to low). Data from a file is read by the serial shift from low-order byte. The second step consists of adding advanced byte to a new byte of data according to module two.

In the third step the result of addition is used as an index of 32-bit value in the table. The fourth step is addition of the contents of the register to a32-bit value in a table according to module 2.

In the fifth step it is checked whether all the bytes of the file has been read. If the condition is false, then a transition to the first step is carried out. In case this condition is true the register will contain the checksum. Here the work of an algorithm is accomplished.

It is this algorithm that is used in practice when calculating the CRC32 checksum in PKZIP, WinZIP archivers and ETHERNET protocol [3]. A feature of this algorithm is that the data file is read from the lower byte, which is more convenient. However, as mentioned in the description of a direct table algorithm, in this case there are discrepancies in the results of checksum calculation compared with the usual division.

Examples of calculations CRC32

The following are examples of calculations CRC32 checksum for each file, using forward and reverse algorithms table. For a text file containing a set of characters 1234567890, direct table algorithm CRC32 checksum is 6929ACD0, and for reverse table algorithm - 261DAEE5. For the same file (picture.jpg), containing a JPEG image for direct table algorithm CRC32 checksum is 569B681, and for the reverse table algorithm - FF134C9B.

Conclusion

From existing publicly available source codes an algorithm for computing the CRC32 checksum [2] was reconstructed. It is used in practice: for

data transmission protocols (eg, Ethernet, Bluetooth), archivers (for example, Pkzip, Winzip). It was illustrated that during the application of table algorithms (described in the literature [1] and the algorithm used in practice [2]) different CRC32 checksums (with the same generator polynomial) were obtained. This is due to the changed order of reading bytes from a file in the algorithms. The ability to read the file from junior or senior byte requires a different approach to the implementation of the algorithm. To avoid differences in obtained results it is recommended to specify which algorithm is used for calculating the CRC.

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COMPARE ANALYSIS OF ALGORITHMS OF INDECIPHERABLE COMPARISON WHEN BORROWING IN TEXT WAS DETECTED

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The term string analysis is often used in a common meaning and refers to a wide class of problems such as: the localization of the specified selection of the longest matching substrings, calculation of the distance between two lines etc.

A common problem is searching the samples which occur in determined sequence of the symbols more than one time. In this case a specification is needed.

First of all our sequences are one-dimensional and consist of symbols. To comply with the stated requirements they should be limited to ASCII-letters without «space», while strings (chains) consisting of these letters should be regarded as independent symbols. Then mentioned text sequences are composed of such symbols

separated by «spaces». In this case an aggregating of symbols tends to infinity. That is why an alphabet which unites all mentioned ASCII-letters and «space» should be used. Here, a chain of letters on this finalized alphabet is becoming a sequence.

Now a notion of sample should be determined. It is convenient to consider sample as a subsequence consisting of source sequence letters but in the same order. Private case of subsequence is a substring (consists of a number of adjacent source sequence letters).

Further, we should determine how many samples with «k» length in «n» sequence can be in total. First of all let's look at substrings. From a sequence we can extract $(n - k + 1)$ substrings

with «k» length. Common number of substrings can be calculated by making a sum. The following formula is used:

$$\sum_{k=1}^n (n-k+1) = \sum_{k=1}^n k = \frac{(n+1)n}{2} = \frac{(n^2+n)}{2}$$

Thus, evaluation of common substrings quantity is $O(n^2)$ [1].

Using subsequences instead of substrings can show us that upper limit of their quantity is powered (every source sequence letter is in one of two states relatively to a given subsequence which means it is either included or not included in it). So, it is possible to get 2^n subsequences, including empty string ξ .

Further, it is necessary to determine the meaning of repeated subsequences. Repeated examples of sample must be totally different. In this case, only not intersected repeated samples should be considered. For instance: AB subsequence can't be repeated in sequence AAB because its elements aren't intersected because they consist of the same symbol B.

Finally, knowing that the quantity of subsequences in sequence is $O(2^n)$, it is possible to observe that the number of not intersected repeated subsequences in the worst case is exponential. Let's consider the square with 2^n length that is x^2 string, where x consist of n different letters. (For finite alphabets n value is limited by alphabet power). x^2 sequence will contain $2^n - 1$ repeated subsequences without ξ . However, there is only one max repeated subsequence, in particular x. For instance: we have $x^2 = ABCABC$ for $x = ABC$. Not intersected repeated subsequences are A, B, C, AB, AC, BC and ABC, and every of this is subsequence of the max repeated subsequence ABC.

Let's introduce the restriction: it is necessary to find the only max of not intersected repeated subsequence.

So, let's make a more rigorous formulation of the problem. Firstly, it is necessary to introduce a suitable designation:

1. x string with $|x| = m$ length is written as $x_1x_2...x_m$, where « x_i » is the «i» symbol of «x».
2. $x_ix_{i+1}...x_j$ substring of «x» string, where $i \leq j \leq m$, will be denoted as $x(i, j)$. In case of $i > j$, reverted substring is denoted as $xR(i, j)$.
3. Often (x) will denote required sample and (y) mean text string; $|x| = m$, $|y| = m$ and, definitely, $m \leq n$.

The problem is defined. and search algorithms will be considered further.

Simple algorithm of accurate search

Let's denote a considered text as $T = t_1t_2t_3...t_n$, and search pattern as $P = p_1p_2p_3...p_m$, where $n \gg m$. The main problem is searching all the entrees of P in T.

Simple solution consists of subsequent comparison beginning with t_1 and p_1 symbols of T and P until matching or mismatching will be

detected. In the last case we should return to the beginning of comparison (t_1) and move by one letter through the text (now it is t_2) and try again the attempt. For instance: if we search for the pattern «cocos» in text «coco&tc&cocos» we will get:

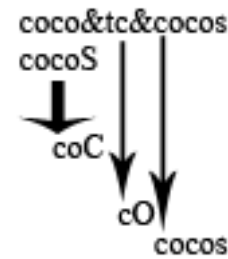


Figure 1 - Searching by pattern

Four characters from the beginning match but fifth doesn't. We cannot continue search beginning with «&», because third and fourth symbols («co») of the text match with a beginning of the pattern and can be used as beginning of accurate matching. In this case it is necessary to check every beginning as example shows. This algorithm requires execution of not less than $n-m+1$ comparisons and works slowly. However, it is very easy to program and it allows us to search using pattern of any length.

Boyer–Moore string search algorithm

There are several modifications of this algorithm. Comparison is not carried out between the first symbol of the pattern and the first symbol of the text but between last character of the pattern and the m symbol of the text (in example it is fifth).

First of all it is necessary to compare «s» and «&»; this letters are mismatched and pattern will be moved. The key point is that the symbol of the text where mismatching is detected will be defined (in that case it is «&») and the place of the pattern where this symbol is will be determined. Depending on that it is necessary to make a decision about size of the shift. In our example the letter «&» isn't contained in the pattern. That means that pattern might be shifted by (m) symbols to the right.

The next comparison will be between the last letter of the pattern and tenth symbol of the text (after shift by five positions). Tenth symbol is «o» and the pattern contains it in second and fourth positions. We should shift the pattern by one position because «i» in the text can be matched with fourth symbol of the pattern.

Let's go to the eleventh character of the text («c»). it is contained in pattern in the first and the third positions; we should shift the pattern by two symbols which is calculated as the size of the pattern with subtraction of number of the last position of the letter in a text contained in pattern.

This leads to the thirteenth symbol «s». But this time we have matching of «s» symbols. We should check comparison of text and pattern again (in this case is executed). If the last symbols are matched but others are mismatched we can use

simple algorithm with shifting by one symbol which has been described before, or we can use any other method in that case.

The main advantage of this method is that the quantity of mismatching is significantly more and, in turn, that leads to big shifts. In considered example when we use Boyer–Moore string search algorithm we need only eight comparisons instead of twenty in simple algorithm of accurate search [2].

Accurate search algorithm of SHIFT-AND

SHIFT-AND search algorithm was developed not so long ago and still isn't widespread. It was published in 1992 by two explorers from University of Arizona and Bell Labs - Udi Manber and Sun Wu. Besides algorithm works fast and is easy to program, it has unique feature: it can be easy to generalize it for the case of approximate search.

Let's assume that it is necessary to find not only entrees of P in T, but entrees of all the possible prefixes of pattern P in T:

$$P(1)=p_1, \quad P(2)=p_1p_2, \\ P(3)=p_1p_2p_3...P(m)=p_1p_2p_3...p_m$$

In our example we will consider every entry of five patterns: «c», «co», «coc», «coco» and «cocos». Let's make the table which reflects for each position of the text, whether this position is the end of every of five patterns. For every position of the text there is five-element vector-array of bits where every k bit equals to one if position matches with the last entry of k prefix. As a result we have a table consisting of m rows and n columns:

| | c | o | c | o | & | s | c | & | c | o | c | o | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| c | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| o | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| c | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| o | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| s | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Table 1 – The table of entrees

The most interesting is the last line because it corresponds to the searched entry of the pattern in text but other rows are also important.

If to consider, for instance, two first columns of the table it is possible to see that the units in

second column can appear when both of the following conditions are observed:

1. The unit can be placed only in position which corresponds to «o» in pattern (because $t_2 = o$).
2. The unit can be placed if the first column has the unit in the same position.

The first condition ensures the coincidence of the last letters, and the second - the coincidence of the previous letters.

To check the implementation of the second condition it is necessary just to shift down the first column. To check the implementation of the first condition fast characteristic vectors of m length are prepared.

Characteristic vector for letter «o» in that case has units only in second and fourth positions (in positions where this symbol is placed) and zeros in others cases - 01010. Characteristic vector for letter «c» - 10100, for letter «s» - 00001, so, for others symbols of the alphabet the characteristic vectors – 00000.

The check of the first condition is carried out by comparison of first column shifted down (first column 10000 becomes after shift *1000) and characteristic vector for «o». Positions, where units are matched, get single values, the other are set to zero. The resulting value becomes the second column of the table.

The only exception relates to the first position, for which second condition is obviously true because previous position does not exist. Therefore, the first position is always filled with unit when shifted. Thus, for the third column (10100) after shifting and adding a unit we get 11010. Now, after comparison (a bitwise AND operation) with the characteristic vector for «o» (01010), we obtain 01010.

The most important, as we noticed, property of this algorithm is that it is possible to generalize any case to approximate search case.

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CONSTRUCTION OF CONFLICT MATRIXES IN A BUS LOCAL NETWORK WHILE DESIGNING REAL-TIME SYSTEMS

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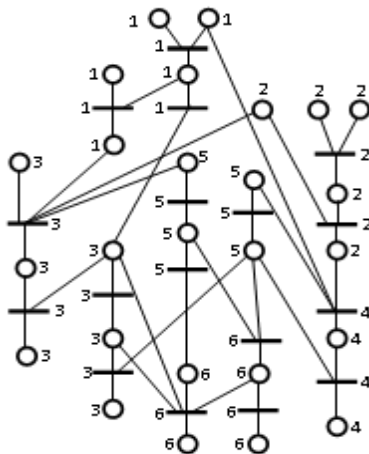
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Today real-time systems (RTS) are very common. Many of them there are several stations that are combining in network. There are two types of RTS. It is «hard» and «soft». But in the both types, one of the main measures is time. Main aim on the all stages of RTS development is reducing the response time of the input impact. Time of control action calculation in RTS must not be higher than priori set values. These restrictions are very hard for high-dynamic control systems. RTS developers should make more efforts to find solutions. These solutions must ensure system availability with restrictions.

Major time delays in the system are occurring when there are two actions. First action is performing the software modules of technological algorithms, which implement function of system. Second action is data transmission between stations in local network. Data transmission via network happens every time, when performing the modules, which use resources more than one stations. For example, module is performed on one station, but necessary dates are stored on other stations. Time-consuming of data transmission between stations can be as time of modules performing. When computer system is developed, very important is determining numbers of stations to perform functions, and very important is construct local network of system to reduce time-consuming of data transmission. [1]

Sources data to solution of this task is information about microprocessor stations, which located on topologic area of control object, and about program capacity, which presented as data-flow graph (DFG). DFG is showed on the picture 1.



Pic. 2. Data-flow graph

Circles in DFG are data, but strips in DFG are operations, which are performed by functions of RTS. Data and operations in DFG are marked by figured. Every figure is number of station, on them will be stored data and performed operations.

Development of a common bus topology local network takes place in several stages. Firstly, an outline of local network is created, depending on the DFG. A number of buses and stations, and connections between them are determined by user. Secondly, matrix of transmitted data is determined, depending on the DFG. Last step is determining conflict matrix and constructing a graph of conflict based on conflict matrix.

Conflict matrix is a matrix, which shows presence of conflict between two elements of network. Rows and columns of this matrix contain paths of data transmission between stations. If paths of data transmission intersect, then in the cell of matrix there is a TRUE indicator, otherwise the indicator is FALSE.

When local network is developed, first two steps are always implemented in the same way. A user is working out a structure of local network himself. After doing it, he fills matrix of transmitted data. Result of network analysis depends on last two steps. These steps are preparation for analysis, and the third step is creation of conflict matrix. It is a part of analysis of a network. There are few types of conflict matrix.

First type of conflict matrix is very common. This algorithm was invented earlier [2]. It is creation of conflict matrix basing on connections of stations. When you create this matrix, you must consider connections of all stations of local network. If two connections are shared by one bus, then simultaneous date transmission to these connections is impossible. In this situation a conflict may occur. In this case, a TRUE indicator must be filled in the cell of matrix (on the cross between conflict connections). Matrix is fully created, when all connections are checked.

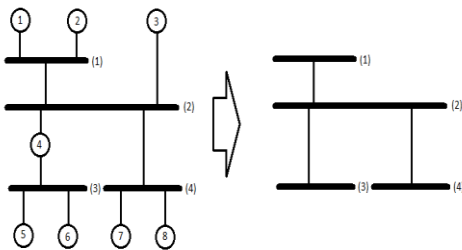
Second type of conflict matrix is less common. Rows and columns of this matrix contain busy bus numbers, but not station connections. Construction of the conflict matrix can be divided into two stages:

1) Conversion structure of local network to structure, where only buses are used, but stations are ignored;

2) Analysis and conversion of structure for obtaining conflict matrix.

Let's look at each step in more detail.

First step of network analysis is conversion of structure of a local network to structure, where only buses are used. This stage is needed to facilitate algorithm of finding all paths of buses, which exist in this network. We check all connections of each bus to implement this step. If bus is connected with other buses, then it proceeds to the next connection. But if a bus is connected with station, then we check connection of this station with other buses. If a checked station has connection with other bus, then a connection between two buses is indicated and station is ignored. But if station doesn't have other connections, then this connection is ignored in a bus. As a result there are transformed matrixes of bus connections, which contain only connections with other buses. Graphic solution of this stage is showed on the picture 2. It is connectivity graph, where all vertices belong to one set. This graph is more easy to use then more difficult graphs, where all vertices belong to few sets.



Pic. 3. Conversion structure of local network to structure, where uses only buses

The last stage is analysis and conversion of bus structure. It is done for creating a conflict matrix of this local network. Conflict matrix will be created depending on bus structure. We can fill conflict matrix by hand. Rows and columns of conflict matrix are bus paths to data transmission. Example of conflict matrix on buses of local network is showed on table 1.

Table 1. Conflict matrix on buses

| k | 1 | 2 | 3 | 4 | 12 | 23 | 24 | 123 | 124 | 234 |
|-----|---|---|---|---|----|----|----|-----|-----|-----|
| 1 | k | | | | | | | | | |
| 2 | | k | | | | | | | | |
| 3 | | | k | | | | | | | |
| 4 | | | | k | | | | | | |
| 12 | | | | | k | | | | | |
| 23 | | | | | | k | | | | |
| 24 | | | | | | | k | | | |
| 123 | | | | | | | | k | | |
| 124 | | | | | | | | | k | |
| 234 | | | | | | | | | | k |

Conflict matrix is containing N-by-N cells, where N is number of tag arrays in a set. All pairs of tag arrays in a set are compared for filling conflict

matrixes. If both arrays don't have intersection (do not exist two elements with the same index and both values are TRUE), then data can be transmitted simultaneously on this paths. In appropriate cell of conflict there is FALSE indicator. But if both arrays have intersection, then data can't be transmitted simultaneously on these paths and there is conflict, because two transmissions will be separate on one or more buses. When we compare all arrays of a set, there is a conflict matrix on the buses for current local network.

Comparing conflict matrixes on buses and stations, there are advantages and disadvantages in both matrixes. In algorithm that creates conflict matrix on buses there is more time to prepare for analysis, but the body of algorithm works faster, then the one in a second algorithm. When local network increases in size, then the size of conflict matrix increases too. If station is added in network, then maximum existed number of cells of conflict matrix on stations is increased in order of arithmetic progression, but if bus is added in network, then maximum existed number of cells of conflict matrix on buses is increased in order of geometric progression. For example, there is a local network with three buses and six stations. Maximum existed number of cells of conflict matrix on buses is seven, but maximum existed number of cells of conflict matrix on stations is fifteen. Propose that a number of stations and buses increase by one. After addition, maximum existed number of cells of conflict matrix on buses is fifteen, but maximum existed number of cells of conflict matrix on stations is twenty one. Size on buses is increased by 7, on stations by 6.

Creation of conflict matrix on buses is more effective for small and middle networks, because for creation and storing all matrixes less recourse are used then in algorithm for stations. It is true, the maximum size of conflict matrix on buses is bigger than size of conflict matrix on stations, because in paths for conflict matrix on buses only neighboring buses are used and many existed paths unused. As a result this method is more effective to simulate local network in RTS, because need less time for performing.

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VGI: A MODERN WAY OF GEORESEARCHES

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For a long time development, support and employment of web map services or web-GIS have been a prerogative of government agencies and big companies. Such services were notable for its locality and narrow subject orientation. Users who had an access to these services and their data had an opportunity only to view them. But after global map service Google Maps had been released in 2005 and API to this service had been published the way of development and use of web map services had considerably changed. Since that every user who had an Internet access had been having an opportunity not only to view web maps but develop and publish their own ones. There was a possibility of global-resource sharing, addition and editing of the data on map as well. These data are called VGI (volunteered geographic information). Thus the conception Web 2.0 which is based on user-generated content was projected on web-GIS.

Volunteered Geographic Information (VGI) is a type of citizen science which is connected with spatial data. Nowadays it is a new growing area of information gathering. The author of the term VGI is geographer Michael F. Goodchild who noted that "a remarkable phenomenon ... has become evident in recent months: the widespread engagement of large numbers of private citizens, often with little in the way of formal qualifications, in the creation of geographic information, a function that for centuries has been reserved to official agencies. They are largely untrained and their actions are almost always voluntary, and the results may or may not be accurate. But, collectively, they represent a dramatic innovation that will certainly have profound impacts on geographic information systems (GIS) and more generally on the discipline of geography and its relationship to the general public. I term this volunteered geographic information (VGI), a special case of the more general Web phenomenon of user-generated content ..." [1].

User-generated content, and its subset, volunteered geographic information, covers a span of geographically-based initiatives and abilities, including such novel applications as Wikipedia, Wikimapia, OpenStreetMap, and the overall concept of web mashups (overlying disparate data and existing maps to produce a new map). As Goodchild states: "These are just a few examples of a phenomenon that has taken the world of geographic information by storm and has the potential to redefine the traditional roles of mapping agencies and companies." [1].

VGI systems (volunteered GIS) are always put in contrast to systems which are developed by government agencies and big companies. The main difference is in the principles of data application. In VGI systems data can be added by any user who uses this system. Herewith it is not necessary for users to be a specialist in geoinformatics or mapping. On the one hand this opportunity allows to support data actuality at top-level, that is to quickly react on changes and amend a map immediately. On the other hand these data can be incorrect as only users bear responsibility for its credibility. In government and private systems data are added by experienced users who are acquainted with geographic information technologies and peculiarity of map information. In such systems data are reliable and correct. But the problem is in alteration which can be enough prolonged as opposed to volunteered GIS.

Thus the accuracy of the information provided and how useful it will be in the future are one of the most important problems. As Goodchild points out, heavily-relied-upon mapping sites such as Google Earth have a well-known error component – they are not 100% accurate. Professional GIS scientists recognize this, the public may not, and use of available technology such as this comes with built-in error issues [2]. Nevertheless VGI technology is moving forward and its popularity continues to grow from day to day.

Because data accuracy is an overriding factor in the usability of VGI, a strong data vetting mechanism is needed. Some current VGI projects have strongly stressed this need for accuracy, and, indeed, eBird, which is one of the largest VGI projects currently underway, states that: " A database is only as good as its weakest record. If even a few records can be deemed questionable, then the entire data set can be labeled as such. With that in mind, we should all strive to keep the eBird data as clean as possible. You can do your part by being conservative in the field and meticulous in your data entry, and we can do ours by building better connections between the eBird community and scientists" [3].

Overall, the use and validity of VGI is dependent on the use that will be made of the data. This is where the geographic extent of the data comes into play. For regional and national studies, precise spatial accuracy is probably not an issue. However, for local studies, and for studies looking at development of predictive models, both spatial and attribute accuracy need to be high.

Valid VGI projects need to assess how their data will be used and what the acceptable accuracy levels will be [2].

Because volunteer initiatives are based on developing a cohort of keen individuals with enough experience and skill in their area of interest to make significant contributions, it is important to ensure that the VGI system they participate in meets certain requirements. Volunteers must remain engaged, and the product of their work should be readily seen. Some key factors in retaining volunteer contributions include the following:

- One of the most important aspects to volunteer data collection centers around contributions: contributions to the system should be easy. Complex systems that require too many steps will turn volunteers off and reduce the numbers of contributions.
- Contributors want to be able to view the results of their contributions, especially maps. While interactive GIS maps are the best way to map data, they are not necessarily the most user friendly. It is important to develop maps that are readily viewable and do not require familiarity with GIS mapping icons, for example. The means by which the public interacts with the maps should be as intuitive as possible without the need for extensive tutorials to view the data.
- Web sites and public interfaces should be current. If the information provided on a project web site is not current, then users and participants will drift.

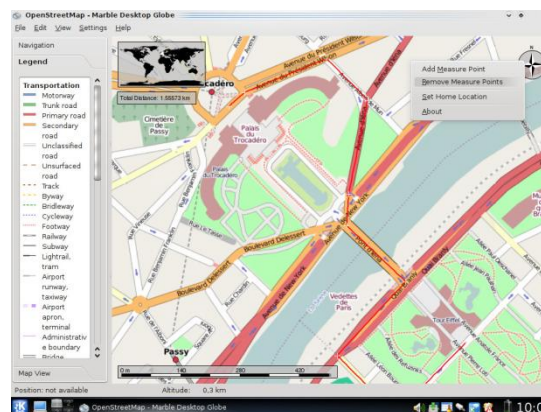
In the mid 1990s the U.S. Federal Geographic Data Committee published its Content Standards for Digital Geospatial Metadata, a format for the description of geographic data sets. The project was very timely, given the rapid increase in the availability of geographic information via the Internet that occurred at that time. Metadata were seen as the key to effective processes of search, evaluation, and use of geographic information. [1] Nevertheless, and despite numerous efforts and inducements, it remains very difficult to persuade those responsible for creating geographic data sets to provide adequate documentation.

Given this evident reluctance to provide documentation, it is perhaps surprising that the opportunity to create and publish VGI has engaged the interests of so many individuals.

Self-promotion is clearly an important motivator of Internet activity, and in its extreme form can lead to the exhibitionism of personal web-cams. Despite the vast resources of the Web, it is still possible to believe that someone will be interested in one's personal site. The popularity of some blogs can be misread as suggesting that an audience exists for any blog.

At a different level many users volunteer information to Web 2.0 sites as a convenient way of making it available to friends and relations, irrespective of the fact that it becomes available to

all. This may underlie the popularity of sites such as Picasa, which allow contributors of personal photographs to point others to them, but it scarcely explains the popularity of Flickr or Wikimapia, where content is comparatively anonymous. Contributors to OpenStreetMap may derive a certain personal satisfaction from seeing their own contributions appear in the patchwork, and from watching the patchwork grow in coverage and detail, but there can be no question of self-promotion in this essentially anonymous project [1].



Pic. 1. Open Street Map interface

VGI has the potential to be a significant source of geographers' understanding of the surface of the Earth. By motivating individuals to act voluntarily, it is far cheaper than any alternative, and its products are almost invariably available to all.

It is already clear in many fields that such informal sources as blogs and VGI can act as very useful sources of military and commercial intelligence. The tools already exist to scan Web text searching for references to geographic places, and to geocode the results. Thus the most important value of VGI may lie in what it can tell about local activities in various geographic locations that go unnoticed by the world's media, and about life at a local level. It is in that area that VGI may offer the most interesting, lasting, and compelling value to geographers.

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THE COMBINED ESTIMATION METHOD OF THE AVERAGE ENVIRONMENT VELOCITY AND RECEPTION CENTER COORDINATES

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Introduction

Mathematic modeling is widely used in solving various problems in geophysics and geology. Considering costliness and often also impossibility of conducting experiments in the real environment, many of the issues of fieldwork methods and interpreting the results of treatment processing and obtaining the final results of geological results are solved with the help of mathematical modeling. Purpose of this research is mathematical model creation that will allow evaluating spatial position of nonvertical wells.

Directional drilling gradually becomes the main type of drilling both on land and in sea at sinking of wells from fixed sea platforms. At the same time there is a tendency to requirements increase for the accuracy of hitting bottom wells at a given point and for compliance with the design of the borehole. That is why there is a need to ensure effective control of the spatial position of a wellbore [1].

Problem statement

Currently inclinometers are used for this purpose. An inclinometer or a clinometer is an instrument for measuring angles of a slope (or tilt), elevation or depression of an object with respect to gravity. In particular it is used for measuring the angle of drilling in well logging. Usually inclinometers don't operate on tilt angle that is less than 3° and hold significant errors in estimate of zenith angle. This leads to uncertainty about the true location of the wellbore and large imprecision in the well data analysis.

Vertical seismic profiling method (VSP) can provide the initial data for the wellbore position estimation. VSP is a method of borehole and near borehole seismic surveys in seismic frequency range. The method is based on experimental study of the propagation of seismic waves in interior points of the real medium [2].

The scheme of observations in VSP (figure 1) is determined by the position of excitation points (EP) and arrangement of reception center (RC). For the standard VSP technology reception unit is located in the well and displaced vertically occupying different positions in depth. Excitation of seismic signal takes place on the Earth's surface [3]. The time during which the signal reaches the given point is recorded in the reception center. Transit time and EP coordinates allow us to construct a system of equations. From this system we can find an average speed of the signal and the RC coordinates.

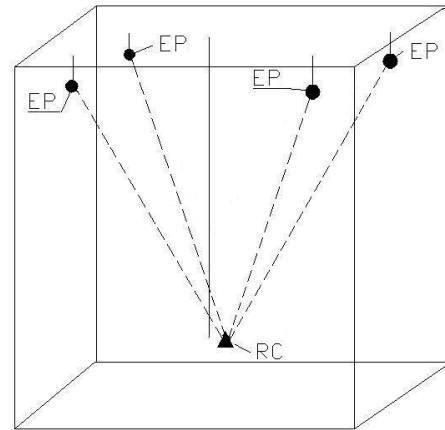


Figure 1. The scheme of observations in VSP

Real environments in petroleum geology and geophysics are usually described by layered models. It is assumed that velocity and density change monotonically inside layers. On the borders these parameters have discontinuity. That is why it is advisable to use an average speed which specifies the medium averaged characteristics from the surface observations to the predetermined depth. Using of average speed is acceptable because usually all EP are located in one layer, so waves from every EP pass the same number of layers.

Algorithm description

Suppose we know the location of EP. It is required to find the RC coordinates and average speed if we know the arrival time of the waves from each EP to the RC due to the different VSP observations.

If we assume that average speed u of the wave propagation in this medium from every EP is the same then the connection between RC coordinates (x_r, y_r, z_r) , EP coordinates (x_i, y_i, z_i) and arrival time t_i can be determined by a system of nonlinear equations (1). Each equation describes sphere with radius $t_i u$ and focus (x_i, y_i, z_i) . The solution of the system is the point located at the intersection of four spheres.

$$\begin{cases} (x_1 - x_r)^2 + (y_1 - y_r)^2 + (z_1 - z_r)^2 = t_1^2 u^2, \\ (x_2 - x_r)^2 + (y_2 - y_r)^2 + (z_2 - z_r)^2 = t_2^2 u^2, \\ (x_3 - x_r)^2 + (y_3 - y_r)^2 + (z_3 - z_r)^2 = t_3^2 u^2, \\ (x_4 - x_r)^2 + (y_4 - y_r)^2 + (z_4 - z_r)^2 = t_4^2 u^2. \end{cases} \quad (1)$$

The system consists of four equations with four unknown parameters. To solve the system we transform the equation 1+3 to linear equations for the unknown by subtracting equation 4 from it.

$$\begin{cases} -2(x_1 - x_4)x_r - 2(y_1 - y_4)y_r - 2(z_1 - z_4)z_r = \\ (t_1^2 - t_4^2)v^2 - (x_1^2 - x_4^2 + y_1^2 - y_4^2 + z_1^2 - z_4^2), \\ -2(x_2 - x_4)x_r - 2(y_2 - y_4)y_r - 2(z_2 - z_4)z_r = \\ (t_2^2 - t_4^2)v^2 - (x_2^2 - x_4^2 + y_2^2 - y_4^2 + z_2^2 - z_4^2), \\ -2(x_3 - x_4)x_r - 2(y_3 - y_4)y_r - 2(z_3 - z_4)z_r = \\ (t_3^2 - t_4^2)v^2 - (x_3^2 - x_4^2 + y_3^2 - y_4^2 + z_3^2 - z_4^2), \\ (x_4 - x_r)^2 + (y_4 - y_r)^2 + (z_4 - z_r)^2 = t_4^2 v^2. \end{cases} \quad (2)$$

We simplified the system introducing new variables:

$$K_i = -(x_i^2 - x_4^2 + y_i^2 - y_4^2 + z_i^2 - z_4^2), \quad t_i = t_i^2 - t_4^2, \\ x_i = -2(x_i - x_4), \quad y_i = -2(y_i - y_4), \quad z_i = -2(z_i - z_4), \\ i = \overline{1,3}.$$

To solve the system (2) Gaussian elimination was used. The value of the RC coordinate after second reduces:

$$x_r = L_x + v^2 P_x, \quad y_r = L_y + v^2 P_y, \quad z_r = L_z + v^2 P_z, \quad (3)$$

where

$$L_z = \frac{K_3 x_1 - K_1 x_3 - \frac{K_2 x_1 - K_1 x_2}{y_2 x_1 - y_1 x_2} \cdot (y_3 x_1 - y_1 x_3)}{z_3 x_1 - z_1 x_3 - \frac{z_2 x_1 - z_1 x_2}{y_2 x_1 - y_1 x_2} \cdot (y_3 x_1 - y_1 x_3)}, \\ P_z = \frac{t_3 x_1 - t_1 x_3 - \frac{t_2 x_1 - t_1 x_2}{y_2 x_1 - y_1 x_2} \cdot (y_3 x_1 - y_1 x_3)}{z_3 x_1 - z_1 x_3 - \frac{z_2 x_1 - z_1 x_2}{y_2 x_1 - y_1 x_2} \cdot (y_3 x_1 - y_1 x_3)}, \\ L_y = \frac{K_2 \cdot x_1 - K_1 \cdot x_2}{y_2 \cdot x_1 - y_1 \cdot x_2} - \frac{z_2 \cdot x_1 - z_1 \cdot x_2}{y_2 \cdot x_1 - y_1 \cdot x_2} \cdot L_z, \\ P_y = \frac{t_2 x_1 - t_1 x_2}{y_2 x_1 - y_1 x_2} - \frac{z_2 x_1 - z_1 x_2}{y_2 x_1 - y_1 x_2} \cdot P_z, \\ L_x = \frac{1}{x_1} (K_1 - h_1 L_y - z_1 L_z), \\ P_x = \frac{1}{x_1} (t_1 - h_1 P_y - z_1 P_z).$$

Then we substitute the obtained values in the last equation and make the change of variables:

$$(K_x - v^2 P_x)^2 + (K_y - v^2 P_y)^2 + (K_z - v^2 P_z)^2 = t_4^2 v^2,$$

where

$$K_x = x_4 - L_x, \quad K_y = y_4 - L_y, \quad K_z = z_4 - L_z.$$

In this way we make biquadratic equation. Its solution is the following

$$v = \sqrt{\frac{\frac{b}{2} \pm \sqrt{\frac{b^2}{4} - a \cdot c}}{a}},$$

where

$$a = P_x^2 + P_y^2 + P_z^2, \quad b = -2(K_x P_x + K_y P_y + K_z P_z + \frac{t_4^2}{2}), \\ c = K_x^2 + K_y^2 + K_z^2.$$

We can discard two of the four solutions of biquadratic equation because the speed cannot be negative. Out of two remaining velocities that one should be chosen that gives the closest to the real data result after substituting in the equation (3).

Algorithm testing

The resulting technique has been investigated on simulated data. EP coordinates are presented in the table 1. EP coordinates and velocity were changed according to to the following law:

$$z_n = 10n, \quad x_n = -\frac{z_n}{10}, \quad y_n = \frac{z_n}{10}, \quad v_n = 1600 + (\frac{n}{6})^2, \\ n = \overline{0,200}.$$

Table 1. Input data

| Wellbores | 1 | 2 | 3 | 4 |
|-----------------|-------|-------|-------|-------|
| Coordinate x, m | -1000 | 0 | 0 | 1000 |
| Coordinate y, m | 0 | -1000 | 1000 | 0 |
| Coordinate z, m | 0 | -4 | 0 | 0 |
| Time t, s | 1.445 | 1.429 | 1.445 | 1.431 |
| Velocity u, m/s | 2200 | | | |

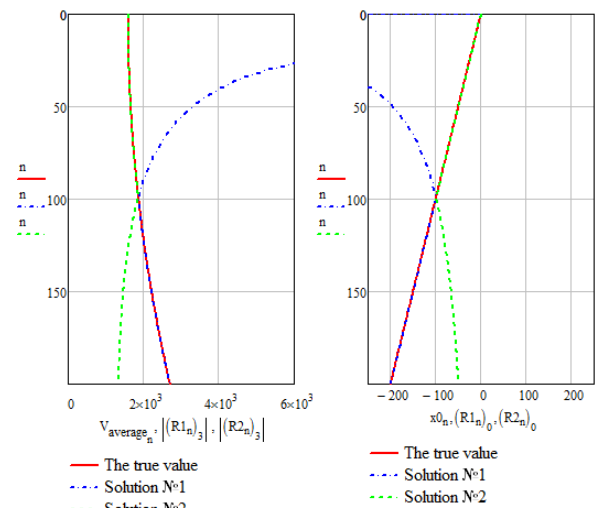


Figure 2. The true and estimated by the algorithm values of velocity and coordinate x

Results of the algorithm are presented in the figure 2. The graphs show that technique allows us to obtain an exact solution but the duality of the speed rate leads to uncertainty about the correct solution in each reception point.

Conclusion

Thus a combined estimation method of the average environment velocity and coordinates of a RC (3-4) was developed that does not lead to algorithmic imprecision. The method requires further research to identify correctly one of the possible solutions.

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AUTOMATION OF GAS COMPRESSOR STATION

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Technological processes in gas and oil industry are almost impossible to do without computers.

Each year automation of processes is becoming more popular element on the market of goods and services. The main task of automation is an increase of efficiency of the manufacturing.

It is important to build good system of control to reach good results of efficiency and productivity of the system.

The object of automation in this article is a gas compressor station.

In the process of mining natural gas reservoir the reservoir pressure gradually decreases. When the pressure is less than 60 atmospheres, it is advisable to compress natural gas to 70-76 atmospheres. This problem is solved by gas compressor stations.

Compressor station is a complex set of technological objects. In a compressor station the main element is the gas compressor unit (GCU), which compresses gas. GCU consists of centrifugal compressor, engine and auxiliary processing equipment.[1]

GCU work

After a start, the starter motor spins the rotor of high pressure. Atmosphere air, which is purified in a complex air-cleaning device, enters the compressor of the motor where it is compressed. After that it enters the combustion chamber, where it is divided into primary and secondary streams. Primary stream of compressed air is mixed in the flame tube with a fuel gas. The resulting mixture is burned at constant pressure. So it is important to measure and control pressure here. A low-pressure turbine (LPT), which actually acts as a rotor, spins because of the action of gases from the high-pressure turbine (HPT). A mixture of combustion products, after going through LPT, enters the power turbine (PT), which spins the rotor of supercharger through the output shaft (Fig. B.).

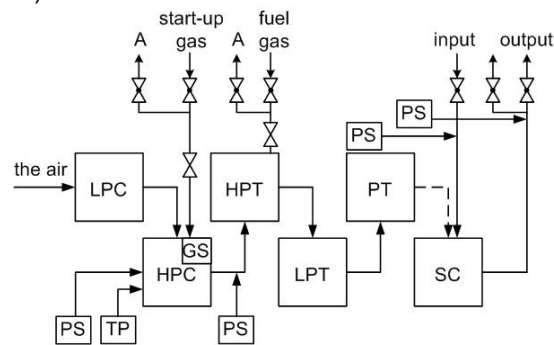


Fig. A. The scheme of GCU working

LPC - low-pressure chamber

HPC - high-pressure chamber

HPT - high-pressure turbine

LPT - low-pressure turbine

PT - power turbine

SC – supercharger

PS – pressure sensor

TP – temperature pointer

System of automation

There are few main functions of a system of automation control. They are: command, control and regulation and some information functions.

Command functions

Command functions include:

- GCU working mode control;
- automatic verification of the launch readiness;
- automatic protection of GCU according to processing parameters;
- automatic control of actuators and valves of GCU gas manifold using specified algorithms;
- remote control of actuators and auxiliary equipment;
- extra emergency stop because of control system failure or because of the operator's command.

Control functions

Control functions include:

- Monitoring of equipment state and deviations from technological parameters;
- Automatic continuous monitoring of serviceability of the control circuit for actuators and auxiliary equipment;
- Automatic functional testing of hardware and software tools in a system of control with the alarm of failure.
- Checking the functioning of the protection systems.

Information functions

A system of automatic control provides a wide range of functions for presentation of different information about the object. [1]

Building a system

Microcontrollers are used at all stages of preparation and processing of oil. Siemens has released microcontrollers which can be programmed with Simatic Step 7 software. With the help of the editor the programming is becoming easier. There is a possibility of using three languages in this editor: FBD, LAD, STD.[2] FBD can be used to program the microprocessor for GCU because its visibility. It is a language of functional block diagram. FBD is a sequence of

logical blocks, triggers and timers. They run sequentially.

These programs can perform different functions. Among them P-, PI-, PID-controllers and more complex algorithms to control actuators.

Programs can be checked on the stand. One of these stands is the FESTO stand. PLC S7-313C is installed on this stand. The main advantage of using this stand is the opportunity to observe the process with lags which are inherent to real process. Alternative method is to model work on Step7 simulator, but it is not possible to achieve good visibility and proximity to real object.

To provide human-machine interface and visual presentation of GCU processes it is possible to use WinCC - the HMI system, which works with Microsoft Windows operating system. Connection between the GCU automation system and WinCC is established to provide control of technological processes.

WinCC allows operator to monitor the process. The process is displayed graphically. The image is updated with each change of state of the process.

WinCC provides process control by the operator. E.g. operator can set values of some parameters or he can open the valve with the graphical user interface.

The system automatically notifies the alarm about the critical state of the process. E.g. if a predetermined limit value is exceeded, then a message appears about it.

In WinCC process values can be printed or saved in electronic form. This simplifies the process of documenting the process and allows to analyze the technological data later.

The most important subsystems of WinCC are:

- graphic system;
- alarm detection system;
- archiving system. [3]

For the automation system of pumping unit there is an interface in WinCC, which includes monitoring and management.

The automation system is shown in Fig. B.

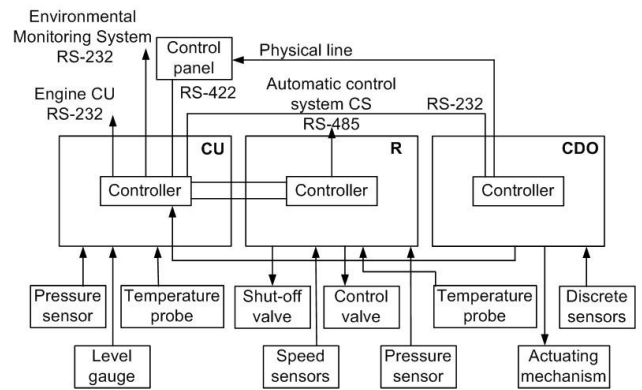


Fig. B. The system of automation

At the field level, there are sensors and actuators, which pass data through the converters to the second level. At the second level there are the control unit (CU), regulator (R) and communication with the object (CDO) units.

After second level data comes in supervisory control and data acquisition (SCADA) system. In our case it is WinCC. In this system we can monitor all processes in real time.

As we can see the system of controlling GCU is complex hierarchy structure. It requires not only knowledge of a process, but also knowledge of building three-level system.

A large number of organizations involved in the design automation. This is a relevant and well-paid field of activity. So this sphere requires good specialists in automation.

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ENVIRONMENT'S STRATAL MODEL FORMATION USING THE LAND AND BOREHOLE SEISMICS

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Introduction

Seismic exploration is one of the leading Earth crust geophysical investigation methods. Seismic methods dominant position in exploration geophysics is caused by its large propagation distance combined with highly detailed exploration. One of these methods is vertical seismic profiling (VSP) method, based on an experimental analysis of seismic waves' propagation in real environment interior. VSP includes any kind of seismic measurements, where one of the elements (excitation source or elastic vibrations receiver) is placed and moved inside the borehole, and another one lies on the day or in a shallow borehole cavity [1].

Problem statement

One of the most important phases of working with seismic exploration data is their interpretation. VSP data interpretation includes such stages as environment's velocity model formation, stratigraphic binding of the reflected waves and near-well space exploration. This paper concentrates on environment's stratal model formation by using the VSP, GIS and CDP data. The task of forming such models is indecorous, that is it has multiple decisions and is usually solved using solely GIS or VSP data. Moreover, the dynamic characteristics have never been previously taken into account in the transition to the stratal model, or in the stratigraphic binding of the reflected waves.

Geological cross-section can be divided considering the elastic wave propagation speed value into relatively homogeneous geological material layers, at the borders of which the velocity changes stepwise. Stratal velocity is the mean wave propagation speed in the given layer in the direction perpendicular to the course [2]. It is based on seismic logging data and also using the results of VSP. Usually, boundaries of the regions with different physical properties match the geological boundaries, which is used in seismic data interpretation.

The distance between the devices in the borehole cavity while using VSP exploration method can vary depending on the required accuracy and minuteness of the work. Each depth, on which one of the receivers is located, is associated with seismic wave time of arrival while recording data.

The input data to the formation of the stratal model are cable depths h_i and the corresponding

normal wave arrival time t_i $i = 1, \dots, N$, where N is the amount of the receiving points, that are used to plot the travel-time curve – seismic wave advent time graph, that defines vertical wave travel time from the surface to the given depth [3]. This model allows estimating the existing formations boundaries.

Algorithm description

We will use piecewise-linear approximation of the travel-time curve to form the strata model, i.e. select sections, on which the wave speed can be considered constant. The approximation will be carried out using the following algorithm:

1. Set $i = 1$, $j = N$,

2. Find the value of the general line equation coefficients A , B and C , $Ax + By + C = 0$, that passes through two points $(t_i; h_i)$ and $(t_j; h_j)$:

$$A = t_i - t_j, \quad B = h_i - h_j, \quad C = h_i \cdot t_j - h_j \cdot t_i.$$

3. Find the distance from each of the $i + 1, \dots, j - 1$ travel-time curve points to this line on

the time axis:
$$\rho_l = \left| \frac{-(A \cdot h_l + C)}{B} - t_l \right|.$$

4. If the largest of those distances does not exceed the specified bound ϵ , discard the points $i + 1, \dots, j - 1$. Otherwise, repeat steps 2-4 for $i = 1$, $j = s$ and for $i = s$, $j = N$, where s is the index of the point, the distance from which to the current line is the greatest.

As a result of the given algorithm work, the points that were not discarded – $(\bar{t}_i; \bar{h}_i)$, $i = 1, \dots, M$, where M is the amount of those points, will define the formation boundaries. Layer velocities can now be calculated using the following formula:

$$V_i = \frac{\bar{h}_i - \bar{h}_{i-1}}{\bar{t}_i - \bar{t}_{i-1}}, \quad \text{where } i \text{ is the index of the layer.}$$

Formation boundaries reflection factors are calculated by using the formula:

$$k_j = \frac{V_{j+1}\rho_{j+1} - V_j\rho_j}{V_{j+1}\rho_{j+1} + V_j\rho_j}, \quad j \text{ is the index of the}$$

formation boundary.

The result of solving the direct travel time problem is usually the synthetic time section in the form of pulse seismogram, which are then subjected to the convolution with the impulse that simulates seismic signal.

Getting the reflection factor trace in the depth scale $k(h)$ from the set k_j is not difficult. However, we will need not $k(h)$ for the convolution operation, but a reflection factor trace in a time scale. If we use the velocity function for the discrete transformation $k(h) \rightarrow k(t)$, those substantial reflection factor values, that will not get between discretization nodes, will be lost.

That's why a new rule should be added to the $k(h) \rightarrow k(t)$ transformation: when the reflecting boundary gets between the check points, the substantial reflection factor value is recorded in the nearest check point. Another way is defining the reflection factor trace element value as the arithmetic mean of the reflection factors in certain vicinity. If there are no reflection factors in the vicinity, the corresponding reflection factor trace element value is set to zero.

In order to form a synthetic seismogram, we should perform a convolution of reflection factor trace with some kind of impulse:

$$w(k) = \sum_j u(j)v(k-j),$$

where $u(j) = k(t_j)$ is the reflection factor trace and $v(t)$ is the impulse.

As an impulse we can use autocorrelation function of the CDP (common depth point) data, analytical impulse (Pusirev's, Berlage's, etc.), impulse form, obtained from the VSP data. The Berlage's impulse has the following form:

$$F(t) = a \cdot t^n e^{-\alpha t} \sin(2\pi \cdot f_0 \cdot t),$$

where a is the signal amplitude in arbitrary units, α is the damping constant and f_0 is the signal frequency.

By the correlation coefficient of the real and synthetic seismograms the accuracy of the formed strata model can be estimated. By changing the specified bound ε , a higher correlation value can be obtained, and, respectively, a more accurate strata model.

Algorithm testing

The developed algorithm was analyzed on the VSP and CDP data of the Kontorovichskoe deposit occurrence. To get the synthetic seismogram a convolution of the reflection factor trace with the Berlage's impulse was performed.

A convolution of the reflection factor trace with the real seismogram autocorrelation function or with the impulse form, obtained from the VSP data, has also been carried out. In the second case, the convolution is performed depth-wise, that is for different depths the corresponding VSP impulse forms are used.

Conclusion

The algorithm was used in the Severo-Ostaniinskaya area data interpretation. The best correlation was obtained by forming the synthetic seismogram by convolution of the reflection factor trace with the real seismogram autocorrelation

function on the borehole #15 of the Severo-Ostaniinskaya area (the correlation coefficient is 68.57%).

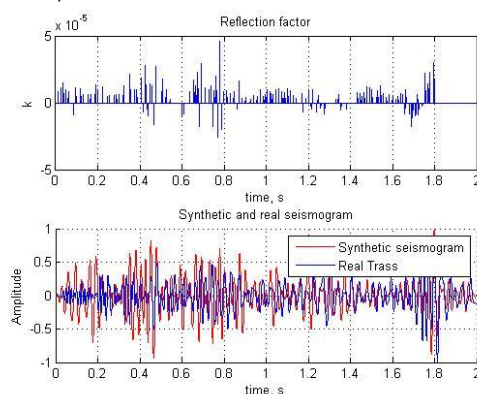


Fig. 4. Reflection factor and real and synthetic seismogram graph of the Kontorovichskoe deposit occurrence

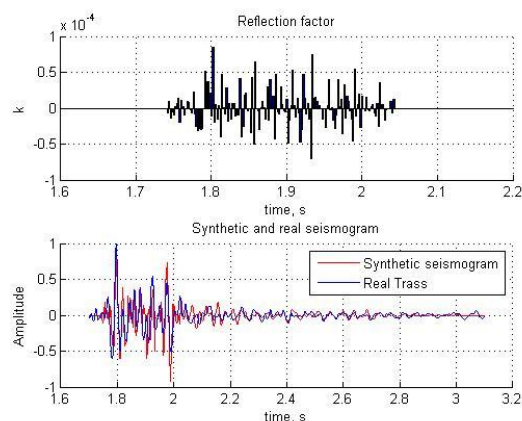


Fig. 5. Reflection factor and real and synthetic seismogram graph of the Severo-Ostaniinskaya area

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ADAPTATION PROCESS OF THE PLM-SYSTEM SMARTEAM TO THE REQUIREMENTS OF A COMPANY*

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Introduction

Nowadays all companies seek to increase their production efficiency of to remain competitive in the rapidly expanding goods and services market. Traditionally, two methods of effectiveness increase are used. The first is equipment procurement and the second is the company's staff training. However the greatest efficiency is achieved by implementation of information systems providing integration, storage and dissemination of information used in manufacturing processes. It is the method that allows combining of all information flows, people and data at an enterprise into a single unit. Currently, Product Lifecycle Management systems (PLM-systems) have become increasingly popular among the Russian companies.

Modern information systems and technologies, particularly PLM-systems, are considered as a strategy to improve efficiency, productivity and profitability of business processes [1]. The main advantages of the PLM-systems are the following:

1. Information support of product at all stages of life cycle, beginning with marketing research and ending with utilization;
2. Organization of a unified information space uniting automated systems intended for effective problem solving in engineering and planning and control of manufacturing and resources of a company;
3. Implementation of a paperless information exchange between all participants of the product life cycle. At the same time the information that was once created is stored in an integrated information environment, is not duplicated, does not require any conversions in the process of exchange and keeps actuality and integrity [2].

Purpose of the research

Like any complex system the enterprise is a multifaceted structure that includes huge number of factors. Creating a PLM solution it is impossible for a developer to take into account conditions and specifics of each company. Therefore it becomes necessary to adapt the selected software suite to the existing requirements. To do this a number of conditions should be observed. One of the most important conditions is the ability for information system to provide an engineer with tools for flexible customization or modification of its configuration.

The employees and students of the Automation and Computer Systems department of the Institute of Cybernetics of Tomsk Polytechnic University are

engaged on a contractual basis in the implementation and adaptation of PLM-system SmarTeam in the instrument making department of the JSC "Academician M.F. Reshetnev "Information Satellite Systems". One of the most important parts of the system implementation is to design user interfaces for the staff of the department. However in the design process it has become clear that the standard SmarTeam tools do not allow meeting customer requirements.

In connection with foregoing, authors of the article were tasked to adapt interfaces of the PLM-system to the design and testing area of on-board radio-electronic equipment.

Mechanism of programming in SmarTeam

To form user cards which are the main means for interaction of employees with PLM-system SmarTeam special tool called FormDesigner is used. This tool allows designing forms related to a data model. Frequently, operations available on default in SmarTeam do not satisfy needs of the staff working with the newly created card. To change or add operations, there is a tool for writing scripts called Script Maintenance. This function package allows to create interfaces necessary for users.

The important part in the designing is writing scripts. It uses the built-in language SmartBasic, procedural API interface that provides a set of predefined classes, functions, structures and constants. Programming takes place in the built-in editing environment SmartScript Editor. The mechanism for handling scripts is illustrated in Figure 1.

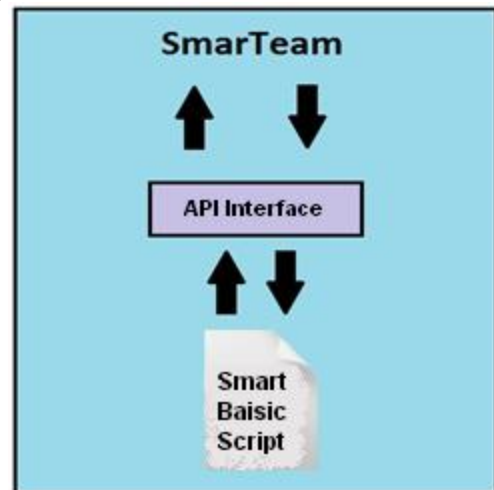


Fig. 3. The mechanism for handling scripts

This technology copes excellently with standard tasks which are observed in practice of the companies' majority. This method of programming is simple and clear enough for every developer.

However, it is necessary to point out some shortcomings:

1. The development environment is little functional and inconvenient for programming of complex algorithms;

2. One of the authors' tasks was to create a dynamic element in the form. But the above mentioned technology does not allow implementing such a task. The reason for this fact is that the required functions are implemented by developers in the form of stubs (empty functions);

3. Access methods for properties of the form elements have not been implemented either. Therefore it is not possible to change the user cards appearance in a program code of the written script.

The method of the problem solving

These deficiencies have been resolved with the help of third party development tools and Windows system libraries.

To date, a popular development environment is Microsoft Visual Studio, which has several advantages. These include the possibility of better debugging, system IntelliTrace, allowing to write a code quickly and without any syntax errors, as well as the possibility of acceding to the process of debugging the code running in the SmarTeam. The programming language C# was chosen, that is an object-oriented programming language, widely used among developers.

Windows system libraries (WinAPI) are used for applications to interact with the Windows operating system. WinAPI functionality provides the ability to change the windows in any Windows's application. Speaking about the windows all forms of the elements from button to application window are meant. The authors have used these opportunities to solve the listed problems in the standard programming techniques in SmarTeam.

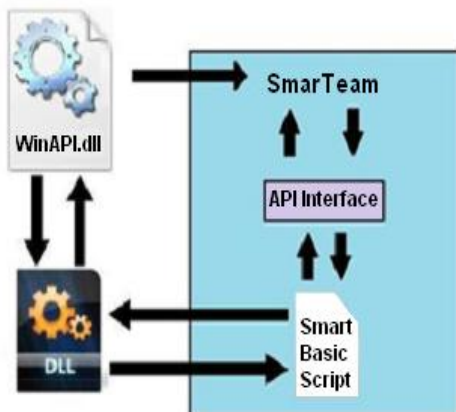


Fig. 2. The mechanism of SmarTeam's API Interface bypass

In Figure 2 a mechanism of bypassing SmarTeam's API interface and interaction with the PLM-system directly, by WinAPI's facilities is shown. Mechanism of the proposed solution is described further.

Microsoft Visual Studio allows you to create dll libraries. DLL - dynamic link library, which is used repeatedly by different applications. The script written in SmartBasic creates copy of the DLL written in advance in the language C# in computer memory. Then the script transfers control to the program code of the library. In turn, WinAPI functions are imported in this code and control is passed to them. WinAPI functionality provides the ability to interact directly with the interface of PLM-system. This approach allows you to create, delete or change the properties of SmarTeam windows, and all of this happens dynamically during the execution of the script. Thus, we can summarize that the gaps in the standard mechanism of SmarTeam's programming were filled. However, it should be said that the problem has not been completely solved. It is known that any system that works with patches, will never work as reliably as originally conceived and organized system.

Conclusion

More and more companies are switching over to the Product Lifecycle Management technologies. Naturally, the development of PLM-system for each type of enterprise is not possible. Therefore, some standards are being developed which should be adapted to the specific company. As practice has shown the customer requirements sometimes do not correspond to the potential of implemented software, so the alternative ways of the problems solution must be found. The solution found by the authors is very convenient for user interfaces creating because it provides the access to window forms of implemented PLM-system and allows you to change windows properties dynamically. The authors note that this solution can be applied for all programs running under the Windows operating system as well as for the program product described in the article.

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THE MODEL OF EMERGENCY PROTECTION SYSTEM OF THE TOKAMAK KTM

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Safety plays an important role in any power systems is. Tokamak KTM installation is a source of high-risk components. The component parts of the installation are unique in its technical performance and have a very high cost. There is a need to design and develop an effective emergency protection and alarm system which allows even at the early stages of the emergency state performs the required set of protective measures.

Different emergency situations can appear at any modes of the tokamak KTM operation, at which it's necessary to protect people and equipment. It's especially typical for electromagnetic system (EMS) of tokamak, power supplies and HF heating systems

The most typical emergency situation for tokamak is the cooling system failure, insulation failure between the structural elements KTM, including the windings of EMC, pulsed electromagnetic loads on the design of KTM, especially when plasma is disrupted. The possibility of these and other events may lead to the complex operation irregularity, but damage repair will take much time and will result in huge financial costs.

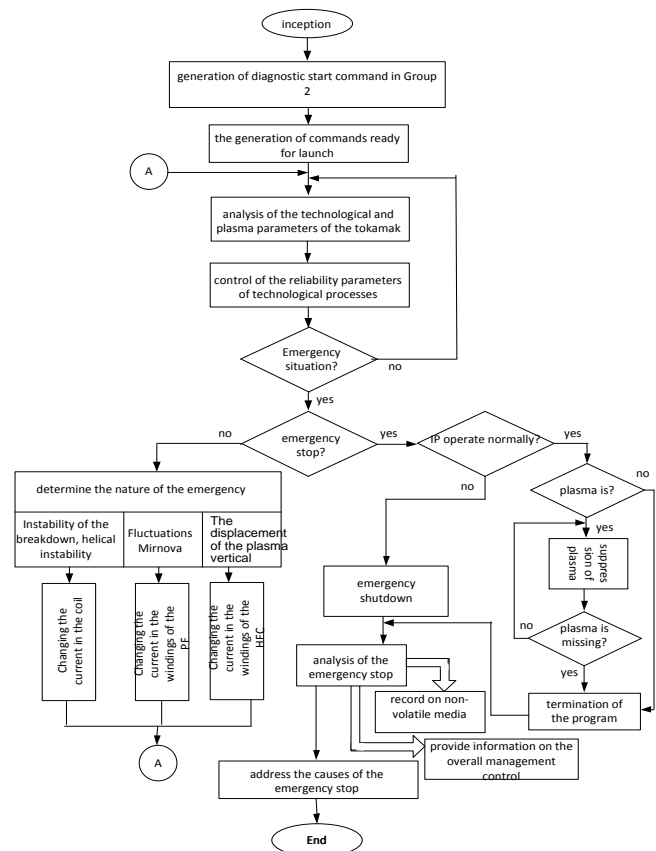
Emergency protection system (EPS) of KTM is designed to control the most critical technological equipment and personnel safety of KTM parameters and to prevent emergency accidents. In the case of emergencies, the SDR must perform the algorithms of protective effects, providing translations of the stand set to a safe condition and reduce the consequences of possible accidents. The EPS should provide automated execution of the following functions:

- Continuous monitoring of key process parameters of the EPS and the development of control actions in the case of emergencies.
- The performance of regularity monitoring of the SAE technical means, including self-test problems. To transfer the installation in a safety condition including the faults in the SAE devices.
- The maintaining of the accidents database with the ability of automatic identification of the equipment current condition and options for fault isolation to the implementation of one of the types of protective actions. In case of failure of automatic identification - ensuring the participation of the operator in making decisions. The work of the EPS can be represented by the block diagram shown in Figure 1.

According to the flowchart during the tokamak operation there is a continuous measurement of

the parameters according to which we can control the installation condition, then the measured parameters are compared with its regulation value. As a result of this comparison, the need of the protective procedures is proved.

Figure 1. The algorithm of the functioning of EPS



For the organization of the EPS operation a set of control parameters of a tokamak shall be determined, its regulation values should be set and the procedure for comparing the current value of the controlled parameter with the value of regulatory material should be designed, which may be of different complexity and should be presented in true form, because the parameters measured in real time, will be statistical.

Designing the SDR we consider the following events that may lead to emergency situations:

1. Overheating of the chamber walls and the uneven heating of the chamber and the structural elements.
2. Touching the walls of the plasma vacuum chamber.
3. Exceeding the allowable displacement of the plasma horizontally or vertically.

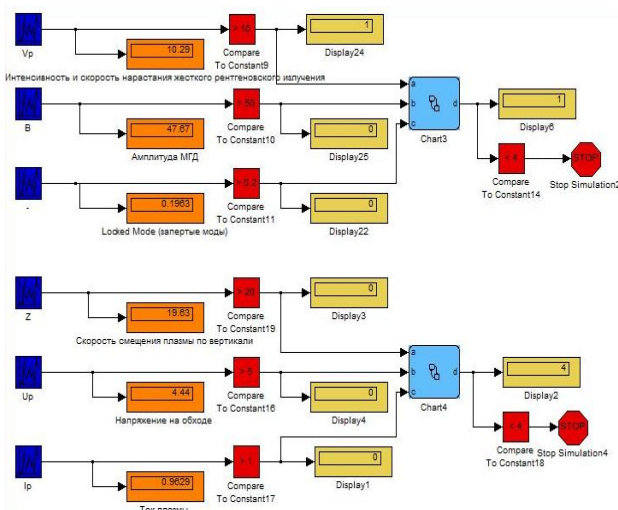
4. The appearance of the locked MHD - mod.
5. The emergence of disruptive instability.
6. Development of small disruption of the plasma.
7. Exceeding the limits of mechanical stress.

These events are characterized by a number of technological and plasma-physical parameters by which they can be identified.

The model of tokamak KTM emergency protection system. To save money and get a visual overview of the SDR at different modes of the tokamak, there is a work of a computer model construction which is close to the reality. The model must perform all the functions of the GPA described above and clearly fulfill the assigned tasks. The model is designed in MATLAB in Simulink package. There are the following designing stages:

- Collection of information. At this stage, the information about the unit itself, and the measured and monitored parameters was collected. Also the information about possible accidents and their consequences was collected.
- Data processing. The data obtained in the preceding paragraph have different dimensions, types and values of both negative and positive in the areas that provided a number of problems in the implementation of the model.
- Creating a computer model - the stage at which all the collected and processed data that we are in and sold directly to the computer model through a series of algorithms.
- Regulation of the model. At this stage, the refinement of the elimination of errors of inaccuracies and errors in the algorithm model, the diagnostic of various modes of operation is carried out.

Figure 2: Detail of EPS model.



- Check for the adequacy. At this stage the adequacy of the model to its requirements and how its work is closer to reality.

There is a brief description of the model. The basic principle of the model is the constant

comparison of controlled parameters to their setpoints.

Also it's possible to note that nowadays the model is mainly aimed at stopping the system in case of emergency. With the further development we plan to expand its functions for maintaining the efficiency that is the production of certain regulatory actions based on an assessment of system stability.

As for the structure, the model is divided into four blocks. Each block controls the three parameters; each parameter is continuously compared with the control value. These values are getting to the truth table, based on which the system determines the type of emergency situation and decide to stop all system. During the process all the data are displayed on the screen of the operator.

To run the model, it's necessary to specify the controlled parameters, the reference values of these parameters and press the bottom "start". All the changes occurring in the model operation and a decision taken by the program displayed on the screen of operator.

The main difficulty in modeling is the lack of information about events in the tokamak chamber processes and that is why the input data have only approximate values. For full compliance functions of the model to the functions of EPS a number of modifications are required, such as the different-level simultaneous control of extreme parameter values, the logging, self-test-launch, the mathematical modeling of the input parameters that will be performed during the regulation.

Also we are planning to create a control actions block generation that will detect and prevent an emergency before it occurs. In addition to these improvements there is a need of the SDR interface with other systems, such as plasma control system, subsystems, control flow diagrams, and others.

At the moment we have a prototype of the SDR model which is under regulation. We can evaluate its functionality after checking the adequacy of the model.

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METHODS OF COLLECTING INFORMATION ABOUT EQUIPMENT STATE IN MONITORING SYSTEMS

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Nowadays with the development of IT infrastructure it is crucial for companies to have a good and stable platform for software. Even small companies use software systems, databases and other means for simplifying the work.

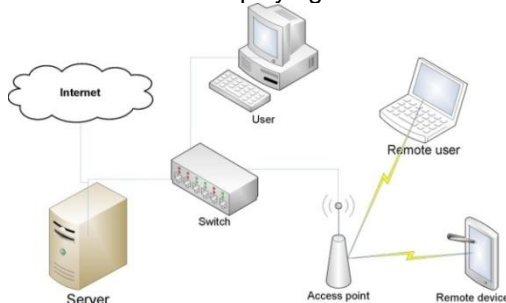


Figure 5. IT Infrastructure

However, a failure of any node of the system can cause considerable harm to the business and create inconvenience to the user. To prevent and timely detect it there are monitoring systems.

Monitoring systems may range from utilities to massive software packages that use all the features of monitoring endpoint devices. The simplest way of monitoring is to send requests via Internet Control Message Protocol (ICMP).

Internet Control Message Protocol is a protocol included in the protocol stack TCP / IP and defined in RFC 792. This network protocol is used to provide control, troubleshooting, and error messages while data is being transmitted as well as to perform some service functions. When you send an ICMP-message, the message format: TYPE, CODE, checksum is generated as well as data necessary for this type of request.

For example, the utility *ping* uses ICMP protocol with type 8 messages – for echo requests and 0 – for an echo reply. There are some rules of oscillations of ICMP-packages. First, ICMP packets are not generated for the answer to broadcasting requests since loading on a network will increase in this case and it will cause network overloads. Second, if the packet is lost, the new one is not generated. This protocol is simple to use and implement on all network devices. This makes it suitable to fast diagnose network connection, to check the availability of node and to identify problem areas of the network, but it does not allow revealing a complete picture of the network.

Standard WMI (Windows Management Instrumentation) is more difficult. This feature allows seeing a state of devices that are based on Windows. The tool is the basic technology for centralized monitoring and management of

Windows systems. The technology is readily adapted to the implementation of the standard Windows WBEM (Web-Based Enterprise Management), which was created to perform monitoring tasks based on open Internet standards. The technology is based on Common Information Model (CIM), implementing an object-oriented approach to the representation of system components. This approach allows applications, systems and drivers to add their classes, objects, methods and properties to the model. WMI, as an adapted system, includes CIM therefore it supports any parameters of OS added as well as devices and applications functioning in it. Monitoring objects are dynamic resources since the object parameters are constantly changing. So the object parameters are created at the request of the user of the data and they are not stored permanently. Object properties are stored in the repository – WMI repository – located on the polled machine. Special attention is paid to security issues. At the first stage of checking safety on the OS level is implemented. It means that Windows registration data is requested to access data and methods WMI. Depending on the network structure the request is transferred to DC (Domain Controller) or processed locally on a remote node. Depending on the rights of the user in the system (domain) it can get access not only to data reading but also to node controlling. At the second stage safety is implemented on the level of name space and DCOM (Distributed Component Object Model) protocol. It allows implementing the partitioned access of the user to objects and methods WMI. It means that the user who has rights to control the node can receive no access using WMI. Each object of the OS has its own description of safety including the access list where users who have access to object are set. WMI Query Language (WQL) is used to request data in technology WMI. To request data it is possible to use only commands SELECT.

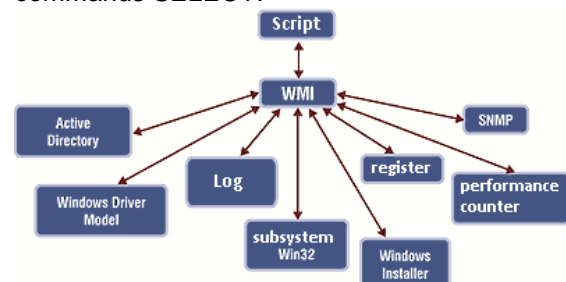


Figure 6. Script based WMI

Language is used in scripts, when requesting the node; however, there are standard facilities for checking requests by means of the graphic utility *wbemtest* used for interacting with structure WMI on a local or remote computer. To simplify the process of writing scripts and programs, there are special utilities which help to view WMI space structure and to show examples of using all classes. Despite the large number of the data and the simplicity of its processing there is also a drawback – the technology can be used only on Windows devices. On the other hand, monitoring of such equipment as switches and routers is often required in the network. To monitor such nodes there is technology SNMP.

Simple Network Management Protocol is a simple network management protocol based on the architecture of the UDP. SNMP is a component of the stack TCP/IP so most network devices support this protocol. This technology is designed to provide management and control of network devices through the exchange of agents and managers. SNMP agents are installed on the nodes of the respondents. They collect data on the node and transfer it to the manager on-demand. The agent can send information to its own manager on changing the status of any node by using TRAP operation. The manager is an information collection station periodically interrogating all agents of a network and collecting statistical information to create reports and analyze the work of the network infrastructure.

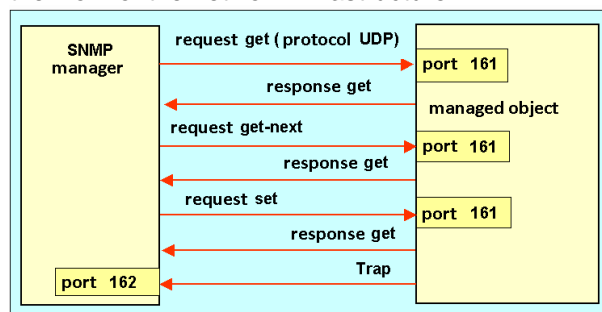


Figure 7. SNMP message exchange

The controlling system can request the agent to provide information on a current state of the node entrusted to it by requesting the operation of GET protocol (the request of value of the specified variable), GETNEXT (request of the following value, according to tree MIB) and GETBULK (request about transferring great volume of data). The data which can be received by means of SNMP protocol is defined in MIB (Management Information Bases). The controlling base contains the hierarchical name space which has the unique code of object (OID). Thus, each unique code of object identifies a variable which can be read through SNMP. Bases use the standards set in notation ASN.1. Thus, all objects in a network are divided into 10 groups and described in MIB: system, interfaces, exchanges, and translation of addresses, IP, ICMP, TCP, UDP, EGP, and SNMP. SNMP protocol has some versions. At the

moment there are three of them: SNMPv1, SNMPv2c, and SNMPv3. Each subsequent version completes the previous one by adding some functions. The first version of the protocol due to its simplicity is the most popular one. However, simplicity of the version has caused some safety problems – messages are transferred by plain text. The second version of the protocol has improved safety by adding line integrity checking (MD5) and encryption algorithm (DES). Nevertheless, safety of packets was not sufficient enough and version SNMPv3 appeared. The last protocol version uses high-grade system of authorization through hashing, temporal marks and enciphering messages. Thus, this version is simpler than v2 and more protected than v1 has. The dialogue between the agent and the manager happens with the help of SNMP messages which have SNMP protocol version, the password (community string) containing the sequence of characters which serves as the pass to interaction of the manager and a control object and value of the identifier of request. For generally available data and simplification of exchange adjustment in local area networks the password is installed with the word *public*. Protocol usage in local area networks conditions the demand for the protocol of the first version. However, when requesting the nodes via public networks it requires special protection with enciphering the information transmitted in order to avoid interception of messages and the subsequent usage to do harm.

Having considered three methods of collecting information on the availability of a network node and its main operating parameters we can make some conclusions. Protocol SNMP is suitable to work with most devices – it can be recommended as the primary method for collecting data. However, it does not take into account such details as monitoring of applications including the services of Windows, which play more important role in the work of both software packages and network structure. So, when monitoring large networks, it is necessary to take into account all details of applications and tools to select poll method appropriately. In addition, the use of ICMP allows reducing network load and receiving information about the availability of a node on time.

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LINEAR MODEL FOR PLASMA CURRENT CONTROL IN KTM TOKAMAK

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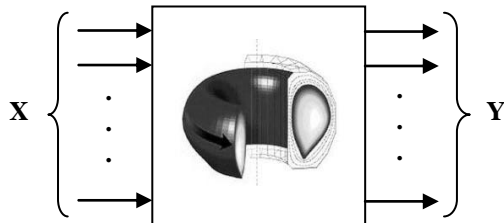
1 Introduction

Putting into operation of the Kazakhstan Tokamak for Material testing studies (KTM) supports ITER project in plasma material interaction investigations in the field of fusion [1]. Thus the development of a control-oriented linear model for the control of plasma current as a part of KTM software support becomes vitally essential task.

Moreover, linear control theory as the most developed control theory will help to select and adjust a linear matrix controller applied to multi-input and multi-output (MIMO) object [2, 3].

2 Regression model

It was shown that the control of plasma current and shape calls for a MIMO approach because of the strong output coupling between the controlled parameters [4]. Plasma parameters response to coils currents changing described in the picture 1 where multivariable input (X) and multivariable output (Y) are matrix-vectors.



Picture 1 – Tokamak as a MIMO object

Equation (1) shows the relation between input and output parameters.

$$\begin{pmatrix} Y_1 \\ Y_2 \\ \dots \\ Y_n \end{pmatrix} = \begin{pmatrix} A_{11} & A_{12} & \dots & A_{1m} \\ A_{21} & A_{22} & \dots & A_{2m} \\ \dots & \dots & \dots & \dots \\ A_{n1} & A_{n2} & \dots & A_{nm} \end{pmatrix} \times \begin{pmatrix} X_1 \\ X_2 \\ \dots \\ X_m \end{pmatrix} + \begin{pmatrix} C_1 \\ C_2 \\ \dots \\ C_n \end{pmatrix}. \quad (1)$$

Here we will discuss only static mode of tokamak model (static model) when $A_{11} \dots A_{nm}$ are numbers. So, the main objective of this work is to find parameters $A_{11} \dots A_{nm}$ for which the deviation between the response from linear model and corresponding object with the same input actions would be minimal.

Firstly, a particular set of input parameters should be defined. Central coil current I_{CS} and poloidal flux coil currents $I_{PF1} \dots I_{PF6}$ uniquely define magnetic field configuration and the static current density distribution of the plasma. Therefore, vector X consists of seven components

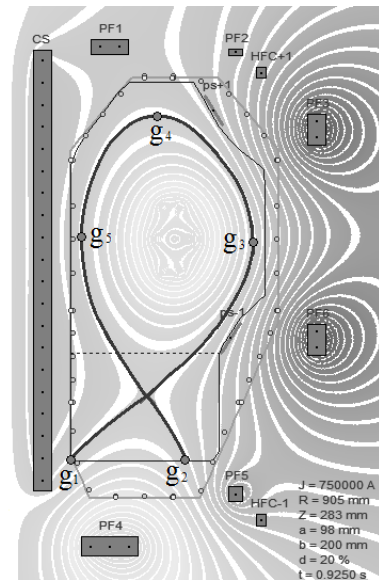
corresponding to the control coils currents: $I_{CS}, I_{PF1} \dots I_{PF6}$.

Formally,

$$X = \{I_{CS}, I_{PF1}, I_{PF2}, I_{PF3}, I_{PF4}, I_{PF5}, I_{PF6}\}. \quad (2)$$

To different types of magnetic configurations are possible during normal KTM operation. Consequently, these two configurations require special numerical parameters or coordinates determining the shape of plasma. The particular set of the object controlled parameters are also different.

The first magnetic configuration (picture 2) includes X-point located directly on the last closed flux surface (LCFS), or separatrix here.



Picture 2 – Divertor magnetic configuration at $t=0,925s$ KTM Base Scenario

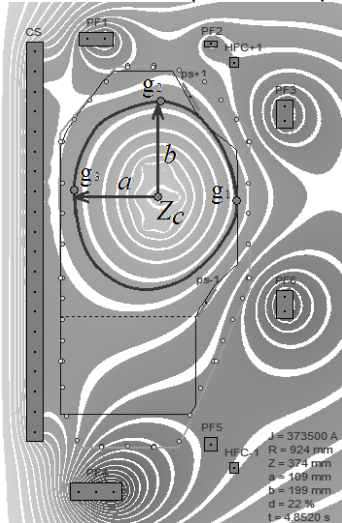
In this case five control points $g_1 \dots g_5$ should be used as a set of controlled parameters. First two parameters g_1 and g_2 describe the intersection point of contour and vacuum vessel limiter. Next three parameters g_1, g_2 and g_3 describe minor radius, maximum radius and the upper edge of plasma.

So, we get,

$$X_{divertor} = \{g_1, g_2, g_3, g_4, g_5\}. \quad (3)$$

Another magnetic configuration (picture 3) include closed magnetic surface which contact with the limiter at only one point. Parameter g_1 describes coordinates of this contact point. Parameters g_2 and g_3 are similar to the previous

case. Two more parameters related to the plasma shape stability are needed here: plasma elongation k equals to b/a and vertical position of plasma Z_c .



Picture 3 – Limiter magnetic configuration at $t=4,852s$ KTM Base Scenario

Thus, we obtain,

$$X_{limiter} = \{g_1, g_2, g_3, k, Z_c\}. \quad (3)$$

A special application was used as a simulator and plasma model with the aim of providing an adequate background to derive control-oriented regression model.

3 Factorial experiment

In order to provide independent calculation of each element A_{ij} a full factorial design with seven factors was organized. An application designed in MS Visual C++ 2005 automates the data processing arranged in «Yates order». Table 1 shows an arrangement of the experimental data.

Table 1 – Experiment data arranged in «Yates order»

| Exp No | x_0 | Factors | | | | Response | | | |
|---------|-------|---------|-------|-----|-------|----------|----------|-----|----------|
| | | x_1 | x_2 | ... | x_m | y_1 | y_2 | ... | y_n |
| 1 | +1 | +1 | +1 | ... | +1 | y_{11} | y_{12} | ... | y_{1n} |
| 2 | +1 | -1 | +1 | ... | +1 | y_{21} | y_{22} | ... | y_{2n} |
| 3 | +1 | +1 | -1 | ... | +1 | y_{31} | y_{32} | ... | y_{3n} |
| 4 | +1 | -1 | -1 | ... | +1 | y_{41} | y_{42} | ... | y_{4n} |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| $N=2^m$ | +1 | -1 | -1 | ... | -1 | y_{N1} | y_{N2} | ... | y_{Nn} |

Elements A_{ij} can be evaluated using the following formula:

$$A_{ij} = \frac{1}{N} \sum_{u=1}^N y_{uj} \cdot x_{ui}, i \in [1, m], j \in [1, n], \quad (4)$$

where,

x_{ui} – coded factors value:

$$x_{ui} = \frac{X_{ui} - X_{0i}}{\Delta X_i}. \quad (5)$$

Variation ΔX was chosen to be 0,5 kA for each factor. Initial levels X_{0i} depend on the type of magnetic configuration.

4 Model validation

Model adequacy was checked using the term of adequacy dispersion:

$$\sigma_{par}^2 = \frac{1}{N-1} \sum_i (\bar{y}_i - \hat{y}_i)^2, \quad (6)$$

where

\bar{y}_i – observed value;

\hat{y}_i – predicted value;

The adequacy checking results are shown in table 2. It can be argued static linear model gives acceptable accuracy for divertor magnetic configuration only.

Table 2 – Model adequacy checking results

| Parameter | Magnetic configuration type | |
|---------------|-----------------------------|-----------------------|
| | Divertor configuration | Limiter configuration |
| σ_{q1} | 0,52 sm | 1,9 sm |
| σ_{q2} | 0,27 sm | 20,65 sm |
| σ_{q3} | 2,7 sm | 9,8 sm |
| σ_{q4} | 5,7 sm | – |
| σ_{q5} | 1,3 sm | – |
| σ_k | – | 0,05 r.u. |
| σ_{Zc} | – | 4,1 sm |

5 Conclusion and future developments

A special application for static linear model parameters calculation was designed using described statistical methods. Basic feature of the model was revealed is that the model parameters are significantly different from one set of initial control currents levels to another.

Further work will focus on the implementing the designed model in a control loop for adjusting the multivariable matrix-controller.

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TECHNOLOGY OF DEVELOPMENT THE SOFTWARE PRODUCT FOR ON-LINE PROCESSING OF REGULATORY DOCUMENTS

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Introduction

Nowadays, one of the topical issues for the Government of the Russian Federation is the electronic document management. The problem is reduced to improve the transparency of state and local governments, the effectiveness of their interactions with citizens and organizations, the quality of their services. [1] However, for realization of tasks no decision has been found yet. On the other hand, there is a problem of time, both citizens and public servants. Solution to all these questions could be the creation of web-application, which brings together government agencies and implements the interface between them and the users, which would contain a database of all regulatory documents. Also, the application must fill out and send to the users of these documents on-line.

Due to lack of counterparts, it seems to be expedient to design a web-application corresponding to the requirements above. To implement such an application it has been decided to use the technology enabled by platform Microsoft Silverlight - a powerful platform for creating and delivering rich Internet applications (RIA), and multimedia web-based interface. [3]

The web-application created integrates government services and implements the interface between them and the users to fill out and send documents on-line, and it also contains a database of all regulatory documents.

The application combines multiple services and the courts to ensure that users have the possibility to complete and fill all necessary documents from one place. Thus, the application provides the ability to view a list of required documents, fill them and send to the relevant authorities.

In addition, to store an electronic archive of documents using a database it contains information on all major public services, their subsidiaries and affiliates, as well as information on employees who are responsible for a particular procedure.

The given research is aimed at:

- substantiating the necessity of creating such application;
- describing the technology of developing this application;
- explaining what kind of customers will be interested in using this application;
- describing the advantages of web-application;

- exploring the modern market of web-applications and comparing this product with competitors,

Clearly, in contemporary Russian society the need for a tool that would make a quick and easy process of interaction with government services, while minimizing direct contact is vividly expressed. Such tool is this new web application. [3].

The rationale of creating the software product

Due to the fact that the web-based application for on-line filling in the documents has not been established yet, there is no information and literature on the subject. But to create such software as well as for this research the main guide was "*Electronic document and the concept of one stop*" by V. Balal. This handbook is not only teaching literature for IT professionals to design the software, but it has excellent statistical and research data on this topic.

This work describes algorithms and technologies for designing web-applications in general, as well as information about new software platform Silverlight, with the help of which our application was written.

According to the order of the President of the Russian Federation signed in 2008, the program of the electronic movement of documents comes into force. This issue has not been covered thoroughly, but article "*The Introduction of a Unified Automated System of Document*" in the Moscow newspaper *Onlineweek* describes the problems of government in working with documents and sets clear targets for the software developers.

The author referring to the Civil Code and science and technology statistics leads the proof of the importance of the issue. Since workflow system in state institutions of the Russian Federation has a tendency to become more complicated every year - there are new rules and requirements for registration and updating of the law acts, an important task for government is to create web-applications combining government services and to implement the interface between them and the users which would contain the base of all regulatory documents.

The creation of such software will simplify and streamline the movement of documents and help to save time of both: citizens and public services. [2]

Description of the technology of developing the application for processing of regulatory documents

The process of development such kind of program product includes not only standard stages of program development but also the marketing research and consultation with government departments. In common, the technology of developing this kind of software product can be summarized as following:

- complex marketing research;
 - collecting necessary regular document forms;
 - developing the project of the future application;
 - designing the database
 - coding;
 - testing and debugging;
- completing the documentation.

SWOT-analysis of the application created

To make sure that such kind of software product will be in demand and successful on the market, it is necessary to estimate all strengths and weaknesses of the product.

| | | |
|----------------------|---|---|
| Internal environment | <u>Strengths</u> | <u>Weaknesses</u> |
| | <ul style="list-style-type: none"> - simple and user-friendly interface - high speed of processing the operations - detailed database of documents | <ul style="list-style-type: none"> - desirability of using the Internet - necessity of regular database updating |
| External environment | <u>Opportunities</u> | <u>Threats</u> |
| | <ul style="list-style-type: none"> - lack of real competitors - great social significance - possibility of getting government grant for developing and promotion | <ul style="list-style-type: none"> - possibility of the occurrence of competitive products - complexity of cooperation with government institutions |

Table 1.

Testing the beta-version has shown significant advantages of this application, proved its uniqueness and promised that sets it apart in comparison with other modern information technologies. The key advantages of the application are:

1. large database of documents;
2. simple interface;
3. ability to work as autonomous and work in the internet;
4. on-line administration.

Unfortunately, the web-based application, despite a lot of benefits, also has some drawbacks concerning technical and software components, and, of course, the economic one. They may be described as following:

1. limited free use of internet access in some locations;

2. the need to store sensitive data on remote servers;
3. the refusal of government agencies to cooperate.

Customer focus is one of the basic conditions for the success of firms in the market, as far as success of the new software product on the market depends on.

Because of scientific and technological progress the need for web-applications for on-line document management will considerably grow during the next 5-7 years, and by 2018 the demand for such software will stay the same for the next 12 years. [2]

In the market of web-applications related to documents, this product is supposed to be a monopoly, but a potential competitor is the site of public services (www.gosuslugi.ru). It was an organized attempt to unite databases of documents from several governmental agencies. The information collected on this portal is designed to familiarize users with the actions and tools with the help of which you would have to cope with future problems.

According to comparison web-application with a competitor our product has more advantages than the portal of public services, such as a large database of documents as well as the possibility of autonomous work in case if there is no access to the Internet. Finally users of the site need to go all time-consuming procedures of filling in the documents and attending the government departments personally, even if they registered on the site.

The target group of this software product is quite wide as it includes not only individuals but also companies which want to optimize the process of taxes payment. The proportion of different parts of customer universe can be represented as the following pie chart:

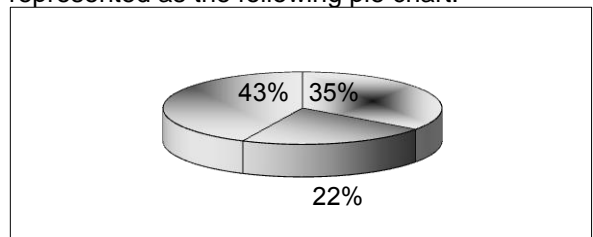


Figure 1.

This pie chart shows which groups are potential clients of web-application. Approximately 20 % of the clients are commercial and noncommercial organizations, 35% are sole proprietorships and just under the half of clients are individuals. According to marketing statistics, such part of the users took exactly half of the total world's population.

Conclusion

In terms of scientific and technological progress and the growing importance of modern information technology system of document in public

institutions of the Russian Federation needs to automate its operations to improve efficiency of processes.

Creating web-applications, combining government services, which contain the base of all regulatory documents, and carrying out the filling and sending these documents by the users on-line will simplify the process of sharing documents between government agencies and citizens.

This study allows ordinary users to evaluate the importance of web-applications for online filling of documents in the modern world of IT. Results of the study reflect the uniqueness and usefulness of such an application in practice, as well as allow us to estimate the position of this product on the market, which certainly can be useful to business and government.

Predicting nearest and long-time prospects of developing such software also helps future work on this application and makes more scientists and developers to become interested in this issue.

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ORGANIZING OF IMAGES CUSTOM FILTERS TESTING FOR «THE ULTRA FAST X-RAY IMAGING OF SCIENTIFIC PROCESSES WITH ON-LINE ASSESSMENT AND DATA-DRIVEN PROCESS CONTROL» (UFO)

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Introduction

The UFO project is being developed by Karlsruhe Institute of Technology (KIT) jointly with Saint Petersburg State University of Civil Aviation, Shubnikov Crystallography Institute and Tomsk Polytechnic University. The UFO [1] is an intelligent as well as interactive imaging; one of its features is data processing online by means of available graphics processing units (GPU) and field-programmable gate arrays (FPGA).

This system is designed for use on two experimental stations which shall be optimized for execution 3D and 4D X-ray visualization technological and biological processes. The first station should be implemented at the KIT on basis of ANKA synchrotron, the second one at the National Research Centre "Kurchatov Institute" on basis of Siberia-2 synchrotron.

1. The problem description

The UFO system uses an organized sequence describing the procedure of applying filters for processing the input data. Filters are specified using the file extension *.cl which contains an algorithm of data processing on GPU, internal functions are called OpenCL-kernel. The sequence is described by the user within JSON-file [2] that

allows you to modify the kernels describing the filters, and the sequence of their application to data without having to recompile the program. Due to the fact that OpenCL kernels are compiled and run on GPU (if there is suitable GPU otherwise the kernel will be launched on CPU) there is a problem in verifying the results of the data at the output of a filter or a series of filters.

2. The solutions

One of the solutions can be writing the program that allows specifying a set of input files (for instance a file that was obtained by processing on the GPU and reference file) and performing a comparison between them. Such an approach is ineffective, as previously, we need to handle one or a few output files to the UFO and then perform the testing (in its simplest form it is a comparison with the reference). Furthermore, changes in the test function would require recompiling the program defining a test.

We offer an approach based on the principle of the organization, which was used in the UFO. This approach allows us to describe the test in the form of JSON-file and perform a comparison by means of [3] OpenCL-kernel, thus we can avoid recompiling of the program while changing the

testing function or the structure of the test, e.g. sequence of filters applying.

3. Description of implementation

For testing we have implemented a class, an object of which takes the full path to JSON-file describing the structure of the test. Thus the end-user should only provide the transferring the full path to the JSON-file and specify a callback function, in which the final results will be estimated.

The testing process is divided into several stages, the implementation of each subsequent phase requires the completion of the previous one.

Description of the stages:

1) Before the start the processing, the analysis of JSON-file and forming the structure of test which contains such activities as creating the set of data sources, set of sequences and filling them by data is performed. In addition, an object of the class that receives the data from the sequences, performs the data transmitting to the testing kernel and obtains the result is created. After that, the binding of sources with sequences and sequences with a processing-object by special element transmitting the data from the last filter of the sequence (or from the input of the sequence, if it is empty) is performed.

2) In the first stage, the parallel processes of reading the data from those sources, which are connected to at least one sequence, are started. In the case of connecting more than one sequence is with more than one source, the data is copied to the additionally connected sequences. Thus, those files that are not used in the test but specified in JSON-file as the sources will not be read and it will decrease the memory consumption by the program.

3) In the second stage, when all data is read and transferred to the inputs of sequences, the processing of each sequence will be run in a separate thread. Each executable sequence applies its filters (if they were specified in JSON-

file) to its input data in accordance with the order they are specified by the user, then the processed data are being transferred into the transmitting object. (in Fig. 2 labeled as "Connector").

4) In the third stage, when all the sequences are processed and the data from them is transferred to the connector, the kernel of processing unit (in Fig. 2 labeled as "KERNEL") configures OpenCL and then consequently reads one block of data from each connector and transmits it for processing to the testing OpenCL-kernel in accordance with the specified arguments. After finishing of all blocks processing in all sequences, the final data is transmitted in the callback function (in Fig. 2 labeled as "Custom Analysis Function").

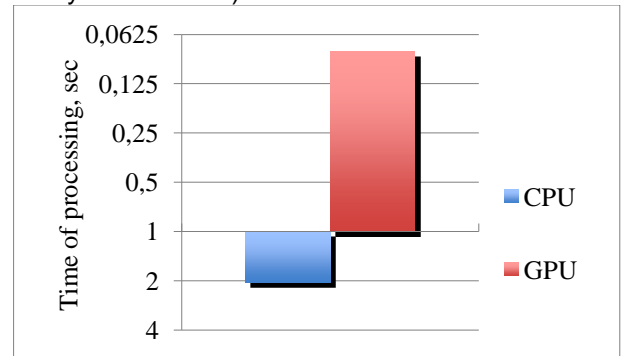


Fig. 1 High-speed performance while comparing the data on CPU and GPU

4. Comparison of the results

The test was carried out 20 times for GPU and the same for CPU (Fig. 1), the image with the size of 2250 pixels was used as the input data. From the data obtained it is clear that the implementation of this test on the CPU took 26 times longer than on GPU. In this case we have used merely the comparison of the intensities at each point in each image.

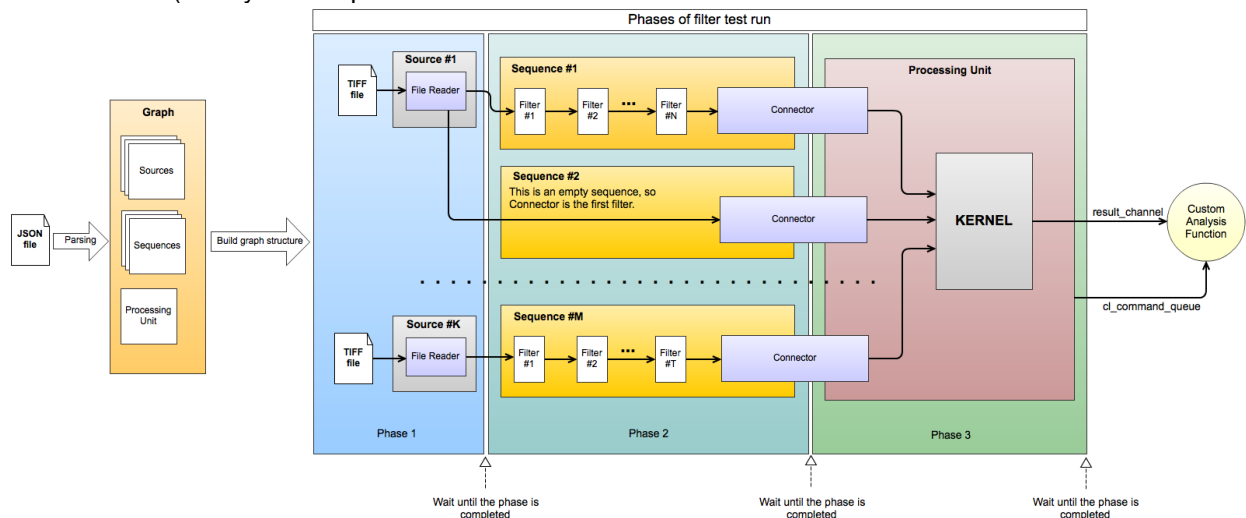


Fig. 2 The diagram of testing process

5. Conclusion

The developed system of classes allows testing or comparing several sequences at once that are working with an adjustable number of sources. In addition, changing the sequences of filters, the sources or the function of testing is not required to recompile the entire application if it has used developed classes, thus saving the time of testing.

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THE DATA PROCESSING, IN VARIOUS RESEARCH PROBLEMS, BASED ON WAVELET TRANSFORMATION

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Wavelets are mathematical functions that satisfy certain mathematical requirements and are used in representing data or other functions that can help you analyze the different frequency components of the signal in time. With wavelet analysis, we can use approximating functions that are contained neatly in finite domains. Wavelets are well-suited for approximating data with sharp discontinuities. All this makes wavelets interesting and useful for different engineering problems.

Wavelets as a tool were developed independently in different fields such as mathematics, physics, engineering, geology, medicine and many other spheres.

Nowadays there are too many new wavelet applications in different fields such as data compression or decompression, calculation of variants in finance models related to specific time scales, images sharpening, and a human vision simulation for robots, forecast of geomagnetic conditions, natural disasters and technological production parameters.

The wavelet transform is in fact an infinite set of various transforms depending on function used for its computation. This is the main reason for finding the term “wavelets transform” in different situations and applications. There are two main types of the wavelet transforms. They are discrete wavelet transform using orthogonal wavelets and non-orthogonal wavelets with continuous wavelet transform. These two transforms have the following properties and applications:

- The **discrete wavelet transform** returns a data vector of the same length as the input is. It is used for signal coding, representing a discrete signal in a more redundant form, often as a

preconditioning for data compression. Here each function can be described by the formula 1 where c is an amplitude of harmonic oscillations of the definite frequency

$$f(x) = \sum_{jk} c_{jk} \psi_{jk}(t) \quad (1)$$

- The **continuous wavelet transform** returns an array one dimension larger than the input data. One of the most popular applications of wavelet transform is image compression providing significant improvements in picture quality at higher compression ratios over conventional techniques. Transformation is given by the formula 2 where s is a scale and ψ is a mother wavelet.

$$\gamma(\tau, s) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{s}} \psi * \left(\frac{t-\tau}{s}\right) dt \quad (2)$$

Sets of both transforms allow analyzing data fully. Data can be restored without gaps or overlaps that is to say the process is mathematically reversible. Wavelet analysis is used for decomposing a signal in new coordinates that is the frequency dependence of time.

Some examples and examples of these transformations application are considered in more detail below.

As a matter of astronomy, astronomical applications of wavelets differ from other applications because of the nature of astronomical images and signals. Here wavelet algorithms have led to very impressive results in denoising, discriminating signal from noise and detection and analysis of astronomical sources that is to say all applications within the field involve some form of signal or image processing. Astronomy is driven by sophisticated technology for both ground-based

and space-based observations, and this technology has led to problems that appear to be well suited to wavelet techniques.

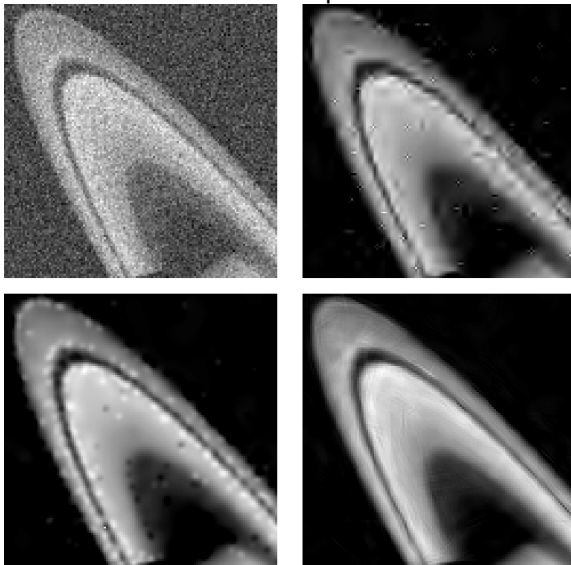


Figure 1 –The wavelet transform application for the Saturn image

In Figure 1 a base top left image and three types of its wavelet transforms are shown. Base image has noise. At the top right, the image is filtered using the bi-orthogonal wavelet transform. At the bottom left and right, the image is filtered by the “à trous” wavelet transform algorithm and the “curvelet” transform. The “curvelet” retains the clear edges but with significant loss of important details. The “à trous” wavelet transform gives better boundaries, but it shows numerous small-scale blemishes.

One more example of wavelet transform in other spheres is sub-band coding that is any form of transform coding that breaks a signal into a number of different frequency bands and encodes each one independently. Often it’s aimed at music and speech recognition. The best solution for this signals type is multi-resolution analysis, which is essentially the wavelet solution because in most practical signals, low frequencies are stationary over the length of the signal. High frequencies however, tend to come and go over short intervals of time. Therefore, low frequencies should be analyzed over a longer time interval, and higher frequencies should be checked over a short interval.

Wavelets are also widely used in Medicine and Biology. Examples of their use are ensuring accurate heart diseases detecting by means of electrocardiography (ECG) and echocardiography and neoplasms by digital mammography.

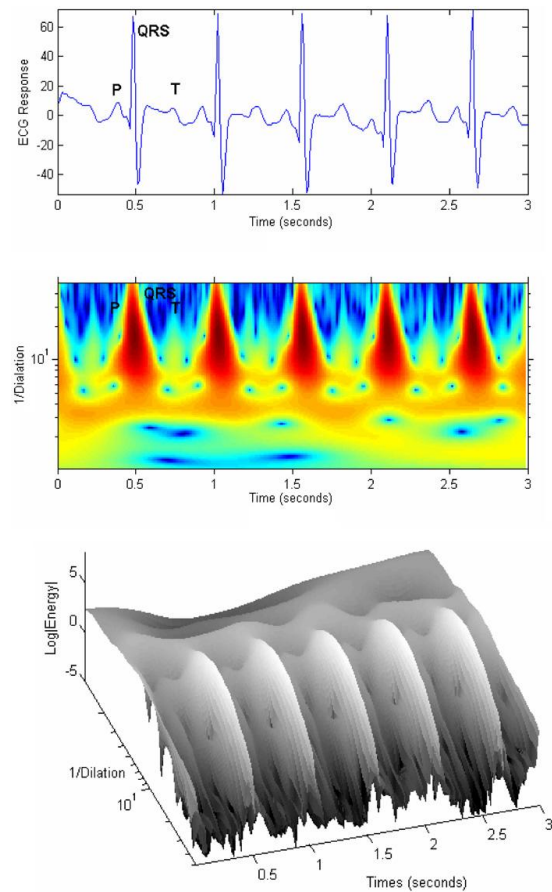


Figure 2 – Wavelet transform of ECG sinus rhythm

The analysis of ECG is widely used for diagnosing of many cardiac diseases. Since most of the clinically useful information in the ECG is found in the peaks and boundaries of its characteristic or fiducially waves. Nowadays a significant amount of research efforts are devoted to the development of accurate and robust algorithms for automatic detection of the major ECG characteristic waves.

As it was mentioned this transform provides a description in the time-scale domain that allows the suitable signals representation to have multi-resolution characteristics such as the ECG signal. Indeed, the ECG characteristic waves have different frequency content. Different implementations are proposed for this problem solution, most of them are based on the well known wavelet-based technique.

An algorithm extracts the characteristic points of the ECG signal; their timing and morphological information is analyzed to diagnose a set of cardiac problems directly related to alterations in the heart’s electric activity such as abnormal conduction in different parts of the heart or problems in the depolarization or repolarization phases.

One of such algorithms is depicted in figure 2. It contains three beats of a sinus rhythm from a human heart together with its wavelet energy scalogram shown as both a plan view and a three-dimensional surface relief. It should be mentioned

that the energy logarithm is plotted in the figures as it allows functions with large differences in their energy amplitudes to be made visible in the same plot.

Wavelet analysis is developing in various fields of science and can be practically applied in a variety of engineering problems. Considering the history of its predecessor (Fourier transform) we can suggest that the wavelet transforms will have a long history. The main applications can be summarized in three main areas; they are data compression, speech and music recognition and image processing. In these areas wavelet transforms is the leading method. In addition this transform is useful for pure mathematic applications such as solving partial differential

equations and many other fields. In conclusion it is important to mention that wavelet transform is a powerful and very useful tool for mathematic applications.

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RESEARCH OF ECONOMIC TIME SERIES WITH A HELP OF NEURAL NETWORKS

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Thanks to fast and rapid growth of information technologies people and machines become related more intensively. People explore machines, and machines in turn overtop their creators vastly. As a result, such concept as Artificial Intelligence emerged. Artificial intelligence (AI) is the intelligence of machines and the branch of computer science that is aimed to create it. Research of AI capability is a perspective and actual task nowadays.

Quotation prediction was chosen as an example for this work. Forex(the foreign exchange market) was chosen as a project domain because of large quantity of open data. Researched was carried out with artificial neural networks.

An artificial neural network (ANN), usually called neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. It is one of a number of AI technology. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase. Modern neural networks are non-linear statistical data modeling tools. They are usually used to model complex relationships between inputs and outputs or to find patterns in data.

Most systems use "weights" to change the parameters of the throughput and the varying

connections to the neurons. Artificial neural networks can be autonomous and learn by input from outside "teachers" or even self-teaching from written in rules.

There are numerous algorithms available for training neural network models; most of them can be viewed as a straightforward application of optimization theory and statistical estimation.

Most of the algorithms used in training artificial neural networks employ some form of gradient descent. This is done by simply taking the derivative of the cost function with respect to the network parameters and then changing those parameters in a gradient-related direction.

Evolutionary methods, simulated annealing, expectation-maximization, non-parametric methods and particle swarm optimization are some commonly used methods for training neural networks.

The task is to research neural networks facilities in works with quotation time series. More particularly, it means that neural network should be constructed in MATLAB. Then, it should be trained with some samples. And in result, some improvement in prediction should be recieved.

The cross of simple moving average with different averaging period for definition quotation trend was used. This method is used among traders. It consists in building two SMA, and monitoring cross. When it happened, then trend has changed. In original algorithm a change of trend is determinated after period of quick SMA. Sometimes it is too long. Creation of network which

can predict SMA for short period can help to get information about cross in moment when it happened. It would be more efficiently than original algorithm without prediction.

SMA with two averaging periods – 5 days and 10 days was used. Neural network should predict SMA with a period of 10 days. The cross will be received with moving quick SMA on 5 steps in future. As practice shows, it works.

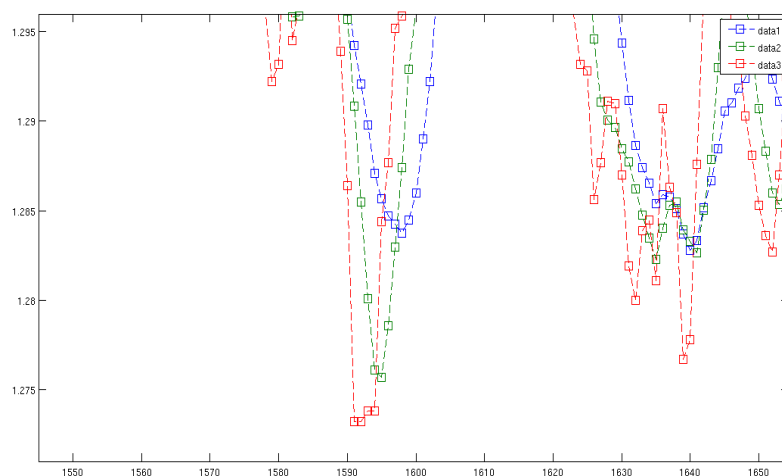


Fig.1. The cross of two SMA and quotation

As a development environment was chosen Matlab. MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

There are a lot of toolboxes for MATLAB, which dilate functionality. They correspond to collections of functions, written on MATLAB language to solve a strict type of problem. They are developed by MathWorks, including Neural Network Toolbox – facility for analysis and synthesis of ANN. As a result, MATLAB is ideal for ANN design and data preparation.

Neural network demand prepared data. Data was prepared, and that process included:

- 1) Data acquisition
- 2) Preparation and normalization

Open values of quotations are available for download from many brokers' sites. They were downloaded from <http://forex-broker.org/clients/Archive/> for EUR/USD. Because of ANN ability for generalization, it was not necessary to smooth data and to delete noise in our case. Normalization was also unnecessary because of one type of inputs. Normalization is used only when data has different dimension, for example one input has values from 1 to 100, and the second from 50 to 200. Without normalization the second input could affect the result more than the first. It is not this case as there should only make the matrix from samples. The choice of model's parameters was the next step. It consisted of:

- 1) Choosing network topology
- 2) Fitting AN characteristics

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3) Fitting learning parameters

Identification of network topology was carried out by empiric method. Different combinations of numbers of neurons and layers were tried. Their capabilities were analyzed with required data. It was established that increasing of numbers of layers does not enhance the result. Because of this the architecture with one hidden layer was chosen. The number of neurons in hidden layer was fitted as 10, number of inputs – 15.

Network consists of inputs, one hidden and output layer. In hidden layer is used sigma function, in output layer – linear function. Because of this a pattern is standard for regression problem.

And the last stage of learning and estimation of results included:

- 1) Learning
- 2) Verification of learning adequacy
- 3) Alignment of learning parameters

In MATLAB there is some number of learning algorithms. Trainlm, a network training function that updates weight and bias values according to Levenberg-Marquardt optimization was chosen. Before training data was prepared. The data was broken into samples – sets of inputs and outputs, whereupon they are represented in matrix – the form that is needed for learning algorithm.

The quality of result can be evaluated from point of view, and from mathematic point of view. Users appraisal bases on tentative profit, mathematical – on simple average value of errors.

For daily period the following results were received: simple average value of error – 9.33 points.

Trading algorithm based on ANN predictions «earned» 55727 points for all time. For comparison, similar trading algorithm without ANN «earned» 18067 points in idem conditions, it is in 3 time less then with ANN.

In conclusion it is possible to say that neural networks showed themselves effective in works with economic time series. Other important thing is that neural networks can be used in almost every sphere.

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ARDUINO PLATFORM BEST PROJECTS

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The last term of studying includes graduation qualification work. Our task is to design a really working system for temperature monitoring in the hive. My tutor advised me to use Freeduino for implementing this system. After some browsing we realized that Freeduino, indeed, is the most appropriate solution. It's the clone of Arduino and fully compatible with it. Except Freeduino there are lots of other Arduino clones.

Arduino is a platform for electronic devices design (the electronic construction set) which interact with physical environment while standard PC's are actually not beyond the virtuality. It is a platform intended for 'physical computing' with open program code, constructed on the simple printed-circuit board with the modern programming environment for software writing. Arduino is applied to create electronic devices with possibility of signals reception from various digital and analog gages which can be connected to it, and to sending this signals to controllers of various actuation mechanisms. The projects of devices based on Arduino, can work independently or cooperate with the software on the computer (e.g.: Flash, Processing, MaxMSP). PCB can be collected by the user independently or bought fabricated (Fig.1).

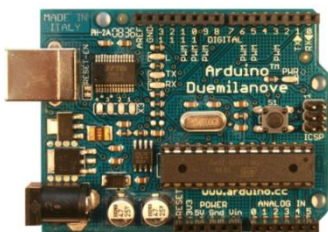


Fig.1. Fabricated Arduino Duemilanove

So, why is Arduino the best choice? There is a huge variety of microcontrollers and platforms

suitable for such purposes. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard and others provide the same possibilities, but Arduino has advantages in price, possibility of programming environment to work on Windows, Mac and Linux. Moreover, it is simple for newbies and, of course, for specialists. In addition, it has different shields for different purposes. For example: Ethernet Shield – Ethernet interface for Arduino, Motor Shield – power module for motors controlling, Proto-Shield - prototyping board, X-Bee shield – board for wireless connections via ZigBee standards [1].

There are several versions of Arduino platforms. The last, "Uno" as the previous Duemilanove is based on microcontroller Atmel ATmega328. Programming language of Arduino devices is based on C/C++. Arduino is easy to learn and currently it is very likely to be the most convenient method of programming devices on microcontrollers.

The Arduino Duemilanove ("2009") which we are using in our project is a microcontroller board based on the ATmega168 or ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything necessary to support the microcontroller: you should simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. [2]

As it is an open source platform there are lots of code examples in the web, lots of books covering Arduino.

Schematic solution of our system is in the Figure 2.

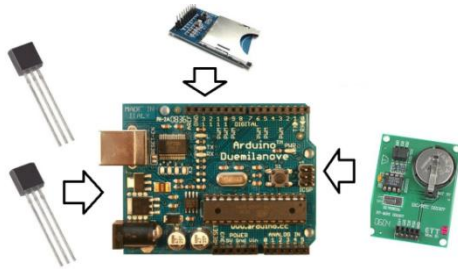


Fig.2. Schematic solution

There are four main devices in the scheme:

1. Arduino Duemilanove – for taking readings from sensors and storing them;
2. Real-Time Clock – for time counting, when central power supply is powered off. It uses energy of a cell-battery;
3. SD-card holder and SD card for storing log files;
4. Sensors to measure temperature.

Such system with the price lower than 70\$ provides all functions required.

Other interesting Arduino Projects:

In October Google Developer Day Moscow 2011 gathered several GTUG-commands (Google Technology User Group) and they demonstrated possibilities of Android devices and Arduino ADK bundle. Arduino ADK (Accessory Development Kit) is a board based Arduino Mega 2560, but it has USB-host interface on MAX3421e microchip. It gives the possibility to connect with mobile devices which use Android as operating system [3].

Robowars project is some kind of a game. Each robot has a small hammer to punch another robot. The goal is to hit the button. Tablet PC has an application, where players can control their robots and see the score and a XBee module to connect to robots. (Fig.3.)



Fig.3. Robowars

Andruido Music Studio project was presented by Almaty team. It has a frame with 8 lasers and photoresistors. This frame is connected to Android-telephone. If one of rays in the frame interrupted, mobile phone plays the sample attached to this sensor. So it is some kind of sampler and you can make simple compositions by using it.

There are even rating lists of Arduino projects in the web. Here are some projects from hacknmod.com:

On the top of the list there is a project which is similar to Andruido Music Studio. It has the same principle as Andruido Music Studio only it is bigger and connected to a synthesizer.

UAV Spy Plane took second place (Fig.4). With a handful of servos, battery pack, GPS unit, and the Arduino programmer you can build your own unmanned aerial vehicle (UAV) drone. It is an absolutely outstanding project provided with a detailed, 22 page tutorial to guide you through the entire building process.



Fig.4. UAV spy plane

Mini Segway robot (Fig.5): using the Arduino, and a couple of LEGO motors and sensors, you can build your own self-balancing segway-like robot. There are not too many details posted about the build yet, but you can read more about the project and watch the demonstration video.

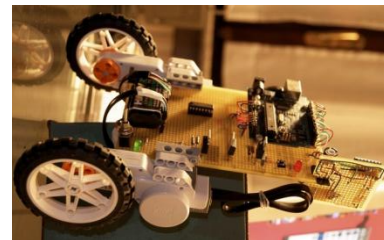


Fig.5. Self-balancing robot

However, there are projects not only for fun. For example, alco-testers and bundles with gas sensors. This sensors let your Arduino smell (and hence you program responses to) overall gas levels for a variety of nasties, including ethanol, methane, formaldehyde, and a bunch of other volatile organic compounds.

Talking plants project: plants can message you when it needs water or sunlight. Here sensor probes, placed into the soil, measures the amount of moisture present. Reading is sent to controllers, then to computer, then via the Internet to your mobile phone.

Another project is to control Servo Motors with the Wii Mote Joystick. The word 'Servo' itself is reeks with coolness. Combine that with the power of the WiiMote joystick and an arduino to steer a boat or plane, for example. There are two fantastic tutorials in the web how to build such system and a video about electric canoe.

Even the latest technology from Apple called 'Siri' can be used with your Arduino microcontroller.

Siri is artificial intelligence. Imagine, you are staying near the door, then asking Siri to open the door, and the door lock opens! American

developers even made a tutorial how to do that. (Fig.6)



Fig.6. Siri opens the door

You can even get an sms message if someone is knocking at the door, or you have forgotten to close the door, and you are asking if the door is opened. Maybe you have forgotten to switch off an oven or TV, you can ask Siri, and do what you want distantly if there is Arduino connected to them.

So, there are lots of applications of Arduino and its clones. Arduino is a computer, with clock frequency as on old Intel i386 but it is so small that can be located on a palm. On the Arduino base it is

possible to build infinite quantity of things. A variety is limited only by imagination.

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CONTINUOUS INTEGRATION

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Continuous Integration is a software development practice where members of a team integrate their work frequently; usually each person integrates at least daily - leading to multiple integrations per day. Each integration is verified by an automated build (including test) to detect integration errors as quickly as possible. Many teams find that this approach leads to significantly reduced integration problems and allows a team to develop cohesive software more rapidly. This article is a quick overview of Continuous Integration summarizing the technique and its current usage.

Currently, Continuous Integration is one of the practices used by the family of flexible methodology. In these methodologies, it is successfully combined with other practices such as unit testing, refactoring, coding standard. But even without it you can get the benefits of continuous integration. As a rule, when designing an information system software code is written by various groups of professionals. Then, these parts are going into

larger modules, which are merged into the system and further tested. But the built process begins only when the module is almost completely ready. According, if at this code stage an error or a problem is detected with the interaction of individual components that's why it have to rewrite a lot.

In general, the practice of continuous integration implies that the code assembly must be started as soon as possible and repeated as often as possible (at least - at each new piece of code). It is possible to find errors or contradictions in the various components on early stages of information system. Then before the error is detected, it is easier to correct it. As a result there are reduced risks of time delaying software development and it provides high-quality code.

After development completion finished system is exposed to functional testing (automated and manual). It allows to determine the system matches with the customer requirement, and to provide an opportunity to test its operation in situations as close to real business scenarios.

The process of continuous integration:

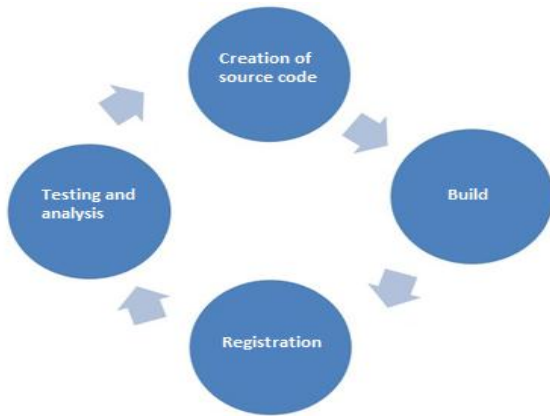


Fig. 4. Stages of Continuous Integration

The future information system code can be created by several teams, and they can be in different offices of the company-developer. To improve the quality and effectiveness of joint work on the code, there are often used special IT solutions - which were given before. This is a version control system. The code is stored in a special repository. If necessary, you can create a branch from the main development the so-called "branches" or streams. From the standpoint of project convenience it is generally recommended to open a separate "branch" for each new element of functionality which is future planned for implementation. After writing the code, "branch", previously passed testing, it adds to the general store and join to the main stream of development.

A programmers team, as a rule, simultaneously leads several streams of development, periodically changing or even removing it. From an standpoint of efficiency for the combining results it is rational way to use a special tool - planner that allows you to create, store and automatically run tasks on assembly code. As planners example, it can bring solutions CruiseControl, TeamCity, Hudson (and its successor, Jenkins), and others.

Result of social poll in territory of Russia:



Fig. 5. 1007 persons have voted. 424 persons have refrained.

As part of each such task planner with specified intervals (for example, the rule of "the emergence of a new change," or at a fixed time) gets parts of the code of the necessary branches of the repository, and starts to build as it was preconfigured by build engineer. Most of problem are of same type, it is so easy to automatically pattern creating.

During the assembly code (compiling and linking) it can be run in parallel unit tests: the call of the code with certain parameters, which should lead to an exactly marked result. This will help to test the code before its inclusion in the final program (system), to see whether the tests call all lines of code, to check for logical errors, etc. Thus it is possible to detect defects that exist in the source code, and which arise in the interaction of the program components, and to check how bugs have been fixed.

If an error is detected the developer have the opportunity to make corrections immediately, and all changes are automatically stored in the repository. Then the planner has received a signal that the code has been transformed, automatically initiates a new iteration of the assembly, and all operations will be repeated. This is one of the main advantages of continuous integration approach - all the changes the program code recorded after each auto is going to again and again checked. As a result, there severely reduced the risks of any future mistakes in the work of created IT systems. In addition, it avoids delays in the work if the project involves teams that are in different regions and time zones and work in shifts. Without the use of CI (continue integration) programmer, writing code, and part of his not having received confirmation (notification) by e-mail about the absence of errors, goes home safely. But his colleagues, who at this moment begins their working day in another region, have to spend his time for detection of defects and their correction. Terms of system development will increase. In the case where the development is with the CI, such situations are avoided.

As a result, the end stage of a project team has ready program that in its structure, such as the covering unit tests, documentation and other parameters responds with quality standards.

Advantages and disadvantages of continuous integration.

First profit – escape of the routine. No need to explain that professionals do not like routine, in addition, people’s time becomes more expensive, and time machines is getting cheaper. In other words, integration problems are identified and corrected quickly, which is cheaper.

2. Immediately run unit tests for recent changes.

3. The continued availability of the current stable release with the assembly products - for testing, demonstration, etc.

4. The immediate effect of incomplete or non-working code teaches developers to work in an iterative mode with a shorter cycle.

5. Simplicity and repeatability. Anyone - any project member: testers, analyst, etc. can build and run the project, because all these operations are automated. Make a mistake it is not possible. Of course, there are disadvantages to this system, but they are not significant as the benefits. For example, the disadvantages include the need for a dedicated server, to spend the time to support the server work. The first argument of every day is weaker and weaker, iron is less and less cost compared with the developer time. Regarding the second argument we can say that the time for maintain the server is quite insignificant compared with the time for detection problems in another way and delayed its removal. To summarize we can say that application of the continuous integration technique in the software development allows you to automate the steps of creating, building and installing the software code. This allows you to monitor constantly its

quality, even at the early stages of the creation IT system to identify errors and fix it quickly. Next functional testing will provide a detailed check and make software at the most appropriate to customer requirements. As the result, this ensures high quality and reliability of the information system.

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FORMALIZED DESCRIPTION OF MANIPULATORS KINEMATIC CHAINS WITH JOINTS OF 3TH AND 4TH CLASSES

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At the present time different types of manipulators include hundreds, maybe thousands constructive models, and their number continues to grow intensively. In this case we need a formalized way to describe manipulators kinematic chains, which allows reflecting full data set about structures and parameters of these kinematic chains concisely. This way of description should be convenient for solving problems connected with forming of data banks about manipulators, and their structural and kinematic analysis on the computer.

A similar method of formalized description of the kinematic structure and parameters was proposed by Alexander Malishenko and described in detail in [1]. The proposed method is based on a formalized description of all links and joints of the chain and includes descriptions of the most common elements of the manipulation mechanisms kinematic chains. These include: a fixed joint, rotational and forward kinematic pairs of the 5th class, the base manipulators and moving links. It is obvious that this list of formalized described elements of the kinematic chain should be supplemented by three elements, encountered

in some of the kinematic schemes of manipulation mechanisms. These elements are: a cylindrical kinematic pair of 4th class, Hooke's joint and spherical kinematic pair of 3th class. The urgency of this problem is attributed to the development of new models of the manipulation mechanisms (and not only in robotics), which kinematic chain contains a cinematic pair of 3rd and 4th classes.

Developed in [1] way of describing the structure and parameters of the manipulator kinematic chains is based on a formalized description of all links and joints included in the chain. In this case, each element is described by its corresponding type identifier and a set of parameters, some of which reflect the structural links in the kinematic chain, and other define their own parameters of this link, or joints. The parameters used to describe the elements of the kinematic chains are positional, i.e. the sequence of their recording is strictly defined.

The sets of structural parameters for the main elements of the kinematic chains (links and joints with one degree of mobility) are presented below [1].

1. Joints. Identifiers of joints begin with S symbol. Their structure has the form StY , where t – is a number of degrees of the links relative mobility, connected by kinematic pair formed by this joint; Y – is a symbol indicating the type of a joint.

1.1. Fixed joint. Formalized description for it is given by $SON(i, j, k, \gamma)$.

1.2. Rotary joint of 5th class. For this type of joints formalized description is given by $S1W(i, j, k, \gamma_0, \gamma, \gamma_m)$.

1.3. Forward joint of 5th class. A distinctive feature of the kinematic pairs with joints of this type – is changing the axis length of one link of a kinematic pair with their relative displacement. The formalized description for this joint: $S1P(i, j, k, q, q_m)$.

2. Links. The identifiers of all types of links begin with Z symbol and have the structure form $ZOY_1, Y_2, \dots, Y_l F$. At the same time, instead of / symbols in the identifier, the symbols of the joints, which include this link, are introduced. The symbol O is used only in cases where link is the base and the symbol on position F – only when it is a final element of manipulator kinematic chain.

2.1 Links-base of manipulators. In the kinematic chain of manipulators there are typically links with identifiers ZOY , and are connected with one joint, where $Y \in \{W, P, N, G, \dots\}$. However, there exist such constructions of manipulators where two or more joints are directly connected with the base. This occurs, for example, when you install manipulator pantographic mechanism on the base. Formalized description of the base is : $ZOY(k, i, L_x, L_y, L_z, \alpha, \beta)$.

2.2. Moving links. They are characterized, first of all, by the type of joints, which they are included into, and also by the number of associated characteristic points of the manipulator (the number of symbols standing in their identifiers after Z). For the moving links the structural parameters – is a set of the data necessary for the unique determination of the transitions between the axes trihedron, connected hard with the links of their characteristic points. These parameters for the mobile links can be selected irrespective of the element types of manipulator kinematic chain determining their characteristic points, and the sequence of their reflection in the identifiers of these links. Description of the link connecting two joints is given by: $ZWQ(k, i, m, \beta, L, \gamma, \alpha)$, where symbol Q is determined by the type of characteristic point ($Q \in \{W, P, N, G, K, H, \dots\}$).

Supplement of the source formalized description is the description of kinematic pairs with two and three degree of mobility.

Cylindrical joint of 4th class. Cylindrical kinematic pair is shown in Figure 1. Cylinder A is located in a hollow cylinder of the cylinder B. The motion of A cylinder relatively to the cylinder B is reduced to slip around and along the joint axis.

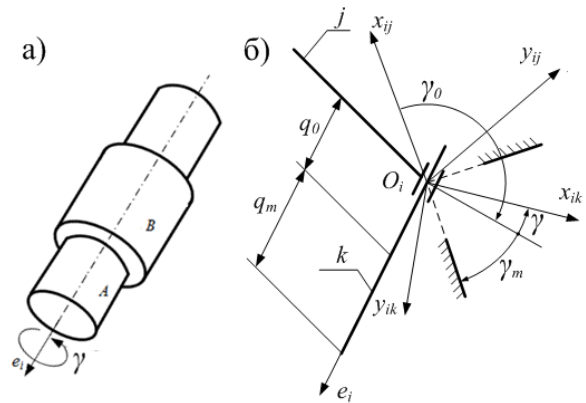


Figure 1 – Cylindrical kinematic pair

Presented kinematic pair allows simultaneous rotation around an axis with forward movement along the same axis, which is a permanent position in relation to adjacent links. The pair, therefore, allows two degrees of freedom.

Presented joint can be represented as a combination of two rotational and forward joints 5th class with zero length of intermediate link. Therefore, the description of this joint i with a number of links j, k as the structural parameters we choose three angles $\gamma_0, \gamma, \gamma_m$, describing the rotational part of the joint, and the deviations q_0, q_m , reflecting the forward movement.

The joint of hinge Hooke type. The most frequent use of this joint is in the prop shaft systems. However, this kinematic pair has two degree of mobility and can be described by presenting it as a combination of two rotary joints 5th class with zero length of intermediate link. This cross-link can be considered as a hard joint with its axis perpendicular to the axis of hinge rotation. In the description of Hook hinge type of joint, as constructive parameters we choose three angles $\gamma_{01}, \gamma_1, \gamma_{1m}$, similar to angles from 1.2, for connection of the first link with crosspiece; angle β between axes of the cross joint; three angles $\gamma_{02}, \gamma_2, \gamma_{2m}$, characterizing the transition from cross to the second link of joint. In such a way the Hook hinge will have a following description $S2G(i, j, k, \gamma_{01}, \gamma_1, \gamma_{1m}, \beta, \gamma_{02}, \gamma_2, \gamma_{2m})$.

Spherical joint of 3th class. It is known, that in the manipulators schemes kinematic pairs with one degree of mobility: rotational or forward, are usually used. Despite this condition, some kinematic connections can be replaced by equivalent kinematic pairs with several degrees of mobility.

An example of such connection is the spherical kinematic pair of 3rd class (Fig. 2).

Relative motion of links connected by spherical joint is possible around three arbitrary axes passing through the center of the sphere, and the number of degrees of freedom equal to three.

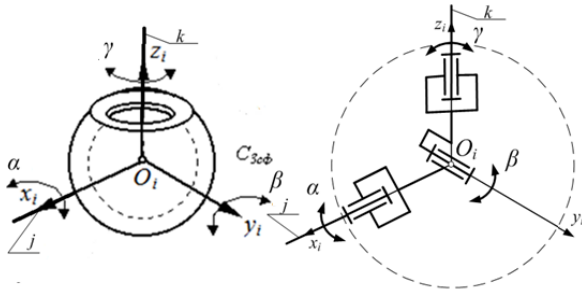


Figure 2 – Replacement of the kinematic pair by equivalent kinematic connection

Formalized description of this joint is $S3S(i, j, k, \alpha_0, \alpha, \alpha_m, \beta_0, \beta, \beta_m, \gamma_0, \gamma, \gamma_m)$.

Conclusion

Thus, described and supplemented in this paper way of formalized description of kinematic chains, intended to describe the manipulation mechanisms, makes it possible to describe any

mechanism (not only a manipulator), containing elements of kinematic chain, which are described in this paper. The main feature of this method is also the universality that allows to create software for solutions of direct and inverse tasks of kinematics.

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A DATABASE FOR THE SYSTEM OF AUTOMATIC GENERATION OF TESTS FOR MULTIPLE CHOICE OF THE SECTION " RELATIONS NORMALIZATION "

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Introduction

Switching to the advanced technologies requires a constant monitoring of knowledge and skills to solve the students' problems. Different tests are used for these aims. Experience shows that this can be done successfully only having mastered the advanced techniques and technologies to create tests. The main one is the multiple choice method. The knowledge control systems almost of all disciplines are created on the basis of these methods. Despite the universal character of testing for specific objects of study the approaches of the generation of arbitrary number of tests (to this extent there is the system universality) are original.

Specificity of the problem

A student's assessing is one of the main difficulties in the teachers' work. The multiple-choice tests are used to facilitate this problem. The drafters of written examinations should have a clear-cut idea about this method of testing to assess students' knowledge with a greater degree of accuracy. To prepare students for the multiple-choice test several strategies can be used. The easiest way is the usage of materials of the previous exams. But the problem of strategy is that

the student is not always involved in the active work. The strategies that actively engage students in understanding the issue and getting an answer to it are the best approach to prepare them for the test.

The multiple-choice tests have a distinct advantage over any other forms of written examinations, e.g. essay questions or questions requiring short answers. Another advantage is the ability to provide meaningful knowledge. Thus, the essay-tests containing three questions or questions that require short answers containing five to seven questions can assess only a limited part of the textbook or lecture notes knowledge they have been developed for. The multiple-choice tests usually contain 30-40 questions and allow teachers to assess students easier in the more meaningful amount of terms. The advantage of less subjectivity and greater coverage of content areas means that the multiple-choice tests are more reliable indicators of students in comparison with the essay tests.

The proposal of the problem solution at university using this system

Multiple-choice tests are considered as a realization in this system. Reasons for this are the following:

1. The specificity of the relations normalization. The relations normalization is based on the removal or addition individual attributes to the relationship, or the selection of certain attributes to a single relationship. It's enough to indicate which attributes should be subjected to certain actions. There is no need in more complex types of tasks.

2. If a teacher uses (e.g. in the exam) several types of testing at the same time, a student needs a certain amount of time to reorient himself to understand the meaning of the task, what should be done, how to enter the correct answer to the test. In other words, too frequent changes of the tasks types will require additional time for their understanding, which takes away time from the actual performance of tasks.

3. The relative simplicity of automating of the verification process and the test results counting.

We obtain the best solution, taking into account all the features of this system, because its distinguishing feature from other test systems or students' knowledge testing is that the system creates automatically all assignments and tests eliminating the tasks repetitions and duplications in the possible extent. It increases the degree of objectivity when the teacher tests students' knowledge. The system also allows the teachers to facilitate their monotonous work of the inputting of all tasks to the system (as it is done in many knowledge test systems). The teacher enters only a small quantity of basic data and the system creates a wide variety of tasks based on the reference data. A large variety of tasks is created due to:

1. The number of initial normalized relations (which determines the amount of the generated non-normalized relations)

2. The removal or rearrangement within the individual attributes of the relations (creating secondary non-normalized relations)

3. The number of questions asked to the non-normalized relations (the same question can be given to several non-normalized relations, so it increases the number of the tasks in proportion to the number of questions)

4. The redistribution of certain tasks in the overall set of tasks per student during his/her testing.

The general scheme of the testing system based on the test generation

The main idea is that the non-normalized relationships are created by the combining normalized relations. Then the tests are created using the selection of question for a non-normalized relation and the tasks with varying difficulty of issues. This idea is represented in the diagram (Fig.1).

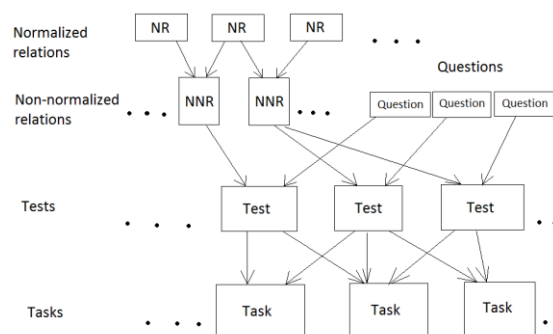


Fig. 6. The scheme of test generation based on the relations normalization

Generation of non-normalized relations

It is based on the normal forms definitions. We consider only three normal forms in this project.

Step 1: Creation of the non-normalized relations containing one violation of any normal form: the first, the second and the third.

The first normal form: the relations with the violation of this normal form are generated from two normalized relationships where one key of relation (a key consisting of only one attribute is considered here) is a subset of the second key relationship, while we take only key attributes from the second relation.

The second normal form: the relations with the violation of this normal form are generated from two normalized relationships, where the key of one relation is a subset of a key of the second relation, while we take all attributes from the second relationship, such as key and non-key attributes (only relations with the difference key attributes of 1 are considered here).

Third normal form: the relations with the violation of this normal form are generated from two normalized relationships, where the key of the first relation is non-key attribute of the second relationship.

Step 2: Creation of the non-normalized relations containing any two violations of normal forms.

Normalization is the most important theme in the process of development of the database. Going on the reverse is expected: from a given set of de normalization of the normalized relations.

The generation of tasks

The tasks are generated according to the questions types included in the tests. The assignments must be generated so that the various tasks contain the same number of tests of varying complexity, in this case, the number of tests containing a question of the same type.

The generation of variants

The system assumes that the teacher who needs to generate the tests for students initially chooses the topics of questions for the current control. Then the system retrieves the questions from the database according to the topics and forms the test tasks for each variant. In the future, the system is supposed to generate such variants for testing that each of them will be unique, and

each generated variant will be similar to others on the questions complexity that will allow a more objective assessment of the students' knowledge level.

Conclusion

In general, the multiple-choice tests allow the examinee to choose several answers. But more commonly, the student is asked to choose only one (the best or correct) answer. In this case the right way to call these tests is "the tests with the alternative choice". The multiple-choice tests suggest an easier, quantitative and formalized processing. In contrast to the multiple-choice tests "the tests with a free answer" don't have an one-valued key (such as a number, a word or a set of the letters) and therefore they require the primary and quantitative processing (coding, categorizing) of the answers. The multiple-choice tests are multipurpose for the knowledge verifying in the

various fields. The tests generation is rational, because the problems of their variations and protection from the results of previous tests usage ("cheating") are solved. You can also try yourself a lot of variants of one test.

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CRM – SYSTEM FOR ESTATE AGENCY

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The abbreviation of CRM (Customer Relations Management) is now on everyone's lips. When it comes to business automation, CRM is the first thing that comes to mind. We believe, there is a strong reason for that, in the highly viable environment and when fighting for the client, the main competitive advantage is not even the product or services and their prices (rivals may have the same product by the same price) but a well-organized system of relationships with customers. Quality CRM-system is the key element when there is a need to automate the company's sales activities and improve efficiency of staff and win customers' loyalty.

When choosing the matching CRM-system, companies can come across considerable complicity. First, the majority of CRM-systems were developed in and for western countries and they focus primarily on the Western model of business in general, and, in particular, sales. Therefore, these CRM-systems cannot be always successfully integrated into Russian reality. Some of CRM-system elements in this case are being used in different way, and some elements cannot be accommodated to the local market at all. Specialized Russian CRM-systems include loads of functions that are not needed by the majority of enterprises (except, perhaps, those companies that are focused on bulk sales). Another aspect is the high price that companies have to pay for such

CRM- software itself, and also for its integration with other systems such as document flow systems and bookkeeping, to create a sole automated enterprise management system.

The specificity of the real estate agency staff includes processing vast amounts of information. The number of estate agents is growing every day. In the chart below the dynamics of labor productivity in the field of real estate transactions is shown.

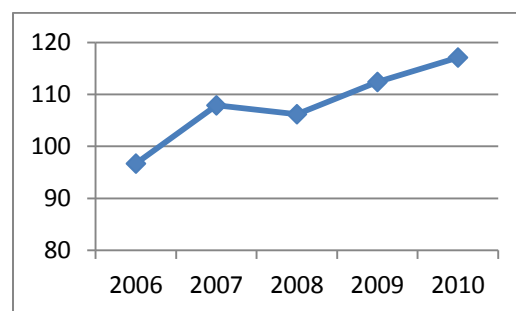


Table 1. The dynamics of productivity growth

Specification of companies working in the real estate market, does not allow to adjust to ready-made solutions. The general idea behind the project is to develop high-tech CRM-systems for real estate agencies and private real estate brokers. This solution will provide:

- ✓ Single information space for all employees engaged in sales process;
- ✓ Automation of interaction processes for both groups of agency's clients (actual and potential clients)
- ✓ Potential to track interactions with customers from the very first contact to the signing of contract stage, and after-sales services;
- ✓ Tracking and monitoring all the stages of transactions;
- ✓ Maintaining multi-level directory of real estate subject to status and the sale of their belonging to investors;
- ✓ Reducing time spending by 75% during the composition of real estate directory;
- ✓ Control and substitution of sales managers;
- ✓ Analysis of agency's activity on different levels, including analysis of managers' performance;
- ✓ Staff motivation based on planned and actual sales figures;
- ✓ Information Support of marketing campaigns in order to increase customer loyalty;
- ✓ Saving sales employees time by 35% when executing paperwork due to automatic generation of standard contracts by filling in templates with data from the database

All these aspects contribute to improving the quality of the staff performance, as well as computerize most of routine processes of Russian real estate agents.

Cloud Computing is the core technology behind this software solution, that is becoming more and more popular nowadays, especially in the western countries. Until recently, Russian companies were not ready to keep all the data and operations on remote servers. However, cloud computing is gradually gaining popularity in Russia, and winning confidence and trust from large organisations. Using a client - server technology makes it easier to accelerate the shell program and data processing.

The main advantage of this system is a built-in call-center, that can be easily integrated into any office ATC. Taking a phone call, a real estate agency employer easily adds new data about the client by creating a new client profile. Later, when getting an incoming call, the software will refer this call to a specific employer that is responsible for that particular client.

In order to computerize routine business processes, we are planning to develop effective-friendly tools. They are:

1. Database filter which helps to accelerate the process of finding and selecting information on proposals. There will be a system option in the database that will automatically generate proposals that respond to current parameters.

2. Project management module allows to recognize each customer as a separate project, and it sets short-term goals and tasks. The system also has built-in reminders and calls recording through PBX integration.
3. By storing the clients' history in the database, users can easily trace the change of price for a particular property, or the history of clients transactions.
4. For the head of the company a specific advantage of this software is the system of automatic report generation that helps a manager to see how many calls each employee has made, and how many successful transactions he/she has completed. This information allows to analyze the situation in the organization quickly and assess the performance of each employee, and his contribution to the overall development of the company. This tool not only facilitates the assessment process for a manager, but it also stimulates employee's motivation.
5. There are many sources of information that keep offers on real estate transactions. For a real estate employer it is almost impossible to process the whole amount of this information. Designated companies provide access to a database with all processed information and the status of real estate ads. The Realty+ system will help to integrate external databases and perform searching through them at the same time.

The information system instruments described in this article are the basic components of this unique product.

The key to success consists of five parts:

- Cloud computing
- Accounts
- Dynamic data updates
- Data encryption
- User-friendly interface

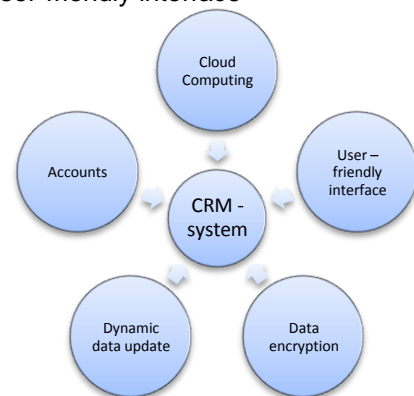


Figure 1. Five peaks of success

The integration of these components will create a unique product that will meet the needs of the Russian real estate agencies and increase productivity by several times.

The need for this kind of program in the Russian market is growing every day, and the need is not met. Development of this product is not only a potentially successful commercial project, but it also a way to improve the quality of the services of estate agents.

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AUTOMATED CONTROL SYSTEMS BASED ON FUZZY LOGIC AS SOLUTION TO VARIOUS ENGINEERING PROBLEMS

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Fuzzy logic is a form of many-valued logic. It deals with reasoning that is approximate rather than fixed and exact. In contrast with traditional logic theory, where binary sets have two-valued logic: true or false, fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false.

The reasoning in fuzzy logic is similar to human reasoning and this often mimics real life. It allows for approximate values and inferences as well as incomplete or ambiguous data (fuzzy data) as opposed to only relying on crisp data that is binary yes or no choices. Fuzzy logic is able to process incomplete data and provide approximate solutions to problems other methods find difficult to solve.

From the mathematical logic it is known that any logic function can be represented by a disjunctive or conjunctive normal form, which implies that the implementation of the propositional calculus is sufficient only three operations: conjunction (&&), disjunction (| |) and negation (!). In classical logic, each of these operations is given in truth table.

Table 1. Truth table for main logic operation

| A | B | A B | A && B | !A |
|---|---|---------|--------|----|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 1 |

In fuzzy logic instead of the values true and false is used the value of the degree of truth, which takes any value from an infinite set from 0 to 1 inclusive. Degrees of truth are often confused with probabilities. However, they are conceptually distinct; fuzzy truth represents membership in vaguely defined sets, not the likelihood of some event or condition.

Therefore logical operations cannot provide in tabular form in fuzzy logic, they are given function. There are maximal (1) and colorimetric (2) methods and for conjunction and disjunction.

$$a | | b \Rightarrow \max(a, b) \quad (1.1)$$

$$a \&\& b \Rightarrow \min(a, b) \quad (1.2)$$

$$a | | b \Rightarrow a + b - a * b \quad (2.1)$$

$$a \&\& b \Rightarrow a * b \quad (2.2)$$

And there is the one method for negation (3).

$$!a \Rightarrow 1 - a \quad (3)$$

While fuzzy logic uses approximate human reasoning in knowledge-based systems, the neural networks aim at pattern recognition, optimization and decision making. A combination of these two technological innovations delivers the best results. This allows combining advantages of both fields whereas neural networks are good at recognizing patterns, they are not good at explaining how they reach their decisions. Fuzzy logic systems handling imprecise information are good at explaining their decisions but they cannot automatically acquire the rules they use to make those decisions. This has led to a new science called neuro-fuzzy logic in which the explicit knowledge representation of fuzzy logic is augmented by the learning power of simulated neural networks.

There are two possible models of fuzzy neural systems.

- In response to linguistic statements, the fuzzy interface block provides an input vector to a multi-layer neural network. The neural network can be adapted (trained) to yield desired command outputs or decisions.

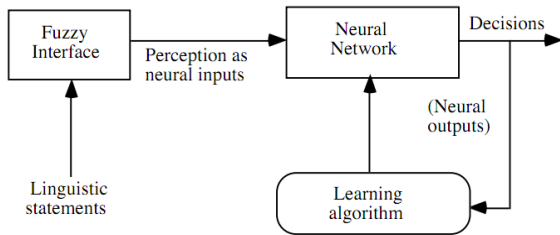


Fig. 1. The first model of fuzzy neural system

- A multi-layered neural network drives the fuzzy inference mechanism. Neural networks are used to tune membership functions of fuzzy systems that are employed as decision-making systems for controlling equipment. Neural network learning techniques can automate this process and substantially reduce development time and cost while improving performance.

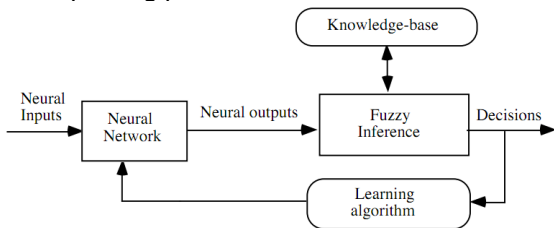


Fig. 2. The second model of fuzzy neural system

The list of fuzzy-logic systems advantages in comparison with the classical system:

- Ability to operate with input data values that cannot be found;
- Possibility of formalizing fuzzy evaluation criteria and comparison;
- Opportunity to rapid modeling of complex dynamical systems and their comparative analysis with a given degree of accuracy, so it can evaluate the different output values.

One of the most widely used applications of fuzzy logic system is a control system. These systems use fuzzy logic thermostats to control the heating and cooling, this saves energy by making the system more efficient. However, almost any control system can be replaced with a fuzzy logic based control system. This may be overkill in many places; however, it simplifies the design of many more complicated cases. So fuzzy logic is not the answer to everything, it must be used when appropriate to provide better control. If a simple closed loop or PID controller works fine then there is no need for a fuzzy controller. There are a lot of cases when tuning a PID controller or designing a control system for a complicated system is

overwhelming, this is where fuzzy logic gets its chance to shine.

Classical example in this field is that of the Sendai Subway system in Sendai, Japan. This control of the Nanboku line, developed by Hitachi, used a fuzzy controller to run the train all day long. This made the line one of the smoothest running subway systems in the world and increased efficiency as well as stopping time. This is also an example of the earlier acceptance of fuzzy logic in the east since the subway went into operation in 1988. Another fuzzy logic application is a sophisticated system of the UK National Health Service, which allows assessing and optimizing the costs of social spending.

Other bright example is the MASSIVE 3D animation system for generating crowds, uses artificial intelligence based on fuzzy logic. This program was used in making of The Lord of the Rings trilogy as well as The Lion, The Witch and the Wardrobe films.

While simulating these crowds, observed human behavior interaction is taken into account, to replicate the collective behavior. Simulating crowds offer the advantages of being cost-effective as well as allow for total control of each simulated character. The characters are attached to point particles, which are then animated by simulating wind, gravity, attractions, and collisions. Animators typically create a library of motions, either for the entire character or for individual body parts. Alternatively, the motions can be generated procedurally that is automatically by software where artificial intelligence for agents which guides the entities based on one or more functions, such as sight, hearing, basic emotion, energy level, aggressiveness level, etc. The entities are given goals and then interact with each other as members of a real crowd would. They are often programmed to respond to changes in environment, enabling them to climb hills, jump over holes, scale ladders, etc.

Let us take a look closely at the practical application of fuzzy-logic for solving the overcoming obstacles problem by robots. Consider the linguistic distance variable with values from zero to infinity. Values can be defined like far, mid and close. For the physical realization of a linguistic variable it is necessary to determine the precise the intervals of variable change.

The grade of membership is determined by the membership function $M(d)$ developed by expert for each situation. This function is shown in Figure 3, where d is distance from the obstacle.

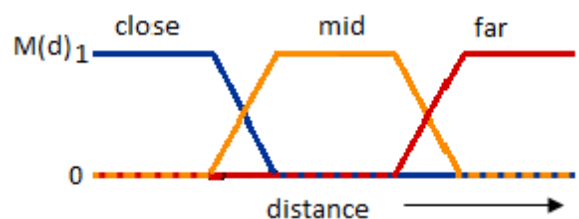


Fig. 3. Linguistic variable and membership function

Then table of rules are created for compliance with the direction and distance to the obstacle.

Table 2. Fuzzy rules for robot

| | | Distance | | |
|-----------|----------|---------------|-------|----------|
| | | close | mid | fur |
| Direction | Right | Sharply left | left | straight |
| | Straight | right | left | straight |
| | Left | Sharply right | right | straight |

Thus, the input data processing according to the rules table, and the result as a control signal supplied to the robot.

In general, we suppose that Fuzzy Logic will have a huge impact on techniques improving because this logic has a lot of usage options.

Nowadays there are widespread fuzzy logic applications, neural networks and genetic algorithms that are called 'soft computing'. The future of fuzzy logic is undetermined because there is no limit to where it can go. And today there are many studies in various engineering problems.

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PROCESSING AND INTERPRETATION OF THE DATA OBTAINED FROM HYDRODYNAMIC WELL TESTING

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To date, the problem of hydrodynamic well testing is being studied by oil industry scientists around the world and a large number of various monographs has been published.

Among the problems of well testing the following should be emphasized:

- Uncertainty in the quality evaluation of the pressure build-up curves (PBUCs) and possibilities to define reservoir parameters basing on them;
- Transfer of some PBUCs to the category of incompletely studied wells (not fully recovered PBUCs).

The primary goal of the current work is studying the PBUC data processing software: PanSystem software.

Topicality of the given work is reduced to creation of a software application that would validate PanSystem software and programming specific formulas required for hydrodynamic well test.

This work was carried out within one of the directions of activities of the "Virtual Oilfield" research and training center of the Institute of Cybernetics of TPU.

In particular, one of the primary goals of the "Virtual Oilfield" project is to support the planning process of geological and engineering operations.

Planning can be carried out with the help of well testing. For processing and interpretation of the data received after testing a well, the present research employs PanSystem software.

PanSystem™ is one of the leading industry software to interpret well testing data. Thanks to the hydrodynamic researches of wells in transient state we have a unique opportunity to obtain information about the properties of the reservoir around the wellbore.

PanSystem software requires the following data for analysis:

- Well parameters
- Reservoir parameters
- Fluid parameters

Measuring the performance of wells or the flow rate of the liquid obtained from the well is necessary to account the company's oil output. Well flow rate also characterizes the geological and technical condition of the producing reservoir and the wells, and therefore is a parameter, measurement of which is required during oil field development and well operation.

The formulae below are used to define the model parameters in PanSystem.

Well production rate is described by Darcy's law:

$$q_0 = \frac{K * h * (P_r - P_{wf})}{18.41 * \mu_0 * B_0 * [\ln \frac{r_e}{r_w} - 0.75 + S]}$$

Storage constant Cs:

$$C_s = \frac{q_s * B_0}{24 * \Delta P_{int}}$$

C_D, the dimensionless wellbore storage constant, is calculated as:

$$C_D = \frac{0.8936 * C_s}{\phi * C_t * h * r_w^2}$$

Radial permeability (k), is determined from a zero-slope line (tg = 0) by:

$$k = \frac{1412 * \mu_0 * B_0 * q_s}{h} \left(\frac{0.5}{\Delta p} \right)$$

The purpose of developing the "PS" software application was:

- Validation of PanSystem software;
- Construction of a diagnostic graph in bilogarithmical coordinates that can be used to determine the flow regime in the reservoir;
- Calculation of the investigation radius of the known data.

To verify PanSystem software in our own software application, we used the data in the form of an .xls file (Excel).

Figure 1 shows the change in pressure and flow rate before closing the well on the PBUC. The same data processed in PS are shown in Figure 2.

Processing of PBUC study was carried out using graph-analytical method. The main graph (Figure 3) for the analysis is a diagnostic graph in bilogarithmical coordinates. The graph represents a horizontal section corresponding to the transition of a well to radial flow regime.

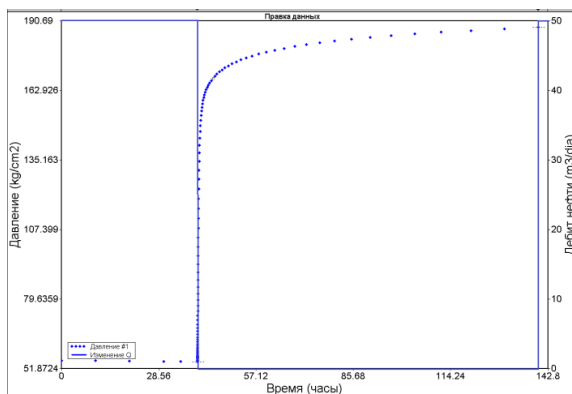


Fig. 6. Review of well performance study (PanSystem)

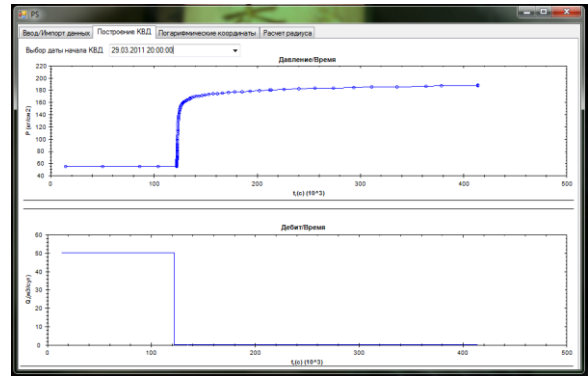


Fig. 7. Review of well performance study (PS)

Figure 4 shows the diagnostic graph of mathematical modeling of PBUC in bilogarithmical coordinates. The upper curve represents the the change of delta Pressure with the depth of the upper perforation holes and the logarithm of time, and the lower curve is the derivative of pressure.

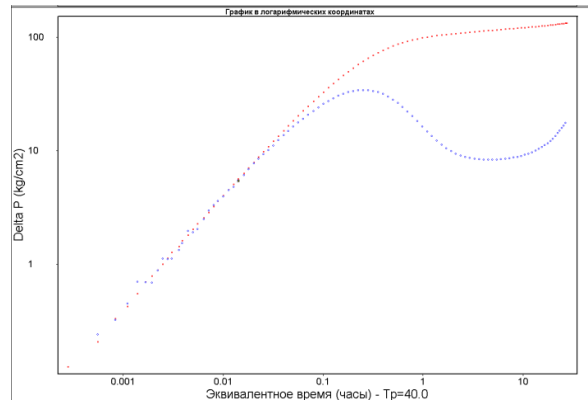


Fig. 8. PBUC diagnostic graph in bilogarithmical (PanSystem)

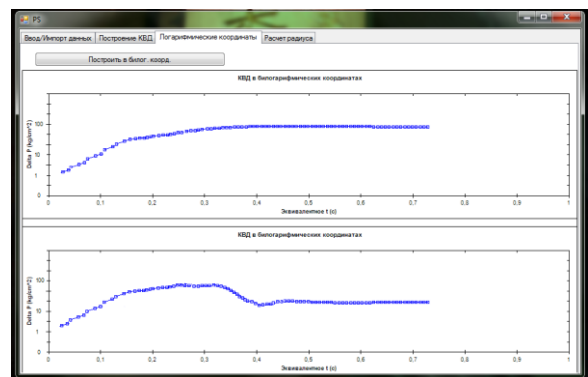


Fig. 9. PBUC diagnostic graph in bilogarithmical coordinates (PS)

According to the known data, for further research for a high permeability oil reservoir it is necessary to calculate the investigation radius (r_{inv} is the investigation radius, which determines the size of the area around the well that influences the results of well testing).

The classical definition of r_{inv} is given by:

$$r_{inv} = 0.037 \sqrt{\frac{k * t}{\phi * \mu * C_t}}$$

where:
 k – permeability (md) - (effective permeability of oil);
 t – time (hours);
 ϕ – porosity;
 μ – oil viscosity (cPs) - (in place);
 C_t – total compressibility of the system (cm³/kgs).

Figure 5 shows the interface for calculating the well investigation radius.

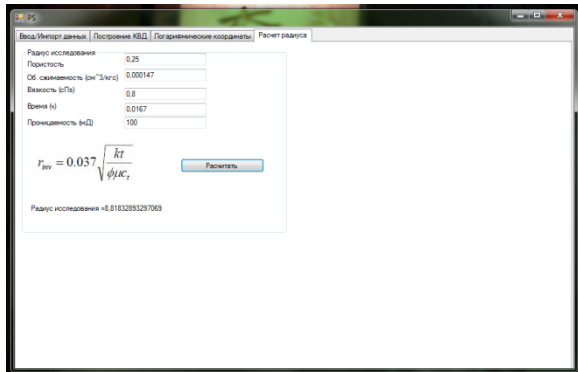


Fig. 10. Investigation radius calculation window

In the future we plan to develop a method for applying the model to the obtained diagnostic graphs for determination of reservoir parameters.

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| Section VIII | |
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**MODERN PHYSICAL METHODES
IN SCIENCE, ENGINEERING
AND MEDICINE**

CONTROLLING TEMPERATURE IN ALLOY HEATING

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Controlling temperature is a widespread technology that allows you to control automatically the heating process. This technology is mostly used in metallurgical sphere when it is necessary to heat alloy uniformly. In our work we consider the physical aspect of this process.

To determine the optimal parameters of the heating mode we will base on finite-element model and take system with an on-off controller. To make the model of this system in COMSOL Multiphysics and export it to Simulink is the most convenient way to make a solution of our problem clear and understandable.

First of all, we need to describe the system that we will use in our research. The main component of the model is a thermal controller that involves two distinct modeling situations:

- Taken as a whole, this dynamic system assumes only a small number of states, making it a good candidate for modeling and simulation with Simulink.
- One of the model's elements, the controller, contains a subsystem that involves heat distribution, which is described with a PDE, the heat equation. It is easy to break this portion of the problem down and model it in COMSOL Multiphysics.

The dynamic system consists of a metal block that exchanges heat with the environment. A heater and a thermostat switch are situated inside the glass-enclosed system. The system works as follows: The thermostat turns the heater on or off when the temperature becomes too low or too high.

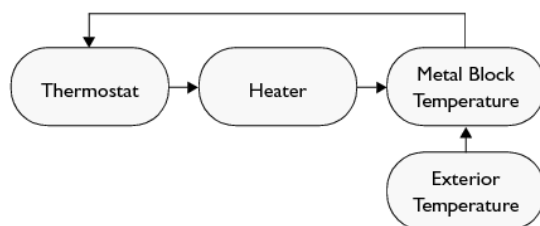


Fig.1 Scheme of dynamic system

To establish a state of metal block we need to use a finite-element mode that is a numerical technique for finding approximate solutions of partial differential equations (PDE) as well as integral equations. The solution approach is based either on eliminating the differential equation completely, or rendering the PDE into an approximating system of ordinary differential equations, which are then numerically integrated

using standard techniques such as Euler's method, Runge-Kutta, etc.

The finite-element model of the metal block requires two inputs:

- The state of the heater, which can be On (1) or Off (0)
- The exterior temperature, T_{out}

As its output, the model supplies the temperature at the thermostat's location.

The PDE describes the overall system's temperature distribution giving the temperature of the heater and the exterior environment. If the heat transfer is so fast that the heat distribution is more or less constant (in space, not in time), a single state is sufficient. Otherwise, controlling the temperature requires modeling a PDE in COMSOL Multiphysics and then including those results in the Simulink environment as illustrated here.

The heat equation is:

$$\rho C \frac{\partial T}{\partial t} - \nabla \cdot (k \nabla T) = Q$$

The boundary conditions come from the level of insulation around the system. On well-insulated sides the temperature flux is zero, which gives the

Neumann boundary condition $\mathbf{n} \cdot (k \nabla T) = 0$.

The poorly insulated sides involve the Neumann condition $\mathbf{n} \cdot (k \nabla T) = k_g / l_g \cdot (T_{out} - T)$,

where k_g and l_g are the thermal conductivity and the thickness of the glass sheet that separates the metal block and the exterior.

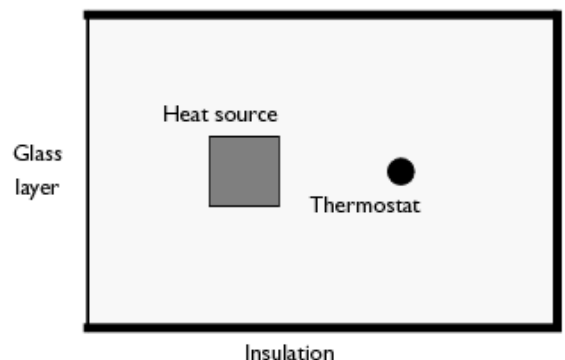


Fig. 2 Visualization of heating system

We use a 2D model because only the temperature distribution in the xy -plane is of interest.

This model is based on the SI system, but to represent the time scale of the problem more appropriately, the time is counted in minutes. This means that all quantities were scaled with units

that contain the basic unit of time by a factor 60 compared to their standard SI values. This model data in the following lists includes this conversion for the thermal conductivity k and the heat source Q .

The modeling in COMSOL Multiphysics takes place in two steps:

- Make the model of the steel plate for the Simulink export.
- Make the model of the on-off controller in Simulink.

On-off controller is the main mean of automation in our system. In control theory, an on-off controller, also known as a hysteresis controller, is a feedback controller that switches abruptly between two states. These controllers may be realized in terms of any element that provides hysteresis. They are often used to control a plant that accepts a binary input, for example a furnace that is either completely on or completely off. Most common residential thermostats are on-off controllers. Discrete form of the Heaviside step function is an example of an on-off control signal. Due to the discontinuous control signal, systems that include on-off controllers are variable structure systems, and on-off controllers are thus variable structure controllers.

To simulate the on-off controller the model uses Simulink. Simulink handles the nonlinear behavior of the on-off controller. The PDE model for the plate is linear; you can do the Simulink export using the linearized state-space form to improve performance. You can also use the mode reduction facility of the Simulink export to improve performance in Simulink, but it only works for linear or linearized PDE models.

The result of exporting a model from COMSOL Multiphysics to Simulink is a structure variable in the MATLAB workspace.

The following variables affect the temperature of the metal block:

- Exterior temperature, T_{out}
- The state of the heater, $HeatState$, which can have the values 1 or 0, corresponding to on or off

The output from the COMSOL Multiphysics model is the temperature in the block where the thermostat is located:

- Thermostat temperature, $Temp$

These varieties are necessary to control the heater.

Then we need to create a scheme in Simulink that is simulates processes which take place in the heater system.

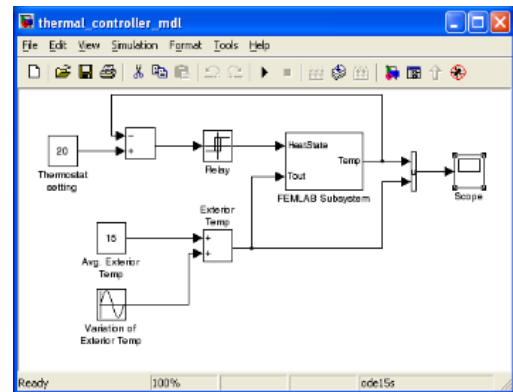


Fig.3 Scheme of heater system in Simulink

When all required parameters are installed we obtain graphics that show us the result of controlling temperature.

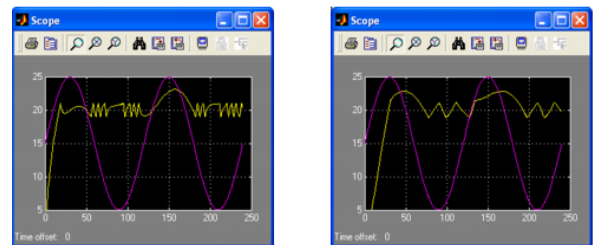


Fig.3 Graphics of temperature in metal block

It shows us that our model of controlling temperature is working correctly.

With the help of this model we can determine all required settings without experimenting on real models that can reduce factories' expenses.

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OBTAINING ANTIREFLECTION OPTICAL COATINGS BY USING DUAL MAGNETRON SPUTTERING SYSTEM

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Keywords: antireflection coatings, magnetron sputtering system, features.

At present obtaining thin films is an important part in various fields of research. Using of coatings makes it possible to combine properties of two or more materials (substrate and coating), resulting in a new system which has characteristics that can not be obtained using a single material. It helps to change physical and chemical properties of samples without changing their structure, but only by changing the surface layer [1].

One of the main types of coatings are optical antireflection coatings, whose purpose is to reduce the loss of intensity of the transmitted light.

Passage of light through each refracting surface, such as a glass-air boundary, is followed by reflection of about 4% of the incident flux [2]. To correct these disadvantages illumination optics is used, that is, the creation of surface coatings on optical parts, which is one of the simplest and the most common applications of light interference.

The phenomenon of interference is used to improve the quality of devices based on optical devices, and receive highly reflective coatings [3]. The principle of creation and effect of the antireflection coating is shown in Fig. 1.

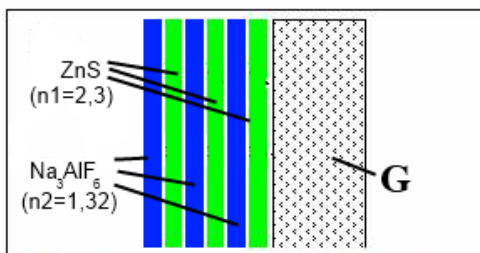


Figure 1. Principle of creation of the antireflection coating.

The substance is chosen so that the refractive indices $n_{\text{layer-air}}$ ($n_{\text{air}}/n_{\text{layer}}$) and $n_{\text{layer-glass}}$ ($n_{\text{layer}}/n_{\text{glass}}$) should be similar in a determined region of the spectrum. Then, the same proportion of the incident radiation is reflected from each of the boundaries 1 and 2. Layer thickness is chosen so that the phases of reflected waves from both sides, had a path difference $\Delta = \lambda_m/2$, where λ_m -average wavelength for this region of the spectrum. These waves are in antiphase and cancel each other in the process of interference. Thus surface will be "enlightened." It is completely devoid of reflectivity, and the whole power of the incident radiation will penetrate the glass [3].

Methods of producing coatings are classified on the basis of the physical essence of the processes underlying them. Methods of producing coatings are classified on the basis of the physical nature of the processes underlying them. By the nature of the formation coating by thermal evaporation and coating by ion sputtering are identified[4].

The method of generation the flow of deposited material by thermal evaporation (fig. 2) consists in heating the starting materials using an energy source to the evaporation temperature.

Evaporation of the substance occurs, when the average vibrational temperature of its particles increases so that it becomes higher than the binding energy with other particles, and they leave the surface.

Ion sputtering (fig. 3) - is a process of momentum transfer, in which the fast particle, such as argon ion Ar^+ knocks atom of the target from the cathode surface. The sputtering target material of argon ion transmits a pulse energy to the atom, which can give momentum to other atoms, causing a cascade of collisions.

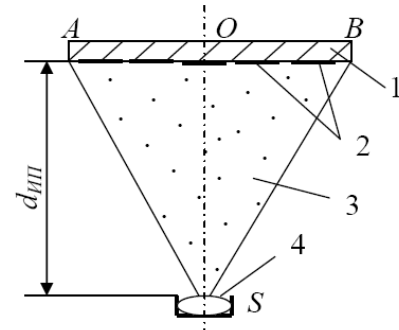


Figure2. Thermal evaporation.

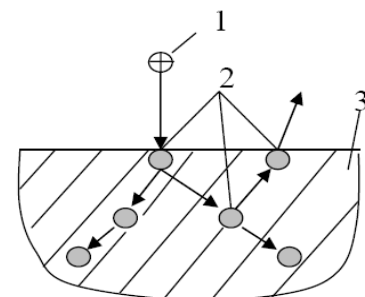


Figure 3. Ion sputtering.

One of the examples of realization of ion sputtering is magnetron sputtering system.

Magnetron sputtering systems are diode sputtering systems, in which the spraying of

material is due to the bombardment of the target surface atoms of the working gas.

Advantages of magnetron deposition in comparison with other types of obtaining films:

1. high deposition rate;
2. good adhesion;
3. excellent surface quality;
4. the possibility of deposition of any material [5].

To work in the field of thin-film technologies, it is necessary to obtain films with exactly known values of thickness.

There is a wide range of methods for control deposition of thin films: spectroscopy, ellipsometry, the diffraction of slow and fast electrons, X-ray photoelectron spectroscopy, atomic force microscopy and others.

Experiment on application antireflection coating of aluminum on a glass substrate was carried out on an installation of vacuum ion-plasma magnetron sputtering with photometric attachment.

The film thickness obtained during a single pass, is calculated as follows. In a sample of glass Al, deposited while recording the value of the photometric boxes after every two passes. photometric console works by reflected signal, where the peaks are calculated by formula 1, and the minima according to formula 2 [6].

$$n_p \cdot d = \frac{(2 \cdot m + 1) \cdot \lambda}{4} \quad (1)$$

$$n_p \cdot d = \frac{2 \cdot m \cdot \lambda}{4} \quad (2)$$

The main deposition occurs in cycles, or passages. One pass corresponds to the motion moved stage with a sample from one end point in the opposite direction. On the central position of the table sputtering of material occurs, and the extreme points of the sample hide protective screens.

The experimental results are shown in Figures 2, 3.

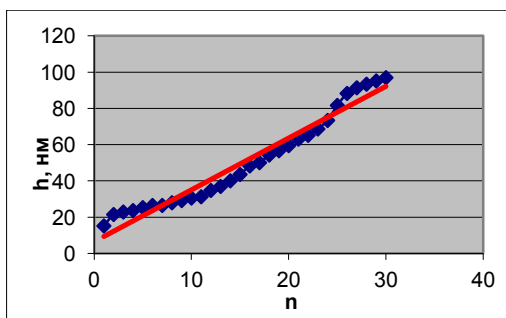


Figure 2. Uniformity of coating aluminum film between passes of photometer.

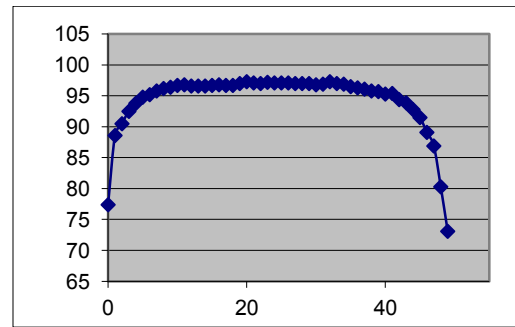


Figure 3. Uniformity of the coating over the entire length of the substrate.

Error in the uniform application of aluminum film on a glass substrate passes between the photometer is 30%.

If we consider the deposition of material along the entire length of the substrate, it is possible to observe the following phenomenon: the edge of the glass plate film thickness is less than in the center of the substrate. This is due to the fact that in the middle of the plate the material is deposited from two magnetrons, and on the edges the particles come from only one close magnetron. Film of uniform thickness is obtained in the range of 8 to 40 cm, which corresponds exactly to the distance between the magnetrons.

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PERFORATING WELLS

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Analysis of fluid flow into wells is very important to manage groundwater and oil resources, excavating subsurface structures, and cleaning up pollution. The perforating method has been successfully and widely used in most producing areas. But to make this method more effective and money and resources saving we need to apply Physics and Mathematics modeling before using it on real objects.

Analysis of fluid flow into wells often begins with the assumption that the intake fluid is uniform along the entire length of wellbore. This assumption runs into trouble when applied to the modeling of perforated wells. When these wells are emplaced, the deep bore hole is lined by impermeable materials. Then a machine pierces the lining so the well takes in fluids in the productive reservoir zones and nowhere else. The perforations are relatively small, typically less than 0.5 m long and with a diameter of less than 5 cm. They are typically oriented at regular intervals cycling down the casing axis.

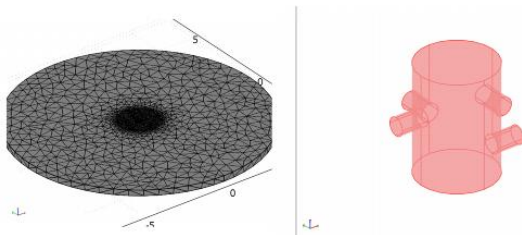


Fig.1 Meshed model geometry

This model characterizes 3D flow to a perforated well using the Darcy's Law application mode. Darcy's Law is a phenomenologically derived constitutive equation that describes the flow of a fluid through a porous medium. Darcy's law is a simple mathematical statement which neatly summarizes several familiar properties that groundwater flowing in aquifers exhibits, including:

- if there is no pressure gradient over a distance, no flow occurs (these are hydrostatic conditions);
- if there is a pressure gradient, flow will occur from high pressure towards low pressure (opposite the direction of increasing gradient - hence the negative sign in Darcy's law);
- the greater the pressure gradient (through the same formation material), the greater the discharge rate;
- the discharge rate of fluid will often be different — through different formation materials (or even through the same material, in a different direction)

— even if the same pressure gradient exists in both cases.

In this model, a well sits at the center of a thin (roughly 0.25 m), horizontal production reservoir that is confined above and below by impermeable units (Fig.1). For simplicity, the producing zone is homogeneous and isotropic with respect to permeability and porosity, and the oil has constant density and viscosity. The geometry is a reach of reservoir with a radius of approximately 6 m, which by design is 60 times greater than the well radius of 0.1 m. The model assumes that the oil moving into the well comes uniformly from the reservoir circumference, and the pressure is known at all perforations. Pumping proceeds initially at a given rate. The withdrawals come strictly through the perforations. This example contains an analysis of a steady flow field.

Darcy's law defines the velocity in the continuity equation that governs this problem. For a dependent variable of pressure, the governing equation reads

$$\nabla \cdot \left[-\frac{k}{\eta} (\nabla p + \rho_f g \nabla D) \right] = Q_s$$

where κ is permeability (m^2); η represents dynamic viscosity ($\text{kg}/(\text{m}\cdot\text{s})$); ρ_f is the fluid density (kg/m^3); g equals the acceleration of gravity (m/s^2); D denotes the coordinate for vertical elevation (m); and Q_s is the volumetric flow rate per unit volume of reservoir for a fluid source (1/s).

At steady state, the flux through the circumference of the reservoir must satisfy the withdrawal at the well. Described by Darcy's law, the flux is

$$-\frac{k}{\eta} \nabla p = \frac{W}{2\pi r_{res} b}$$

where W is the volumetric pumping rate (m^3/s); r_{res} gives the reservoir radius (m); and b is the length of the well interval (m) that takes in fluids (known as the *production interval*). The gravitational pressure drop term $\rho_f g \nabla D$ is tangential to the boundary and thus does not contribute to the flux through the reservoir's circumference. Because all other boundaries are impermeable to flow, the boundary conditions are

$$\mathbf{n} \cdot \frac{k}{\eta} \nabla p = -\frac{W}{2\pi r_{res} b} \quad \partial\Omega_{r_{res}}$$

$$p = p_{well} \quad \partial\Omega_{\text{perforation}}$$

$$\mathbf{n} \cdot \frac{k}{\eta} (\nabla p + \rho_f g \nabla D) = 0 \quad \partial\Omega_{\text{casing}}$$

$$\mathbf{n} \cdot \frac{k}{\eta} (\nabla p + \rho_f g \nabla D) = 0 \quad \partial\Omega_{\text{confining layer}}$$

where \mathbf{n} is the unit vector normal to the boundary.

In this model we calculate the flux through the perforations using boundary integration-coupling variables.

Integration coupling variables give the value of an integral over a boundary, a subdomain, or a point (the source domain); they also transmit the information from one domain to, for example, other boundaries, subdomains, and points (the destination domain). You calculate the total flux through all of the perforation boundaries as

$$flux = \sum \int_{\partial\Omega} \left| \mathbf{n} \cdot \frac{k}{\eta} \nabla p \right| dS$$

where $\partial\Omega$ represents the boundary. This equation takes the absolute value because the flux is everywhere an outflow, but the standards to the perforations do not all point in the same direction.

For modeling optimal way of perforating wells we use COMSOL Multiphysics software. After modeling we got results that shown in Fig.2 – Fig.4.

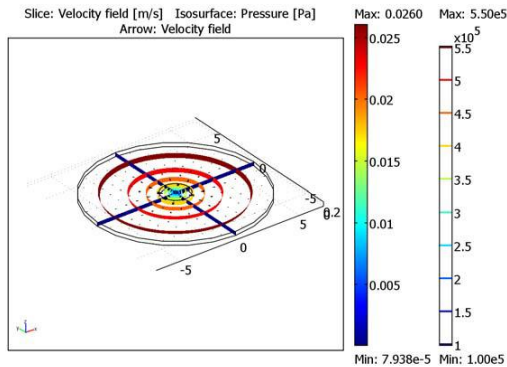


Fig.2 Solution centered at the origin

Fig.2 shows the solution for oil flow to a well centered at the origin. From this view, the pressure distribution and velocity field appear uniform. The velocity is almost constant in the far field.

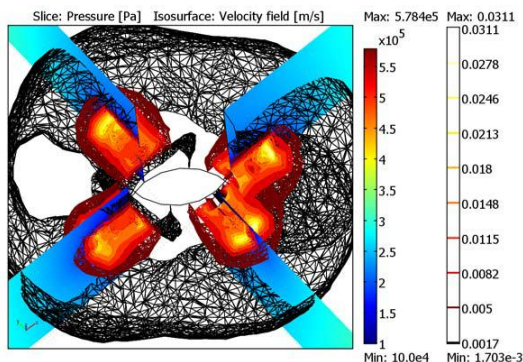


Fig.3 The close-up view of the velocity field

Fig.3 gives a close-up view of the velocity field and pressure distribution immediately around the perforations in the well. The velocity results in Fig.3 are clearly nonuniform. The flow funnels to the perforations produce an antisymmetric swirl over the length of the wellbore. Comparing the pressure estimates in Fig.3 with those in Fig.2 indicates that the nonuniformity produced by the perforations covers a relatively small section of the flow field.

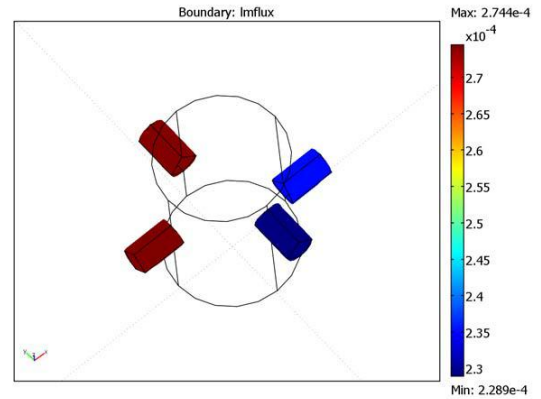


Fig.4 Estimates of fluid flux to perforations in a wellbore

Fig.4 depicts the flux to individual perforations. With this geometry and orientation, a given perforation withdraws anywhere from 22% to 28% of the total pumping. The perforations closest to the impermeable confining units withdraw significantly less fluid from the reservoir than those near the horizontal center line of the producing layer. This leads to the economically significant conclusion that changes in the orientation change the producing capability of a perforation by 6%.

This results show that our model of perforating wells is satisfy the requirements. According to specific needs of concrete situation we can just change simulation parameters and get calculation for that case.

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GEOGRAPHIC INFORMATION SYSTEMS (GIS)

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1. INTRODUCTION

GIS is one of many information technologies that have transformed the ways geographers conduct research and contribute to society. In the past two decades, these information technologies have had tremendous effects on research techniques specific to geography, as well as on the general ways in which scientists and scholars communicate and collaborate.

In geography, many innovations in the application of information technologies began in the late 1950s, 1960s and early 1970s. Methods of sophisticated mathematical and statistical modeling were developed and the first remote sensing data became available. Researchers began also to envision the development of geographic information systems. The mid-1970s to early 1990s was a period of contagion. The first commercially available software for GIS became available in the late 1970s and spurred many experiments, as did the development of the first microcomputers in the early 1980s. This was an exciting time in which the development of powerful software coupled with the availability of inexpensive computers permitted many researchers to test new ideas and applications for the first time. In the early 1990s, or perhaps just a bit earlier, many innovations entered the coordination phase even as other experimentation continued at a fast pace. The strengths and weaknesses of many information technologies were by then apparent, and researchers began to work together to cultivate the most promising applications on a large scale. Arguably, the complete integration of information technologies in geography has yet to be achieved except perhaps in a few relatively specialized research areas. Complete integration across the discipline may, in fact, be many years away.

2. GIS AS AN INTEGRATING TECHNOLOGY

In the context of these innovations, geographic information systems have served an important role as an integrating technology. Rather than being completely new, GIS have evolved by linking a number of discrete technologies into a whole that is greater than the sum of its parts. GIS have emerged as very powerful technologies because they allow geographers to integrate their data and methods in ways that support traditional forms of geographical analysis, such as map overlay analysis as well as new types of analysis and modeling that are beyond the capability of manual methods. With GIS it is possible to map, model, query, and analyze large quantities of data all held together within a single database.

The importance of GIS as an integrating technology is also evident in its pedigree. The development of GIS has relied on innovations made in many different disciplines: Geography, Cartography, Photogrammetry, Remote Sensing, Surveying, Geodesy, Civil Engineering, Statistics, Computer Science, Operations Research, Artificial Intelligence, Demography, and many other branches of the social sciences, natural sciences, and engineering have all contributed. Indeed, some of the most interesting applications of GIS technology discussed below draw upon this interdisciplinary character and heritage.

3. GIS: A GENERIC DEFINITION

GIS is a special-purpose digital database in which a common spatial coordinate system is the primary means of reference. Comprehensive GIS require a means of:

1. Data input, from maps, aerial photos, satellites, surveys, and other sources
2. Data storage, retrieval, and query
3. Data transformation, analysis, and modeling, including spatial statistics
4. Data reporting, such as maps, reports, and plans

4. THE GIS VIEW OF THE WORLD

GIS provide powerful tools for addressing geographical and environmental issues. Consider the schematic diagram below (Fig 1). Imagine that the GIS allows us to arrange information about a given region or city as a set of maps with each map displaying information about one characteristic of the region. In the case below, a set of maps that will be helpful for urban transportation planning have been gathered. Each of these separate thematic maps is referred to as a layer, coverage, or level. And each layer has been carefully overlaid on the others so that every location is precisely matched to its corresponding locations on all the other maps. The bottom layer of this diagram is the most important, for it represents the grid of a locational reference system (such as latitude and longitude) to which all the maps have been precisely registered.

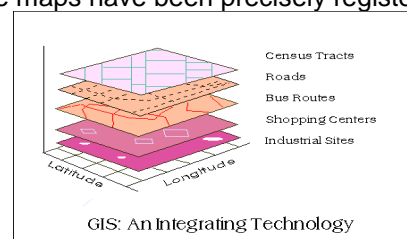


Fig 1. Layer location

Once these maps have been registered carefully within a common locational reference system, information displayed on the different layers can be compared and analyzed in combination. Transit routes can be compared to the location of shopping malls, population density to centers of employment. In addition, single locations or areas can be separated from surrounding locations, as in the diagram below (Fig 2), by simply cutting all the layers of the desired location from the larger map. Whether for one location or the entire region, GIS offers a means of searching for spatial patterns and processes.

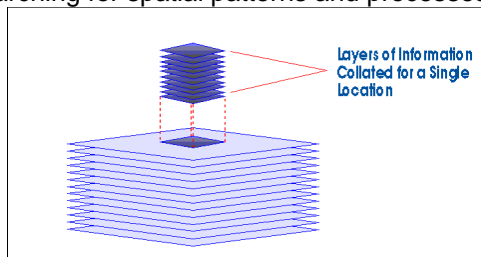


Fig 2. Layers of Information

Not all analyses will require using all of the map layers simultaneously. In some cases, a researcher will use information selectively to consider relationships between specific layers. Furthermore, information from two or more layers might be combined and then transformed into a new layer for use in subsequent analyses. This process of combining and transforming information from different layers is sometimes called map "algebra" insofar as it involves adding and subtracting information. If, for example, we wanted to consider the effects of widening a road, we could begin with the road layer, widen a road to its new width to produce a new map, and overlay this new map on layers representing land use.

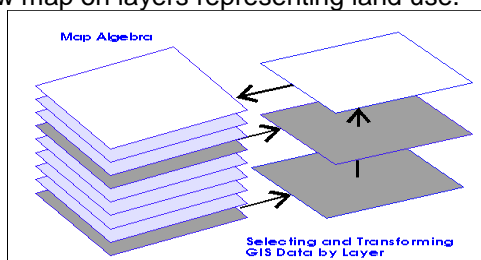


Fig 3. Selecting and Transforming GIS Data by Layer

5. APPLICATION AREAS

GIS are now used extensively in government, business, and research for a wide range of applications including environmental resource analysis, land use planning, locational analysis, tax appraisal, utility and infrastructure planning, real estate analysis, marketing and demographic analysis, habitat studies, and archaeological analysis.

One of the first major areas of application was in **natural resources management**, including management of: wildlife habitat, wild and scenic rivers, recreation resources, floodplains, wetlands, agricultural lands, aquifers, forests.

One of the largest areas of application has been in **facilities management**. Uses for GIS in this area have included: locating underground pipes and cables, balancing loads in electrical networks, planning facility maintenance, tracking energy use.

Local, state, and federal governments have found GIS particularly useful in **land management**. GIS has been commonly applied in areas like: zoning and subdivision planning, land acquisition, environmental impact policy, water quality management, maintenance of ownership.

More recent and innovative uses of GIS have used information based on **street-networks**. GIS has been found to be particularly useful in: address matching, location analysis or site selection, development of evacuation plans.

6. CONCLUSION

These days, dozens of software systems offer GIS decision-making capabilities. The range and number available sometimes make it difficult to discern the differences among systems and the strengths and limitations of each. The important point to remember is that there are as many different types of GIS software systems as there are decision-making processes. Particular GIS software systems are often specialized to fit certain types of decision making. That is, they are customized to meet needs specific to demographic forecasting, transportation planning, environmental resource analysis, urban planning, and so on. These systems may respond well to individual problems, but they are also limiting. Yet quite apart from these more general systems, there are dozens of very specialized software systems that are best suited to one task, one application, or even to just one part of a broader decision-making process.

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RESEARCH INTO ATMOSPHERIC DEPOSITION OF HEAVY METALS AND OTHER ELEMENTS IN OPERATING ZONE OF CHP APPLYING MOSS AS BIOINDICATOR

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1. INTRODUCTION

Environmental pollution causes significant harm to humans and all ecosystems as a whole, which are the main pollutants and heavy metals. Over the past decade, human activities have led to a change in the global biogeochemical cycle of heavy metals. This is why the study of air pollution is a pressing problem.

World can't exist without energy. And there are various ways to obtain it. TPP (thermal power plant) is one of those ways. To get energy fairly inexpensive coal and fuel oil are used. Fuel combustion at TPPs is connected with production of combustion residue containing ash dust, particles of unburned powdered fuel, sulphur dioxide and sulphur trioxide, nitrogen oxide and gaseous products of incomplete combustion. Residual fuel oil combustion is connected with production of vanadium compounds, sodium salt, coke and soot flake. Ashes of some fuels consist of arsenic, free silicon dioxide, free calcium oxide and et al. For these reasons, regular monitoring of the atmospheric deposition in the operating zone of the TPP is necessary.

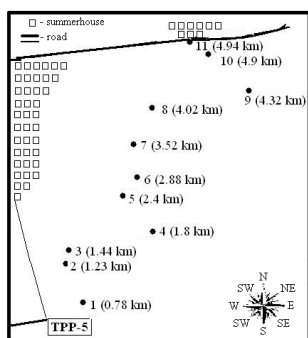


Fig.1 Sketch-map showing the sampling sites (distance from source-CHP5).

The present research is focused on the implementation of epiphytic mosses for assessing atmospheric deposition of heavy metals and other elements in the urban area. This species grows on bark of old trees such as aspens, poplars, birches, which are widespread not only in forests, but also in urban areas [1]. Therefore epiphytic mosses can be used for studying atmospheric pollution in industrial centers and other inhabited areas. Epiphytic moss has a long life cycle, high accumulation capacities [2], has no contact with soil and consequently heterogeneous chemical composition of soil has virtually no effect on them. It is especially evident in urbanized and some other

synanthropic areas; substrate effect of bark of trees is completely eliminated because of its uniformity.

2. MATERIALS AND METHODS

2.1 Studies sites

The study was carried out in the city of Novosibirsk, the largest city of Siberia. There are 5 big TPPs with a total capacity of 2370 MV. The largest thermal power plant is Combined Heat and Power Station-5 (CHP-5) with power of 1200 MW. Fuel used for domestics is mainly fossil coal. The CHP-5 is situated at the eastern end of the city, which makes it possible to estimate the influence of this facility.

The mosses were sampled in autumn of 2010 mainly in north-eastern direction for several km (fig.1). The direction of sampling was chosen in accordance with primary wind rose for this territory.

2.2 Moss sampling

The moss samples were collected in dry weather from the bark of old aspens and poplars at the height of 1.5-2 m above the soil level which corresponds to the air layer which adult person uses to breathe. Also such approach reduces the ability of small soil particles to penetrate into mosses. The background samples were collected also in dry weather at a considerable distance from inhabited localities and factories (northwest Siberia). The collected moss samples were packed in paper envelopes with the information about the identification number and the geographical position. Just after the selecting procedure the moss samples were pre-cleaned from different admixtures (insect remains, plant seeds, soil particles) under laboratory conditions. Then the samples were washed with filtered water, dried at the room temperature and placed in the paper envelopes which were kept just up to the very beginning of the analysis. The green younger parts of the moss were selected to do the analysis. To perform the neutron activation analysis the moss was washed using distilled water, dried to fixed weight in a special chamber at the temperature of 85° C during 24 hours. Moss samples were crumbled and then the probes were pressed and packed into aluminum foil with the mass of 0.3 g and 1 cm in diameter for their long-term irradiation. Five parallel samples were produced for each specimen

2.3 Analysis

Neutron activation analyses were performed at the Laboratory of Radiation Control, Institute of

Physics and Technology, National Research Tomsk Polytechnic University, Tomsk, Russia.

The IAEA/V-10 HAY (International Atomic Energy Agency) standard and cereal herb mixture of SBMT-02 type were used as reference materials to be compared. It took 5 hours to irradiate the probe with thermal neutrons in the vertical experimental channel of the reactor to determine long-lived elements. Further, the irradiated probes were "cooled" over seven days to determine long-lived elements. This "cooling process" was required to reduce the activity of Na24 which causes strong compton background. The measurement of the chemical elements specific activities in the probes was made with the help of a semiconductor gamma spectrometer. The gamma spectra of induced activity were analyzed by means of "Genia-2000" software program developed by the "CANBERRA". The concentrations of 24 elements (As, Ba, Br, Ca, Ce, Co, Cr, Cs, Eu, Fe, Hf, Lu, Mo, Nd, Rb, Sb, Sc, Sm, Sr, Tb, Th, U, Yb, Zn) were determined.

3. RESULTS AND DISCUSSION

The element mean concentrations in moss sampled in the area affected by CHP-5 exceed several times element median concentrations in moss sampled in background territory (table 1).

According to these data using methods of mathematical modeling of air pollutant transport from a point source [3, 4] approximating curves were constructed showing the dependence of the concentration of elements on the distance (Fig. 2)

The following conclusions can be drawn:

- 1) The concentrations of toxic elements obtained in this study exceed background levels by 2-3 times and more.
- 2) The correlation analysis and mathematic simulation of pollutant diffusion in the atmosphere confirm identity of pollution source for some elements.
- 3) Maximum concentrations of toxic elements are observed in moss selected 2-3 km from CHP-5 in the direction of predominant wind.

4) Concentrations of toxic elements decrease to background level 9-14 km away from CHP-5.

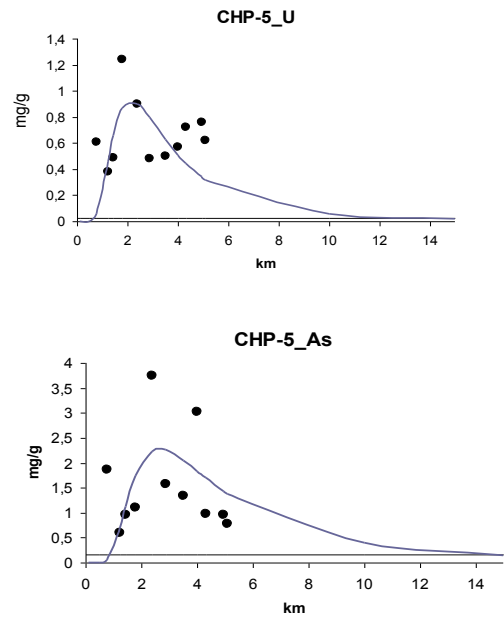


Fig.2. Plot and regression curve for the distance between CHP-5 and concentrations at sampling sites

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Table 1. Mean, maximum, minimum, background values of concentrations elements, mkg g⁻¹.

| | mean | max | min | background level | | mean | max | min | background level |
|----|--------|--------|------|------------------|----|------|------|------|------------------|
| As | 1,54 | 3,75 | 0,60 | 0,16 | Mo | 0,52 | 1,06 | 0,08 | 0,40 |
| Ba | 179,3 | 325,3 | 84,8 | 210,0 | Nd | 2,96 | 8,57 | 0,46 | 0,95 |
| Br | 9,12 | 17,01 | 5,08 | 9,09 | Rb | 12,8 | 19,1 | 5,7 | 4,8 |
| Ca | 112386 | 237698 | 8286 | 19996 | Sb | 1,27 | 2,31 | 0,77 | 0,10 |
| Ce | 5,22 | 7,03 | 3,26 | 0,99 | Sc | 1,36 | 2,23 | 0,66 | 0,20 |
| Co | 2,23 | 4,05 | 1,04 | 1,40 | Sm | 0,70 | 1,59 | 0,27 | 0,22 |
| Cr | 10,0 | 13,9 | 7,0 | 3,5 | Sr | 181 | 421 | 73 | 66 |
| Cs | 1,4 | 4,0 | 0,5 | 0,5 | Tb | 0,14 | 0,35 | 0,03 | 0,06 |
| Eu | 1,69 | 2,56 | 0,33 | 0,01 | Th | 1,00 | 1,63 | 0,53 | 0,13 |
| Fe | 3335 | 5215 | 1650 | 602 | U | 0,66 | 1,24 | 0,38 | 0,03 |
| Hf | 0,28 | 0,40 | 0,15 | 0,05 | Yb | 0,18 | 0,34 | 0,12 | 0,05 |
| Lu | 0,03 | 0,06 | 0,01 | 0,01 | Zn | 152 | 278 | 86 | 150 |

TECHNOLOGICAL FEATURES OF THE DUAL MAGNETRON SPUTTERING SYSTEM FOR REACTIVE DEPOSITION OF THIN FILM COATINGS

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Keywords: a dual magnetron sputtering, a reactive deposition, thin films, a current-voltage characteristic.

The problem of applying thin film coatings is one of the most extensive among the current trends of technology and materials science. Thin-film coatings are used in many fields of human activity and the need for them is constantly increasing. High rates of development of these industries require continuous quality improvement, strength and durability of coatings. [1]

Thin films can be prepared in various ways: by chemical precipitation, electrolysis, magnetron sputtering or vacuum evaporation. [2] Magnetron sputtering has several advantages over other methods of coating:

- a wide variety material of deposition. Can be applied to virtually any metal, alloy, refractory compounds, some types of polymers, and mixtures;

- a high purity coating material;

- high adhesion;

- high quality thin films, compared to the quality of the original surface of the substrate.

However, there are a number of technological problems related with process of sputtering metal oxides. On the one hand, the sputtering speed of oxide is much lower than the speed of sputtering of pure metal, on the other hand, surface is covered with foil. This leads to a redistribution of the electric field in such a way that the work of the magnetron can stop.

To solve this problem it was suggested to use two identical magnetrons connected to the pulse power supply. In this case, each of the magnetrons alternately will be a cathode and an anode. When magnetron has a positive potential, the oxide film will be destroyed. [3-6] This design is called a dual magnetron sputtering system.

Current-voltage characteristic (CVC), hysteresis and velocity of sputtering should be developed for determination of effective technological parameters of the dual magnetron sputtering of thin films of aluminum.

The most important technological parameter of magnetron discharge, which has a significant influence on the deposition process, is CVC. It depends on the discharge power, and the number of reactive gas in the stream. According to this series of experiments were conducted to determine the dependence of the current-voltage characteristics of the magnetron and the concentration of reactive gas in the gas mixture.

The experiments were performed several times in order to collect statistical data. This data describes the dependence of current-voltage characteristics on the concentration of reactive gas in a mixture. The experiments were conducted for 3 and 5 kW of capacity of the dual magnetron.

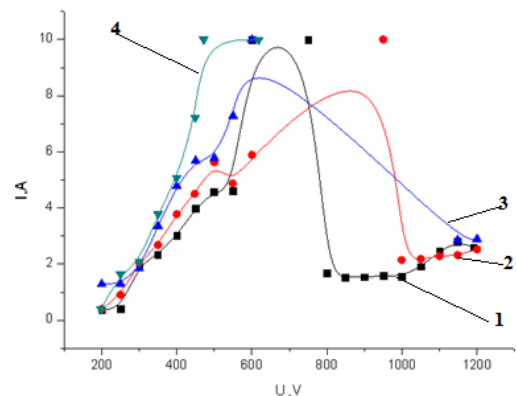


Figure 1 - CVC of the magnetron, when capacity is 3 kW. Concentration: 1 - 10%, 2 - 20%, 3 - 30%, 4 - 40%.

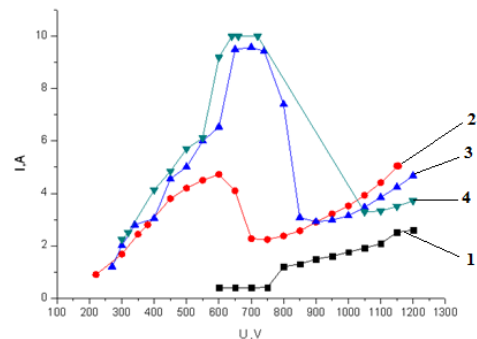


Figure 2 - CVC of the magnetron, when capacity is 5 kW. Concentration: 1 - 10%, 2 - 20%, 3 - 30%, 4 - 40%.

According to Fig. 1, 2, the curve of CVC is non-linear, and there is a maximum of CVC. These facts are explained by growing films of oxide on cathode. Thereby the coefficient of emission of electrons from cathode is changing. As a result, the redistribution between coefficient of ionization and velocity of electrons takes place. So, the discharge of plasma shifts to area of «high current». In addition, result of modifying flow of gases is a variation of pressure of reactive gas. This leads to changing operating points of discharge and therefore a change in the rate of absorption of the gas, this process takes place with short delay and leads to pressure variations and operating point of discharge.

According to comparing Fig. 1 and Fig. 2, the transition area decreases at the expense of the process of transitions reduces.

For an aluminum target, the characteristics of the reactive deposition of continuous operation are:

-maximum power of the magnetron is equal to 5 kW;

- the concentration of O₂ is 20-25%.

So the sputtering is steady.

In addition to CVC, hysteresis has a significant influence on the deposition process. The experiment was carried out for a planar magnetron and dual magnetron sputtering system. The square of the hysteresis loop show the level of stability of thin-film evaporation (Fig.3). For planar magnetron, the process of sputtering is unstable, according to a huge area between curves. In contrast, thin films, which are obtained in DMSS, have good adhesion and high quality. According to these conclusions, power supplies of the planar magnetron are chosen incorrectly. On the contrary, power supplies of DMSS are chosen correctly.

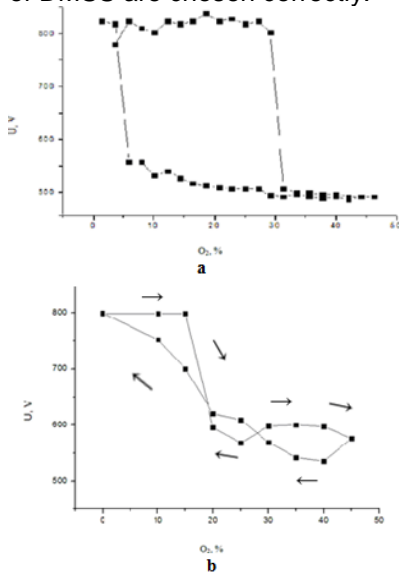


Figure 3 – The hysteresis of discharge plasma: a – a planar magnetron, b – a dual magnetron sputtering system.

Technological process of deposition of thin films requires ensuring the highest velocity of sputtering for a long time.

From Fig. 4, the maximum deposition rate of Al oxide film at concentration of O₂ is 20%. This maximum is 9.65 nm/min.

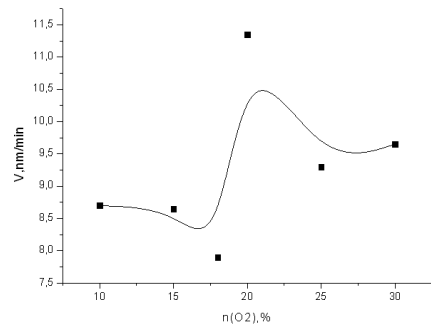


Figure 4 – The velocity of deposition.

After analyzing the data of CVC, the stabilization of the reactive deposition process can be achieved by controlling the composition of the gaseous medium. The stabilization of the reactive deposition process allows the deposition of uniform thin film coatings. As the main result of the work the most optimum conditions of deposition were identified. This work will be useful for industry, if parameters of the experimental setup transfer to the industrial setup.

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EROSION OF METAL SURFACE UNDER HIGH-POWER PULSED ION BEAMS: THE INFLUENCE OF EXPOSURE PARAMETERS ON ITS PROPERTIES

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Various techniques using high-power pulsed ion beams are being developed at present, as their impact on the substance has unique properties. For example, applying effects of removal of atoms from the surface, referred to as erosion control, proved to be very promising for the deposition of thin film coatings.

The question of the optimal parameters of the beam is fundamental for the development of their technological applications. Currently, there is a lack of knowledge of mechanisms of erosion under the action of high ion fluxes. This circumstance hinders the implementation of these technologies into practice. One of the most effective ways of solving this problem is the mathematical modeling [1].

The purpose of this paper is to consider the influence of the beam parameters on the rate of deposition and effectiveness. Lead was chosen in our calculation as the metal which was irradiated by protons.

Mathematical model of erosion was chosen as a tool for the study, as described in [2]. It was built in the proposal that the primary mechanism for removal of atoms from the surface of metals under the action of ion beams with energies of 100 ... 1000 keV and a power density of $10^7 - 10^9$ W/cm² is the surface evaporation. The proportion of sputtered particles does not exceed 1% in the erosion steam.

Earlier investigations [3] have shown that, at a power density of the beam of more than $5 \cdot 10^7$ W/cm², the main part of the particles leaves the surface as a result of evaporation rather than sputtering. Therefore, the partial erosion coefficient D caused by evaporation should be thoroughly calculated. As the surface temperature increases, the flow of evaporating atoms rapidly increases. In this case, the evaporation intensity, in contrast to sputtering, greatly depends on the parameters of the space function of the energy release at deceleration of the bombarding particles in the near-surface zone of the target and the time distribution of the current density $J(t)$.

The erosion coefficient resulting from the evaporation D can be found in terms of the thickness of the evaporated layer Z_{ev} :

$$D = \frac{Z_{ev} \cdot e \cdot N}{\int_0^{\tau} J(t) dt}$$

Here, N is the nuclear density of the target substance, e is the electron charge, $J(t)$ is the

variation of the beam current density during a pulse, and τ is the duration of the irradiation pulse [2].

The base is data on spatio-temporal distribution of power energy $W(x, t)$ in our calculations. Studies have shown that the nano- and microsecond irradiation regimes regularities of thermal and thermo-mechanical processes in solids are determined by power input of energy, pulse duration of exposure, also spatial form of the energy release function.

In determining the function of energy for charged particle beams investigated power range can not ignore the effect of collective interaction of the beam particles. If we assume that the spectrum of particles is constant throughout the pulse, the temporal and spatial distribution function of energy can be considered independent:

$$W(x, t) = \frac{1}{e} \cdot Q(x) \cdot J(t).$$

Here $Q(x)$ is the spatial distribution of energy losses during the passage of a particle through a substance. [2]

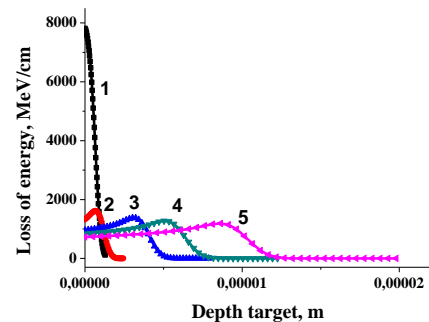


Fig.1. The dependence of the linear energy loss of the penetration depth of ions in a lead target at different values of initial energy: 1 – 500 keV, $C^+ \rightarrow Pb$; 2 – 500 keV, $H^+ \rightarrow Pb$; 3 – 700 keV, $H^+ \rightarrow Pb$; 4 – 1 MeV, $H^+ \rightarrow Pb$

Figure 1 shows the dependence of the linear energy loss of the penetration depth of carbon ions and protons in a lead target at different values of initial energy. Firstly, according to the diagram, the number of energy loss rises gradually at the beginning, then it fall sharply for protons. Secondly, the graph of carbon ions has maximum on the surface of lead, then linear energy loss decreases sharply. Thirdly, the diagram depicts that the loss of energy increases when the initial energy declines for protons.

Figure 2 shows the dependence of the erosion surface of lead on the current density for different values of the initial energy of the beam consisting of carbon ions and protons with constant pulse duration $\tau = 100\text{ns}$. The diagram shows that erosion coefficient increased with the rise of initial energy. Also these graphs represent the increase of erosion coefficient with the rise of current density up to maximum (the maximum for each initial energy), then graphs decrease slightly. Moreover intensity of erosion under irradiation with protons is greater than irradiation with carbon ions at the same initial energy. The shape of the graphs demonstrated that effectiveness of irradiation went down steeply after the maximum of erosion coefficient.

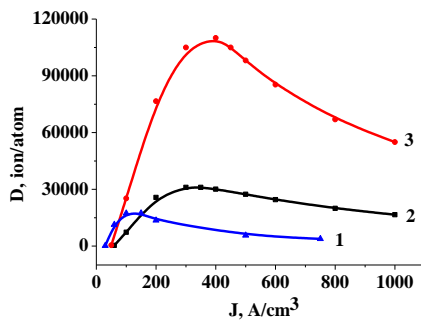


Fig.2. The dependence of the erosion coefficient of lead on the current density for different values of the initial energy of the beam consisting of carbon ions: 1 – 500 keV; and protons: 2 – 200 keV; 3 – 500 keV

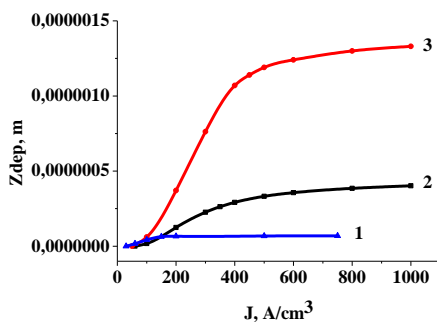


Fig.3. The dependence of the thickness of the deposited layer of lead on the current density for different values of the initial energy of the beam consisting of carbon ions: 1 – 500 keV and protons: 2 – 200 keV; 3 – 500 keV

Figure 3 shows the dependence of the thickness of the deposited layer of lead on the current density for different values of the initial energy of the beam consisting of protons and carbon ions with constant pulse duration $\tau = 100\text{ns}$. The graph shows that thickness went up with the increase of initial energy. Moreover, the shape of the graph demonstrated a gradual rise, then the graph remains practically constant. The next important observation is that the thickness of the deposited layer under irradiation with protons is

thicker than in the case of carbon ions at the same initial energy.

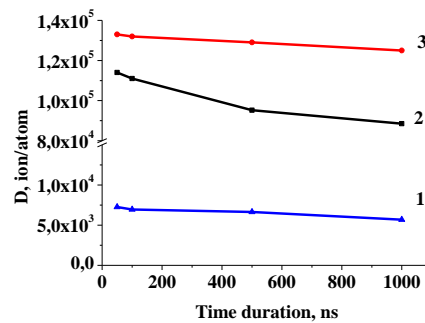


Fig.4. The dependence of the erosion coefficient of lead on the time duration for different values of the initial energy of the beam consisting of carbon ions: 1 – 500 keV; and protons: 2 – 500 keV; 3 – 1 MeV

Figure 4 shows the dependence of the erosion coefficient of lead on the time duration for different values of initial energy of the beam consisting of carbon ions and protons with constant fluence $F = 9 \cdot 10^4 \text{ J/m}^2$. In the first place this diagram depicts that erosion coefficient slightly falls when time duration goes up with irradiation of protons. Secondly, intensity of erosion under irradiation with protons is higher than in the case of carbon ions at the same initial energy. The next important finding is erosion coefficient under irradiation with carbon ions is slowly decreases when time duration increases.

According to the results of calculations the following conclusions can be made:

1. The effectiveness of deposition increases, when initial energy goes up, because of the rise of erosion coefficient's maximum.
2. The erosion coefficient has maximum, that's why further rise of current density isn't effective.
3. The most effective is irradiation when time duration does not exceed 1 mcs.
4. Irradiation of carbon ions and protons has distinction in kind. There is the spatial distribution of energy losses. Because protons lose their energy in thickness of metal and carbon ions lose their energy on the surface of metal.

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DEVELOPMENT OF RECONSTRUCTION ALGORITHMS OF PLASMA FILAMENT SHAPE FOR A MULTIPROCESSOR COMPUTER SYSTEM

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The rate of consumption of natural resources increases each year. Because of the limitations of the latter, it was necessary to find alternative sources that can produce large amounts of energy. One of the most promising solutions to this problem is recognized as the development of systems with magnetic confinement fusion plasmas, including TOKAMAK which occupies leading positions. The successful achievement of physical experiments on controlled thermonuclear fusion in TOKAMAKs is possible only upon receipt of complete and accurate information about the plasma state. Therefore, the TOKAMAK KTM is one of the most important plasma parameters is the shape of the plasma, determined according to the external magnetic measurements.

The structure of the plasma control system is shown in Figure 1. The plasma control in TOKAMAK is carried out using the toroidal and poloidal coils producing a field of force. Characteristics of the poloidal magnetic field at any given time is measured by a set of electromagnetic diagnostics sensors - 36 two-component probe, forming a tangential value (B_t) and normal (B_n) components of the poloidal magnetic field induction. For measuring sensor signals of computer a primary treatment unit is used. It consists of primary signal processing modules MEA-1M (up to 20 units) and local synchronization module (LMS), enabling the simultaneous selection of channels for modules MEA-1M. These modules pre-process the signal and transmit it over a fiber-optic communications unit calculating the position and shape of the plasma. TS-V39 is a cluster of processors DSP-TS - 101 Production Analog Devices. Cycle to control the shape of the plasma is 3ms. The main advantage of the cluster is the ability to perform several steps at once (parallelism), which significantly increases the speed. The shape of plasma was calculated by the data obtained. Information about the current state of the plasma shape and position of the bus VME single-board computer is transferred to Motorola MVME-5500 to calculate setpoints for power supplies and control windings. Further settings are transmitted over Ethernet digital control systems by power supplies coils (div PI), the coils adjust the shape and position of the plasma in turn.

One of the critical conditions for high-quality material science experimentation is the stability of the plasma. To do so it is necessary to receive information on the shape of the plasma column. In this paper, the magnetic surface reconstruction of the plasma filament is done by the method of moving current rings. The task of restoring field sources, produced on their fields is a typical ill-posed problem of mathematical physics. Additional assumptions are needed to address this problem. We assume that the plasma can be represented by a certain number - n of current rings. Each current ring is characterized by two coordinates and current value (r_i, z_i, I_i), $i = 1, \dots, n$.

The problem is formulated as follows: find the position and amplitude of the current rings so that the deviation of the true plasma at the magnetic surface of the reconstructed surface would be minimal. To solve this problem we use using moments of the current density distribution over the cross section of the plasma column, which subsequently helps to find the coordinates of two points (r_1, z_1) and (r_2, z_2) , determine the position of the current center of the plasma to some extent. To clarify this result we solve the problem with some n_j fixed current rings in the location of the points (r_1, z_1) and (r_2, z_2) , but the magnitudes of the currents in them are chosen by minimizing the residual δ .

At the same coordinate current rings lie on the ellipse, which was built using points (r_1, z_1) and (r_2, z_2) found at the previous stage as the foci of the ellipse. Minor axis of the ellipse is chosen empirically so that the ellipse is entirely inside the vacuum chamber. Semi-major axis of the ellipse is given by,

$$H = \sqrt{h^2 + \frac{(r_2 - r_1)^2 + (z_2 - z_1)^2}{4}}$$

The point on the magnetic surface is determined from the equation for the computed coordinates and the currents in the rings, with contributions from the poloidal field coils and the currents in the chamber.

To solve this problem you need to use a cluster based on DSP processors, giving rise to the need to develop an algorithm adapted for multi-structure and performance in PMB. This is the main goal of this work.

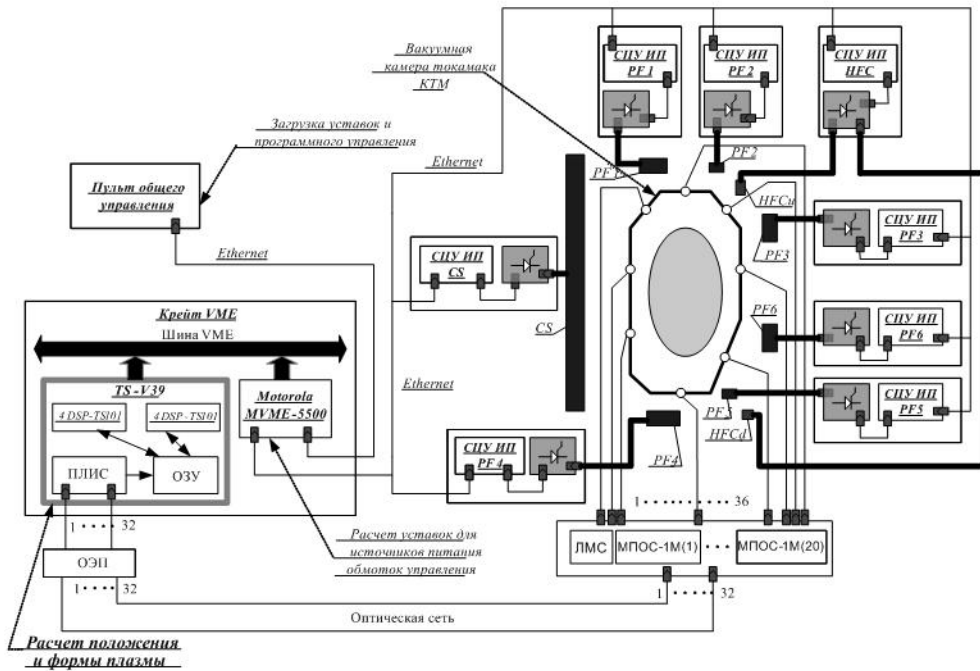


Figure 1. System to control the shape and position of the KTM TOKAMAK plasma

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DOSIMETRY OF X-RAY AND GAMMA IRRADIATION USING GAFCHROMIC EBT FILM

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Introduction

In radiation dosimetry there are numerous problems associated with the measurement of isodose curves and depth-dose distributions in high-gradient regions of beams using conventional measuring systems such as ionization chambers, semiconductors, thermoluminescent detectors (TLD), and radiographic films [1]. Ionization chambers and semiconductors do not provide sufficient spatial resolution for many treatment planning needs: typical resolution of those is about 3mm. TLDs, even small ones, are cumbersome and time consuming when one- or two-dimensional dose distributions are required. The investigation of the ionizing photon beam characteristics is difficult while using silver-halide radiographic films

because of large differences in sensitivity to photon energies in the regions of 10–200 keV. Energy absorption and transfer properties of radiographic films do not match those of biological tissues. Radiographic films also have the disadvantages of being sensitive to room light and requiring wet chemical processing.

These difficulties have resulted in a search for a radiation dosimeter with high spatial resolution which does not require a special treatment procedure, gives permanent absolute values of absorbed dose with an acceptable accuracy and precision, and easy at handling and data analysis. Some of these features have been achieved with the introduction of radiochromic dosimeters. These dosimeters, with very high

spatial resolution and relatively low spectral sensitivity variation, are insensitive to visible light, thus offering ease of handling and preparing in a room with ordinary conditions. Radiochromic dosimeters color directly and do not require chemical processing – a color change (colorless to blue, red, green, etc.) indicates exposure of radiation. Image formation occurs as a dye-forming or a polymerization process, in which energy is transferred from an energetic photon or particle to the receptive part of a colorless photomonomer molecule, initiating color formation through chemical changes [2].

The EBT Gafchromic film is in many ways an improvement of the previous radiochromic films, such as the Gafchromic HS, XR-T, MD 55, HD-810, etc. [1]. The main improvements are higher sensitivity of the film (up to 800 cGy) thanks to the addition of chloride (Cl), improved tissue-equivalence and higher uniformity. As specified by the manufacturer, the EBT Gafchromic film consists of two active layers, each 17 μm thick covered by a surface layer of 3 μm . They are coated by a 97 μm clear, transparent polyester layer, as shown below. The total film is formed by laminating the two pieces together without any intermediate adhesive layer. This brings the total thickness of the film to 0,234 mm. The atomic composition of the EBT film is the following: C (42.3%), H (39.7%), O (16.2%), N (1.1%), Li (0.3%), Cl (0.3%). This brings the Z_{eff} of the film to 6.98, which is close to the effective Z_{eff} of water (=7.3). The film is thus nearly a tissue equivalent. When the active components are exposed to irradiation, a polymerization process starts. After the irradiation, the films are scanned and the absorption maxima lie at 636 nm and 585 nm. This means that the primary absorption peak of 636 nm lies in the red spectrum and the secondary peak of 585 nm lies in the green spectrum, and the energy range of radiation is detected from 15keV to 15 MeV.

Materials and methods

1. Preparation and calibration procedure of films

Calibration curves were obtained in the following way: 10 films with dimensions of 5*5 cm^2 were irradiated by different doses. Before the irradiation the films were scanned in landscape orientation and in transmission mode to define the background. Each piece of the film was placed between plastic water slabs at a depth of 0.5 cm at an SSD (Source to Skin Distance) of 80 cm. Irradiations were performed using a 10*10 cm^2 1.25 MeV photon beam produced by a cobalt-60 source Theratron Equinox (Canada) with the known activity [3]. The films were exposed to 50, 75, 100, 150, 200, 250, 300, 400, 600, and 800 cGy, respectively. The Theratron Equinox calibration was verified by placing a reference

№30013 PTW Farmer ionizing chamber in a drilled plastic water slab at the same point as the piece of the film. The chamber's response was corrected for temperature and pressure. Films were scanned with Epson Perfection V750 Pro (Light source: cold cathode white fluorescent lamp) before and after irradiation. The resolution of scanned digital images was equal to 150 dpi. For most of the experiment the Image Type is a 48-bit color image (16 bit per color: red, green and blue) that is saved as a RGB TIFF-file. For the plotting of calibration curve the red color channel was used. The calibration curve in the red color fits better with the quadratic polynomial fit and has a better reproducibility. The calibration obtained coincides well with one obtained at Medical University in Vienna [4]. The equation 1 is a calibration curve of the film:

$$D(x) = -1.59 + 1.85 \cdot \exp(4.6 \cdot x) \cdot 10^{-5} \quad (1)$$

where x - optical density.

2. Test Measurements

The film was additionally tested using a bremsstrahlung beam of a microtron at Physics and Technology Institute (TPU) (with max. electrons energy of 6.1 MeV, average current 18 mA, pulse rate 8 Hz, irradiation time 90 s). The experimental scheme is shown in Fig.1

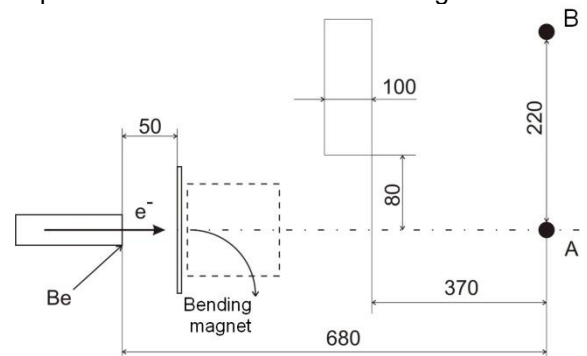


Fig. 1 The scheme of irradiation using microtron gamma beam.

The electron beam of the microtron interacted with a 4 mm Al plate, generated bremsstrahlung, and was bent from the experimental area by a dipole magnet. Bremsstrahlung was collimated by 100 mm thick lead set up 80 mm away from the central axis. The transverse profile of gamma-rays was measured by the film and by the ionizing chamber. In order to be able to compare the experimental data from the film and ionization chamber, the position of the doses on the film was translated into the coordinate of chamber. The latter one is moved from point A to B using a linear feed through with 10 mm step. The radiation doses obtained are shown in Fig. 2.

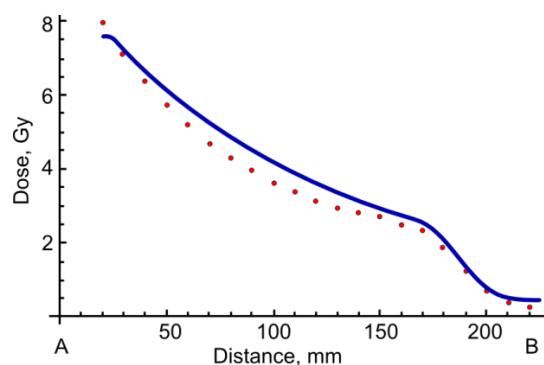


Fig. 2. Doses comparison measured by the film and by the ionizing chamber.

In Fig. 2 one can see that the calibration made with 1.25 MeV photons works rather well with 6.1 MeV bremsstrahlung. However, there are some differences that should be taken into account during precise measurements.

The final test of the films was made using high-current pulsed accelerator ($U=350\text{kV}$, $I=50\text{ kA}$). The electron beam of the accelerator interacted with a tungsten target and generated high-power low-energy bremsstrahlung. This intense photon flux is used to study the material properties and modify them. In this investigation it is important to measure the absorbed doses in some material irradiated. However, because of a intense photon flux the use of a conventional ionizing chamber is complicated. At the same moment each pulse of the accelerator is unique and not reproducible. This fact makes the calculation of absorbed doses a non-trivial task. Anyhow, the films were used to try to estimate the absorbed dose. Two Al filters were set up between the bremsstrahlung source and the film. Fig. 3 shows the 2D distribution of the dose measured by the film after 20 shots. One may easily see the positions of the Al filters. It seems that the spatial resolution of the films is enough to measure small objects irradiated with high accuracy.

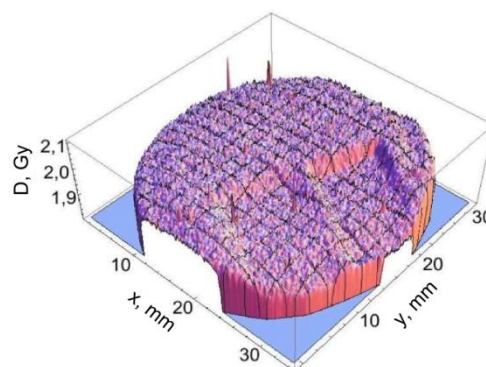


Fig. 3. 2D profile of the bremsstrahlung generated by the high-current accelerator and measured by the EBT Gafchromic film.

Conclusion

The EBT Gafchromic films were tested at different photon sources of Physics and Technology Institute (TPU) and Res. Inst. for Oncology. The obtained results show that these films are suitable for high spatial resolution dose measurements in a wide dose range and wide photon energy range.

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TYPES OF ABSORPTIOMETRY

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Osteoporosis has been recognized as the cause of a major health burden for societies, particularly within developed countries. The health detriment is associated with the consequences of bone fractures and the subsequent increases in morbidity and mortality. Much of the credit for the

current availability of means for identifying groups of subjects at risk of fracture and the provision of means for the effective treatment of excessive bone loss can be attributed to the technique of dual photon absorptiometry. [1]

In this review different types of absorptiometry are considered. Advantages and disadvantages of the method of absorptiometry are presented. At present in such techniques as: single-photon X-ray absorptiometry (SPA), two-photon X-ray absorptiometry (DPA), three-photon absorptiometry (TPA) and dual energy X-ray absorptiometry (DXA) are widely used in medicine. These methods make it possible to determine bone mineral density in non-contact method.

The start of clinical bone densitometry is probably best assigned to the year 1963 when Cameron and Sorenson published their paper on single photon absorptiometry (SPA). There were other groups working with photon absorptiometry in England (West and Reed 1970), Scandinavia (Christiansen et al 1975) and elsewhere but the Cameron and Sorenson paper can be considered the beginning of the development, the initial clinical application and the commercialization of single and dual photon absorptiometry. [1]

Determination of bone mineral density in medicine is very important. This is because the determination of bone mineral density can help to diagnose osteoporosis and monitor its development. The higher is the precision of the densimeter, the earlier can osteoporosis be diagnosed and, consequently, the treatment will be preventive, which means more effective. That is, we must say that radiographic techniques had been used before X-rays were applied. Absorptiometry methods could detect bone loss from the images after a change in bone mineral density by 10-20%.

In single-photon X-ray absorptiometry, several significant improvements compared with the study of the methods of bone radiography were made. First of all, the continuous spectrum used in radiography, was replaced by monochromatic X-ray spectrum. Second, the photosensitive plate was replaced with a scintillation detector. Third, rigid geometry of the beam was introduced as a source and a detector.

The mineral content of bones can be determined by measuring the absorption of a monochromatic, low-energy photon beam which originates in a radioactive source (iodine-125 at 27.3 keV or americium-241 at 59.6 keV). The intensity of the beam transmitted by the bone is measured by counting with a scintillation detector. Since the photon source and detector are well collimated, errors resulting from scattered radiation are reduced. From measurements of the intensity of the transmitted beam, made at intervals across the bone, the total mineral content of the bone can be determined. The results are accurate and reproducible to within about 3 percent. [2]

The method of single-photon absorptiometry was used to determine the thickness of the mineral component of bones and its application to determine the density was difficult. In this case there are two disadvantages of the method. The

first drawback is that the object of study might consist of only two materials with different absorption coefficients. The second drawback is that the radioactive source needs to be replaced after a certain period of time. Moreover, it is always necessary make allowance for the results, since decline in activity is observed and the intensity decreases with time.

Part of the drawbacks of the method of single-photon absorptiometry was eliminated in the method of two-photon absorptiometry. In this method, it became possible to measure the thickness of the sample without saving constant, which expanded the scope of the method. It became possible to carry out scanning the dorsal divisions and the values of the mineral composition of bones which were very important in medicine, because they helped to diagnose osteoporosis more effectively.

There was still the limitation imposed by the assumption that the object consisted of only two radiologically distinct materials each of which was characterized by a single-valued mass attenuation coefficient of μ_b for bone mineral and μ_s for soft tissue. The expression of this limitation can be appreciated from the equation for areal density measurement. For bone mineral, the areal density, m_b , is given by the expression

$$m_b = \frac{\ln I_{0,l} / I_l - R_{ST} \ln I_{0,h} / I_h}{(\mu_{b,l} - R_{ST} \mu_{b,h})} \quad (1)$$

where I_0 and I are the incident and transmitted photon intensities and the subscripts l and h denote low- and high-energy photons respectively.

R_{ST} is termed the soft tissue ratio and is equal to $\mu_{s,l} / \mu_{s,h}$. At first glance, it would seem that equation (1) requires values for the attenuation coefficients which are fixed and applicable to all subjects. If the assumption is made that there is a universal composition of soft tissue, then R_{ST} is a constant and equation (1) can be solved for area bone mass simply from measurements of the intensities of low- and high-energy photons at a single tissue location occupied by bone mineral and soft tissue. Unfortunately, soft tissue composition varies considerably from person to person and differences between patients are encapsulated in the value of R_{ST} which must be determined for each patient.

It might have been anticipated that the restrictions imposed by variable physical properties of soft tissue could be eliminated by increasing the number of photon energies in the incident beam. The feasibility of triple photon absorptiometry (TPA) was examined and demonstrated on phantoms but it could not be applied in vivo because the small difference in attenuation coefficients between lean and fat components of

soft tissue resulted in considerable uncertainties in the mass of either component. To reduce the uncertainty to a clinically useful level would require an increase in the number of incident photons producing an unacceptable radiation dose. [1]

But at present, the most widely used method is dual energy absorptiometry. DEXA is an instrumental technique used to measure bone mineral density (BMD), which is the widely accepted indicator of bone strength. DEXA scanner is the most widely used modern electronic device to diagnose osteoporosis, i.e. the thinning of bones. Human body being a heterogeneous system, use of a dual energy, rather than single energy, X-ray source is necessary for scanning. [3]

Technologists often diagnose osteoporosis by measuring a patient's bone mineral density (BMD). Bone mineral density measures the amount of calcium in regions of the bones. Most methods for measuring BMD are fast, non-invasive, painless and available on an outpatient basis. Bone densitometry can also be used to estimate a patient's risk of fracture. BMD methods involve taking dual energy x-rays or CT scans of bones in the spinal column, wrist, arm or leg. These methods compare the numerical density of the bone, with empirical data bases of bone density to determine whether a patient has osteoporosis, and often, to what degree.

Dual Energy X-ray Absorptiometry is the most widely available method of bone densitometry, and most insurance plans will cover the cost for the test, given that certain medical indicators are present. Bone mineral density measurement with DEXA is painless, and requires no injections, invasive procedures, sedation, special diet or any other advance preparation. During a DEXA exam, the patient lies fully clothed on a padded table while the system scans one or more areas of bone (usually the lower spine or hip). The entire exam typically takes just a few minutes to complete. While DEXA uses x-rays, the radiation dose is less than during a chest x-ray. Each patient's bone density is plotted against the "normal" for a healthy young adult or against age matched control data. A radiologist or other physician then interprets the data and creates a concise report on the status of the patient's bone density. [4]

The DEXA helps to predict the patient's risk factors for osteoporosis. It is a fast, accurate, and less expensive technique. It exposes the patient to

fewer amounts of radiation. So the risk is reduced to a great extent. Studies using DEXA scanning have shown that women with osteoporosis have substantially lower bone density measurements than normal, age-matched women. Bone mineral density is widely accepted as a good indicator of bone strength. Thus low values can be compared against standard bone density measurements. [3]

As a result the method of single-photon X-ray absorptiometry, two-photon X-ray absorptiometry and dual energy X-ray absorptiometry were described. For improving methods of radiography, the method of single-photon X-ray absorptiometry was developed. Due to the disadvantages of this method the method of two-photon absorptiometry was applied. Nowadays the method of dual-energy absorptiometry is used. Dual Energy X-ray Absorptiometry is the most widely available method of bone densitometry. This method determines bone density more accurately than other methods. Therefore, this method is used to predict the risk of osteoporosis.

It is to the credit of bone densitometry that major advances have been made in reducing the impact of osteoporosis upon society. Despite the inherent limitations of the technique, densitometry has been responsible for a raised awareness of osteoporosis and has contributed significantly to improvements in diagnosis and to the development of effective therapies. Future diagnostic advances in the arena of bone fracture risk assessment will require the involvement of engineering assessments of bone fracture resistance. [1]

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MODELING AND ANALYSIS OF ULTRAWIDEBAND BICONICAL ANTENNA

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Introduction

Nowadays, the interest to ultrawideband (UWB) radiators of electromagnetic pulses is rapidly increasing. This is due to a broad range of applications of UWB radiation pulses in radar, communications, wireless technologies, irradiation of objects and medium.

A primary goal of this study is to examine basic characteristics of biconical TEM antenna, such as voltage standing wave ratio (VSWR), amplitude-frequency response (AFR), phase-frequency response (PFR) and radiation pattern required to estimate the bandwidth of antenna.

Bandwidth estimation of a biconical antenna was based on the following criterions: VSWR ≤ 2 , deviation of the AFR of the mean value within ± 1.5 dB (-3 dB of maximum), deviation of the PFC of the linear dependence (Δ PFR) within $\pm \pi/16$ [1].

This study was conducted with two-dimensional simulation program for UWB radiators with axial symmetry based on the Finite-Difference Time-Domain (FDTD) method.

Formulation of the problem

In this paper biconical antenna with the angle of $2\theta_0=120^\circ$ is considered. The dimensions of the coaxial transmission line range from $2a = 2$ mm to $2b = 5$ mm, so that the impedance of coaxial line corresponds to $\rho_{cl} \approx 50 \Omega$, and $L \approx 60$ mm. For the low-frequency region the length of coaxial is up to $5L$. Fig. 1 shows geometry of the biconical antenna.

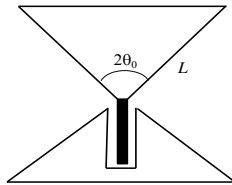


Fig. 8. Geometry of the biconical antenna with plane ends.

In this paper two-dimensional simulation program with axial symmetry based on the FDTD is used. FDTD is a grid-based numerical technique to solve Maxwell's equations. Maxwell's equations are discretized in a leapfrog manner using central-difference approximations to the spatial and the temporal derivatives. The main Maxwell's equations in cylindrical system (r, z) with axial symmetry $\frac{\partial}{\partial \varphi} = 0$, are given by [2]:

$$\begin{aligned} H_\varphi^{n+\frac{1}{2}}[r_i, z_j] &= H_\varphi^{n-\frac{1}{2}}[r_i, z_j] - \frac{\Delta t}{\mu_0 \Delta z} (E_r^n[r_i, z_{j+\frac{1}{2}}] - \\ &- E_r^n[r_i, z_{j-\frac{1}{2}}]) + \frac{\Delta t}{\mu_0 \Delta r} (E_z^n[r_{i+\frac{1}{2}}, z_j] - E_z^n[r_{i-\frac{1}{2}}, z_j]), \\ E_r^{n+1}[r_i, z_{j+\frac{1}{2}}] &= E_r^n[r_i, z_{j+\frac{1}{2}}] - \\ &- \frac{\Delta t}{\varepsilon_0 \Delta z} (H_\varphi^{n+\frac{1}{2}}[r_i, z_{j+1}] - H_\varphi^{n+\frac{1}{2}}[r_i, z_j]), \\ E_z^{n+1}[r_{i+\frac{1}{2}}, z_j] &= E_z^n[r_{i+\frac{1}{2}}, z_j] \\ &+ \frac{\Delta t}{\varepsilon_0 \Delta z} \left(\frac{r_{i+1}}{r_{i+\frac{1}{2}}} H_\varphi^{n+\frac{1}{2}}[r_{i+1}, z_j] - \frac{r_{i+1}}{r_{i+\frac{1}{2}}} H_\varphi^{n+\frac{1}{2}}[r_i, z_j] \right). \end{aligned}$$

The above equations assume that the E and H fields are shifted by a half-step both spatially and temporally. The electric field component tangential to the surface of radiator and is set to zero.

At the edge of the problem area absorbing boundary conditions was used. The thickness of the adsorbing layer ranged from 7 to 10 cells. The boundary conditions at $z = 0$ are "waveguide", thus, the E and H fields are propagated out without reflecting back.

In the absorbing layer finite-difference equation for the finite conductivity takes the form:

$$\begin{aligned} E_r^{n+1}[r_i, z_{j+\frac{1}{2}}] &= a_{ij} E_r^n[r_i, z_{j+\frac{1}{2}}] \\ &- b_{ij} \frac{\Delta t}{\varepsilon_0 \Delta z} (H_\varphi^{n+\frac{1}{2}}[r_i, z_{j+1}] - H_\varphi^{n+\frac{1}{2}}[r_i, z_j]), \end{aligned}$$

where a_{ij} and b_{ij} , while using only one of the indexes: in the direction of $r-i$, and in the direction of $z-j$. At this point, a_{ij} and b_{ij} , give us:

$$\begin{aligned} a_{ij} &= \frac{2\varepsilon_0 - \Delta t \sigma_{ij}}{2\varepsilon_0 + \Delta t \sigma_{ij}}, \quad b_{ij} = \frac{2\Delta t}{2\varepsilon_0 + \Delta t \sigma_{ij}}, \\ \sigma_{ij} \rightarrow \sigma(x) &= (x/d)^m \sigma_{opt}, \quad \sigma_{opt} \cong \frac{0.8(m+1)}{\Delta} \sqrt{\frac{\varepsilon_0}{\mu_0}}. \end{aligned}$$

where x is the direction to the edge, d is the thickness of the absorbing layer, m is the degree of polynomial [2].

The temporal and spatial steps are chosen to satisfy the "Courant-Lewy condition".

Biconical antenna was excited by the signal which is:

$$V(t) = V_0 \sin(\omega t),$$

where V_0 is the amplitude of the signal, ω is a cyclic frequency.

Biconical antenna simulation results

The main task related to the theoretical analysis of biconical antenna was to determine the bandwidth. First of all it was necessary to determine the degree of matching between the

coaxial line and the radiator, which is described by VSWR and is equal to:

$$VSWR = U_{\max} / U_{\min}$$

Amplitude-frequency response is calculated by the square of maximum amplitude of the field at a fixed point in the main direction of radiation and is given by following formula:

$$AFR = 20 \log(E_{\theta}^2 / E_{\theta \max}^2)$$

The wave phase can be obtained by Fourier transform. Thus, phase-frequency response can be represented as a phase deviation from the linear dependence. In addition, the antenna has directional properties, which are characterized by a radiation pattern, and it is calculated as a square of the wave amplitude on a spherical surface in the far-field zone.

Frequency characteristics described above are shown in Figs. 2, 3, 4, 5. In terms of VSWR the bandwidth is limited by the following values: $L/\lambda \cong 0,3$ and $L/\lambda > 10$. AFR on the level of -3 dB provides a range from $L/\lambda \cong 0,65$ to $L/\lambda > 10$, and the PFR deviation from linear dependence provides a band which begins from $L/\lambda \cong 0,2$ to $L/\lambda \cong 4,2$. However, the radiation pattern is destroyed at $L/\lambda \geq 3,25$, so that the bandwidth is from $L/\lambda \cong 0,65$ to $L/\lambda \geq 3,25$, overlap of the frequencies is $\lambda_L/\lambda_H = 5$, where λ_L , λ_H is a wavelengths corresponding to a low-frequency boundary and to a high-frequency boundary.

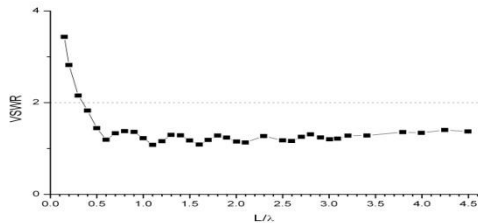


Fig. 2. Dependence of VSWR on the frequency for the biconical antenna.

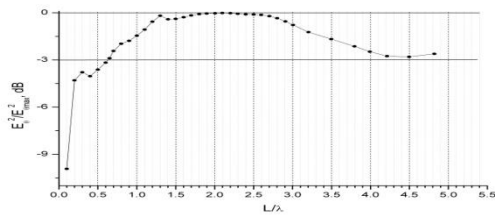


Fig. 3. Amplitude-frequency response.

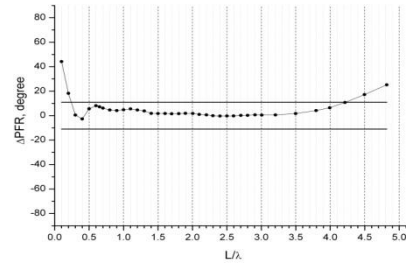


Fig. 4. Deviation of PFR from linear dependence.

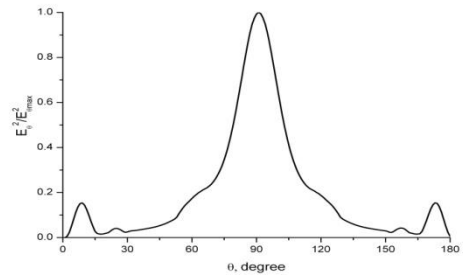


Fig. 5. Radiation pattern at $L/\lambda = 2$.
Summary and conclusion

In this study, two-dimensional problem was considered in order to determine the bandwidth of the biconical antenna with the angle of $2\theta_0=120^\circ$. This antenna was analyzed with the FDTD method. These calculations indicate that frequency range is limited according to VSWR, AFR, PFR and radiation patterns. The lower limit of the bandwidth determines the amplitude-frequency response, and the upper – phase-frequency response, but the shift of the radiation pattern maximum at high frequencies slightly reduces the bandwidth.

Acknowledgment

I would like to thank Petkun A.A., author of the two-dimensional program for simulation of UWB emitters, for assistance.

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| Section IX | |
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QUALITY MANAGEMENT CONTROL

NDMA INFLUENCE ON BIOCHEMICAL INDICES OF RATS IN CONDITIONS OF ACUTE AND CHRONIC ACTION

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Influence of toxic components of rocket fuel on the environment is one of acute ecological problems. The most common component of rocket fuel is dimethylhydrazine (UDMH), or heptyl. Heptyl undergoes transformation with the formation of different toxic products getting into the environment [1].

One of such decay products of UDMH is nitrosodimethylamine (NDMA), exceeding heptyl several times in the toxicity [2].

UDMH and its derivatives are extremely toxic compounds for different animal and plant organisms. Dilute solutions of heptyl gravely impact seeds, the seaweeds, the unicellular and simplest organisms. Besides the spasms are caused in mammals. UDMH and its products of transformation can penetrate the animal organism by any ways: during the inhalation of product vapors, through the skin, through the digestive tract [2].

The purpose of our research is to study nitrosodimethylamine influence on biochemical parameters of the blood of experimental animals. Experiments were carried out in 30 white rats without pedigree.

Rats were divided into 3 groups, 10 in each group. The first group was a group of control rats. In the second group of animals nitrosodimethylamine LD50 of 40 mg/kg dose was injected intragastrically. In the third group nitrosodimethylamine of 1/10 LD50 dose was introduced intragastrically during three months, 4 mg/kg daily.

Water was introduced in the control group. The influence of NDMA acute intoxication was studied in the second group, the blood sample was taken next day. Chronic influence was studied in 3 groups, thus blood was taken 3 months later.

By general bilirubin and connected bilirubin, total protein, creatinine, glucose, the ferments activity – aspartataminotransferase (AST), alanineaminotransferase (ALT), α - amylase, and thymol also test were determined.

The results are shown in figures 1 and 2.

The content of glucose with NDMA acute intoxication in the second group showed 61,5% increase. The content of α - amylase decreased by 6,7% in the second group.

Hyperglycemia was observed in the second group, and it could be explained by glycogen strengthening disintegration in the liver and the muscles, the retardation of proteins and fats biosynthesis, and by the decrease of glucose oxidation velocity in the tissue.

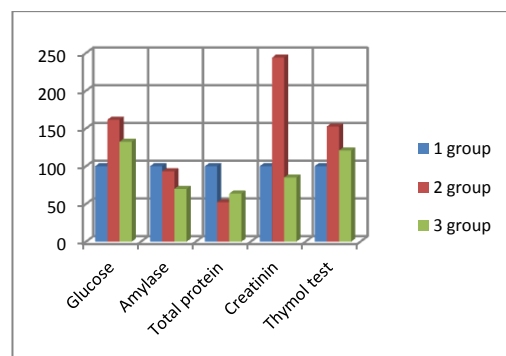


Figure 1. Changes of glucose, amylase, total protein, creatinine and thymol test with the acute and chronic intoxication NDMA parameters

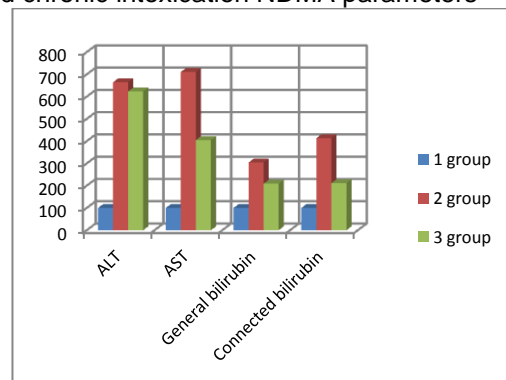


Figure 2. Changes of aLaT, ASaT, bilirubin of general and bilirubin connected with the acute and chronic intoxication NDMA parameters

Decreased amylase value indicates carbohydrates oxidation disturbance with the retardation of their disintegration in the tissue with NDMA acute intoxication. Amylase level as in case of decrease in the blood shows organs work, which produce these ferment insufficiently, for example, pancreas [3].

The research revealed a total protein content decrease in the blood in the second group by 47,7% in comparison with the control group. Such parameters testify proteins plasma passage into the interstitial tissue, due to increase in the permeability capillaries walls, and also hydrazines influence on the polypeptides peptide connections improved a migration of protein particles from the bloodstream into the lymph. According to published data, hypoproteinemia is observed during disturbance of proteins synthesis in the organism - cirrhoses, hepatites, toxic defeat.

With NDMA acute intoxication the creatinine content in the experimental animals blood increased by 143,8%.

The thymol test value showing the liver pathology increased by 52,6%.

The creatinine content increase was caused by functions disturbance of kidneys work. A positive thymol test with by hydrazines intoxication testifies significant changes of liver parenchyma.

Aminotransferases activity of aminotransferases was higher in experimental groups than control data. With acute intoxication, alanine aminotransferase and aspartate aminotransferases contents exceeded control data by 564,7% and 611,2% respectively. It means unfavorable changes in liver parenchyma, and damages of heart muscle.

General and connected bilirubins were higher than the control group data by 204% and 313,7% respectively.

Such high parameters in the exchange of bilirubin, i.e., bilirubinemia, reveal liver parenchyma due to bilirubin penetration through the destroyed hepatic cells in to blood [3].

Thus, significant changes were observed with NDMA acute intoxication in the blood of experimental animals. The glucose increase and α -amylase reduction causes the carbohydrate metabolism change in the organism. Such phenomena are connected with strengthening glycogen disintegration in the liver and muscles, reduction of the glucose rate oxidation, and also the disturbance of the carbohydrates oxidation with the retardation of their disintegration. Aminotransferases parameters increased repeatedly. That could be explained not only by liver functions disturbances, but also by damages of muscles, heart cells and nerve tissues. The bilirubin high content shows nitrosodimethylamine straight toxic influence on liver parenchyma [3].

Glucose parameters in the third group of experimental animals with NDMA chronic intoxication increased by 32,3%.

The α -amylase parameters decreased by 30,1% in comparison with acute intoxication.

Creatinine indices and thymol test with chronic intoxication were decreased by 15,1% and increased by 20,7% respectively.

In the NDMA chronic effect influence research significant aminotransferases changes were revealed in the experimental animals blood. The

exceeding index of ALT was comprised higher than in the control group. But increasing value of AST was by 305,1% more than the first group data.

General bilirubin value increased by 109,1%, and connected bilirubin - by 111,5%.

Determination of aminotransferases in the investigated rats blood with the nitrosodimethylamine chronic intoxication repeatedly showed increased parameters. Increased content of these ferments could be explained by NDMA many-sided action on the organism. Not liver only, but heart muscle, nerve tissues and kidney are also damaged. Nitrosodimethylamine chronic intoxication showed reducing action of amylase, total protein and creatinine. The lowered amylase can be explained by the pancreas insufficiency, total protein value - by the liver insufficiency, creatinine value - by the metabolic disturbances in the organism.

Compared with acute intoxication, chronic intoxication renders smaller influence on the bilirubin, ASaT, and creatinine. Compared with the control group, chronic action has a strong influence on aminotransferases ferments. Whereas, nitrosodimethylamine acute intoxication affects creatinine, bilirubin and total protein significantly.

Thus, according to the data, obtained in the experiments the change occurs with NDMA influence in the blood. It is possible to say that the liver undergoes greatest changes according to biochemical parameters. Pancreas pathologic processes are also observed in connection with hyperglycemia and α -amylase increased content.

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AIR DEDUSTING PROCESS IN CYCLONE APPARATUS

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The process of dust separation in cyclones includes several stages: a twist of flow, concentration and output of particles from the separative zone, shaping a layer in the receiver zone, removal of grasped dust from the receiver. A disturbance of any stage leads to a malfunctioning of a dust catcher. The most effective precipitator is a countercurrent cyclone with its own dust receiver, where the gas flow transports dust into it and lowers its moving speed. As a result there appears a layer formed from the particles, moreover there are particles which size is less than 10 micrometers (μm). The major portion of the particles weighed in gas is thrown to the wall of the cyclone, they assemble into plaits then move downward with the part of the gas flow, penetrating the dust-outlet opening into the cyclone bunker. In the bunker the vortex flow changes its direction and loses speed, as a result the particles bunch precipitation occurs. The gases freed from the particles join the parts separated from the descending spiral of the flow, move on the ascending (internal) spiral to the exhaust pipe. [4]

Turbulence essentially influences the cleaning process, it mainly determines the degree of cleaning. The flow which enters the exhaust pipe continues to revolve intensively. Rotary motion damping is connected with irreplaceable energy losses occurs rather slowly. However, these dust separators have relatively large sizes.

Apparatuses with additional (extension) devices for precipitating the dust concentrate in them are widely used. They are compact, they make it possible to place extension devices in the place which is convenient for unloading the grasped dust. Countercurrent cyclones with its own dust receivers are most frequently used.

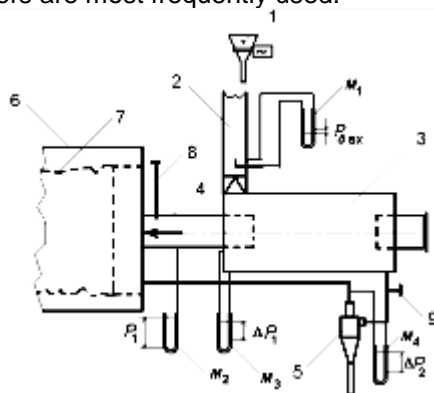


Figure 1. Test bench diagram

Figure 1 shows the test bench of dust catchers, where dust concentration is achieved in countercurrent dust concentrator 3, and the

precipitation of dust occurs in the extension countercurrent cyclonic apparatus 5.

Due to the rarefaction created by the fan there is a reduced pressure formed in capacity 6 and the air with the dust received from the feeder 1 through the branch pipe 2 passes into concentrator 3, it turns, and the dust concentrate passes into cyclone 5. Purified air enters the filter 7 of air collectors 6 air through the leading-out branch pipes of cyclones. The test bench has also valves 8, 9 for flowrate adjustment and manometers M_1 , M_2 , M_3 , M_4 for flow parameters measuring.

Table 1. Measurement data

| $P_{\Delta 1}$ kgs/m ² | P_1 kgs/m ² | ΔP_1 kgs/m ² | ΔP_2 kgs/m ² | t s | G_b x g | G_y n g |
|--------------------------------------|-----------------------------|------------------------------------|------------------------------------|----------|-----------------|-----------------|
| 18 | 200 | 40 | 80 | 18 0 | 59 | 57 |

Figure 2 depicts the diagram of the concentrator with the distribution of air peripheral speed along the radius.

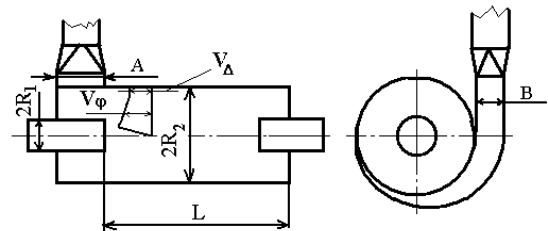


Figure 2. Concentrator diagram

Table 2. Dimensional values of the concentrator

| $2R_1$ mm | $2R_2$ mm | L mm | A mm | B mm |
|--------------|--------------|-----------|-----------|-----------|
| 34 | 100 | 200 | 50 | 22 |

A general dust dedusting coefficient together with the dust output into the extension dust catcher is determined by the formulas:

$$\eta_g = \frac{G_{y\eta}}{G_{ex}} 100 = \frac{G_{ex} - \sum G_{6b\eta X}}{G_{ex}} 100 = \frac{G_{y\eta}}{G_{y\eta} + \sum G_{6b\eta X}} 100 =$$

$$= \frac{C_{ex} Q_{ex} - \sum C_{6b\eta X} Q_{6b\eta X}}{C_{ex} Q_{ex}} 100\%$$

G_{η} , G_{ex} , $G_{6b\eta X}$, C_{ex} , $C_{6b\eta X}$, Q_{ex} , $Q_{6b\eta X}$ - mass, particle concentration, the gas flows.

$$q = 3600 \cdot f_{\eta} \cdot \sqrt{\frac{\Delta P_2 \cdot g \cdot 2}{\rho \cdot \xi_{\eta}}} = 1.52 \sqrt{\Delta P_2} \text{ m}^3/\text{h}, \quad f_{\eta} - \text{a}$$

planned area of extension cyclone, ξ_{η} - an extension cyclone hydraulic resistance coefficient.

$$Q = 3600 \cdot F_T \cdot k \cdot \sqrt{\frac{2 \cdot P_{a1} \cdot g}{\rho}} = 14.4 \sqrt{P_{a1}}, \text{ m}^3/\text{h}, \quad F_T$$

– an inlet pipe area, $K = \frac{q}{Q} \cdot 100\%$, $C = \frac{G_{\text{ex}}}{Q} \cdot \frac{3600}{t}$ g/m³. Table 3 is filled up.

Table 3. Total values

| Q m ³ /h | q m ³ /h | K | C g/m ³ | ΔP ₁ kgs/m ² | η _o |
|------------------------|------------------------|------|-----------------------|---------------------------------------|----------------|
| 61 | 13,6 | 0,22 | 19,3 | 40 | 96,6 |

The calculation algorithm is given by formulas and table 4.

Figure 3 shows cylindrical countercurrent concentrator.

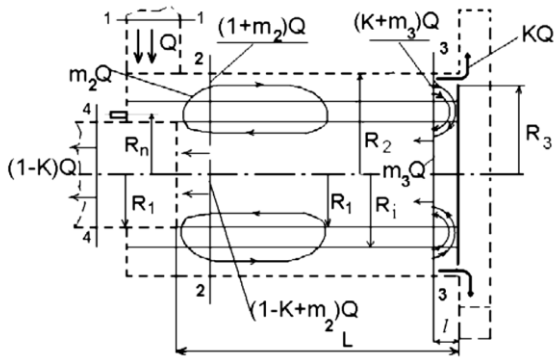


Figure 3. Concentrator flows diagram

Flow diagram appears as the following. The dust-laden gas with the expenditure Q enters through section 1, it enters the annular space with radii of R_i, R₂. The recirculating gas from the cylindrical volume with a radius of R₁ with the expenditure of m₂Q enters into the same space. The volume of gas (1+m₂) Q is passed through the outlying annular of section 2. [2] A large part of the twisted gas in the ring with radii R₁, R_i, between sections 2, 3 moves in the radial direction to the axis in a quantity of 60 – 80%, the smaller part of the gas with expenditure (m₃+ K) Q penetrates outlying ring cross section 3 and between sections 3 and 5 it branches into two flows. Flow with the expenditure KQ is derived from the separative volume with separated dust, the flow with the expenditure of m₃Q enters between sections 3 and 5 into the tube domain with a radius R₁.

Table 4. The design values of a fractional effectivenesses calculated with the formula

$$\eta_{\text{fi}} = \frac{1}{1 + B_1 B_2 B_3}$$

| α | 0 | 0.1 | 0.2 | 0.4 | 1 | 2 | 4 |
|---|-------|-------|-------|-------|-------|--------|---------|
| δ MM | 0 | 1.338 | 1.892 | 2.675 | 4.230 | 5.982 | 8.460 |
| r ₁ ^{α+2} | 0.116 | 0.104 | 0.093 | 0.075 | 0.039 | 0.013 | 0.002 |
| r* ^α | 1 | 0.827 | 0.683 | 0.467 | 0.149 | 0.022 | 0.001 |
| r* ^{α+2} | 0.022 | 0.018 | 0.015 | 0.010 | 0.003 | 0.0005 | 0.00001 |
| r _i ^{α+2} = 0.8 ^{α+2} | 0.640 | 0.626 | 0.612 | 0.585 | 0.512 | 0.409 | 0.262 |
| r ₃ ^{α+2} = 0.95 ^{α+2} | 0.903 | 0.898 | 0.893 | 0.884 | 0.857 | 0.815 | 0.735 |

| | | | | | | | |
|---------------------------------------|------|-------|-------|-------|-------|-------|-------|
| [2 ⁻] = [3 ⁻] | 1 | 1.047 | 1.088 | 1.194 | 1.584 | 2.648 | 4.486 |
| [2 ⁺] = [3 ⁺] | 1 | 1.197 | 1.436 | 2.059 | 6.069 | 37.34 | 683.8 |
| [5 ⁺] | 1 | 1.205 | 1.461 | 2.123 | 6.561 | 43.11 | 905.8 |
| B ₂ | 1 | 0.869 | 0.745 | 0.562 | 0.241 | 0.061 | 0.005 |
| B ₃ | 1 | 0.732 | 0.597 | 0.478 | 0.369 | 0.331 | 0.321 |
| η _{fi} | 0.22 | 0.307 | 0.388 | 0.512 | 0.76 | 0.933 | 0.994 |

The total effectiveness of dust concentration is determined by the proportion $\eta_{T\Sigma} = \sum \eta_{\text{fi}} \cdot \varepsilon_i$, where:

η_{fi} - a fractional concentrator effectiveness

according to design schedule, ε_i - a particles fraction of some fraction in the dust. According to the integral

$$\text{estimation,} \quad \eta_{T\Sigma} = \Phi(X_\Sigma),$$

$$X_\Sigma = \frac{\lg(\delta_m / \delta_{50})}{\sqrt{\lg^2 \sigma_\eta + \lg^2 \sigma_\delta}}$$

the particle median diameter δ_m = 23 μm, dispersion in the weight distribution function of dust is σ_δ = 3. $\lg \sigma_\eta = \lg \frac{\delta_{84.1}}{\delta_{50}} = \lg \frac{\delta_{50}}{\delta_{16}}$ - the dispersion

of particles in the distribution function of partial cleaning factors, where, δ_{84.1}, δ₅₀, δ₁₆ - size of the particles which are separated in the concentrator with effectiveness 84.1, 50 and 16% respectively. [3]

The following values are obtained with the interpolation method: δ_{84.1} = 4.95 μm and δ₅₀ =

$$2.55 \mu\text{m}. \quad \sigma_\eta = \frac{\delta_{\eta=84.1}}{\delta_{\eta=50}} = \frac{4.95}{2.55} = 1.941.$$

According to the table of integral probability function, the cement dust concentrator efficiency is equal to 96%. [1]

According to the calculation, the effectiveness of a standard countercurrent cyclone type SK-34 with a 55mm diametered particles of the cement dust equals η_u = 98,5%.

Thus, the effectiveness of dust control can be determined according to the following formula:

$$\eta_{T0} = \eta_{\text{u}} \cdot \eta_{T\Sigma} = 0,96 \cdot 0,985 = 0,946.$$

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THE JAPANESE CONTROL SYSTEM OF THE ORGANIZATION

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Nowadays the Japanese control system of the organization is the mixture of national traditions and a management advanced experience. The Japanese management system is considered to be the most effective in the whole world and the main reason of its success is the ability to apply the human factor.

The Japanese scientist Chije Nakane has carried out brilliant research, which subject was the types of relations in groups in comply with the national cultures traditions. He suggested the main principles of the inner structure of the analysis concept for social groups, having divided the types of relations between people into horizontal and vertical. Horizontal relations imply the set of individuals with common features (for instance, people of one profession), and vertical relations mean that the individuals with different features are connected by certain social bond (for example, a family, a clan, a club). It is the second, "vertical" type of relations, which is a typical and key the Japanese society.

The group, to which the Japanese belongs, is significant for him as well as family. The head of the Japanese organization is very similar to father, while the members of "family" cooperate spontaneously. Other typical features are the informal atmosphere, minimized internal conflicts and friendly relations within the groups. The firm is considered to be a long-term organization in connection with the fact that it guarantees the lifelong employment. Such relations are supported by «the Law on corporate reorganization» according to which firms which faced financial obstacles and are on the verge of bankruptcy are subjected to reorganization.

Here we can trace the certain system of group decision-making, which implies that the liability rests with all the members of a given group. No one member is entitled to make the decision individually. The essence of Ringi system is that the decisions should be reached by means of a consensus. It means that the decision must be accepted by everyone.

As opposed to the traditional behavioral model of «X» and «Y» the Japanese have developed and successfully applied the model of "human potential" according to which prevails the idea that people need a possibility to apply and develop their skills, and moreover to get a charge out of it. The concept of "human potential" protects the working conditions which provide the skills of an employee to be encouraged and is focused on the

promotion of self-management and self-checking among the personnel.

Another feature of the Japanese management is a special supervisory control system. The management control is the definition which comprises the administrative planning and the feedback and is the tool of managers' activity in achievement of the organizational goals.

The management control is carried out not by means of certain regulations acceptance as typical for the traditional management. Its main tools are help assistance and weak link identification during the operating process. So the essence of this strategy is that the word "control" doesn't imply "to identify – to punish", it's connected with the model "to verify – to help".

In order to maintain the discipline and to improve the workmanship the Japanese management is relied upon compensation; it denies punishment. The compensations are given for beneficial suggestions, life salvage during an emergency, for outstanding results in training courses, excellent performance of responsibilities and for «fidelity to the business as the model for colleagues». There are different types of the compensations. For instance: letters of commendation, presents, money or an additional vacation.

Punishments occur very seldom. As opposed to punishment intimidation tactics the Japanese management devotes attention to self-consciousness of workers and in comply with this fact it supports the "tactics of slogans" which promote increasing of discipline.

The quality management as well as the management control has also become predominant. The historical precondition of it is the nationwide movement for "the absence of disadvantages". This movement had a significant impact not only on goods quality but also on the recognition of responsibility for the quality of the executed work by each employee, which moreover favours their self-control.

Initially the control system and the quality management were based on quality circles.

Kaoru Isikava has, the founder and the theorist of the quality management in Japan, suggested the idea of well-known quality circles creation (QC). Originally, the aim of these circles was training of the Japanese companies personnel in statistical control method. Such training was introduced in the Japanese companies in the 60^s (sixties) years in order to involve the employees into quality improvement program.

Today's quality circles in Japan are voluntary associations of employees from organizations of various levels and various scopes of activity, who meet in their free time for the purpose of search of measures devoted to the quality improvement. Such circles usually have their own slogans. ("Think of quality incessantly", "Quality decides the fate of a company", etc.). They usually operate on the basis of following principles:

- Voluntariness participation;
- Regularity of meetings;
- Specificity of solved problems;
- Identification, studying and quality problems assessment during discussions.

Quality circles imply the method of training and encouragement of the personnel which interests, in its turn, are taken into account in the course of organization activity. Using simple statistical tools, people work in groups, discuss, analyze and solve various issues targeted mostly at cost, safety and efficiency. The Japanese quality circles have been recognized in more than 50 countries of the world.

We can distinguish the features of the Japanese quality management system, which differ it from the western system:

- Quality management on organizational level should include the participation of all links and levels in quality management;
- Manpower development and quality management methods training;
- The vigorous activity of quality circles;
- Activity inspection on quality management;
- Application of statistical methods in management;
- Significant and active enforcement of national programs on quality control.

A participation program on quality provision called "five nulls" is elaborated on the Japanese enterprises. It is defined by the following short rules:

- don't create (conditions for defect emergence);

- don't transfer (defect production for the following processing);
- don't receive (defect production from the previous stage);
- don't change (technological modes);
- don't repeat (mistakes);

These rules are detailed for both production stages and production itself and brought to the notice of every employee.

The Japanese system of complex quality management is connected with redistribution of the responsibility for the quality provision and based on many additional principles, methods and tools of this goal achievement. The definition "null of defects" accurately reflects the essence of the Japanese marketing strategy, which main aim is to struggle for the quality improvement in order to expand the market.

The Japanese management model is distinguished by its striking national colour. However it can be easily applied in another socio-economic and sociocultural environment as far as the Japanese management experience comprises plenty of universal and valuable aspects and complies with the general and global requirements of management improvement and besides it is within the framework of the world-wide development tendencies.

In the conclusion I'd like to make a quotation of Jean-Pierre Lemanna's words, who is the head of the center of Sterling University for Japan studying. These words answer the question about the Japanese experience transfer: "Japan shouldn't be perceived as a country which model can be simply copied. It should be used as a mirror where we can analyze our strengths and weaknesses".

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CLIMATIC CHANGES IN PROKOPEVSK IN CONCEPTION OF THE GLOBAL WARMING.

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Climatic supervisions are conducted in Kuzbass for over a century - from 1898. Besides meteorological services private persons also explore the weather. It is very entertaining and

enthralingly.

This study is **of present interest** because 90 % of scientists think that the process of the Global Warming is going on the Earth: there is a

possibility about 90 % that averages on the Earth will be rising on 4 °C to 2030 and the ice in the Arctic region will melt. The level of the World ocean will rise on 1,5 meters and the temperature will rise on 7 °C to the end of the XXI century.

At the worst the level of world ocean will rise on 100 meters. There is the outline of coastline at the increase of level of the world ocean on 100 meters. In that case the territory of Russia will suffer the most. Almost the whole Western Siberian plain will be under the water.

The aim of the project is to analyze materials for the last 100 years and to reveal factors influencing on the process of changes of climatic conditions in Prokopyevsk within the framework of conception of the global warming.

Time frame comprises the period from 1898 to 2009.

Thus, an object of our research is a climatic environment of south of Western Siberia, Prokopyevsk.

Entering into the XXI century, a man has a great number of troubles, including the global warming.

The global warming is a process of gradual increase of average annual temperature of the Earth atmosphere and World ocean.

Modern changes of climate: the Instrumental watching of climate made in XIX century, registered the beginning of the temperature rise, that had been proceeding to the first half of the XX century.

Climatic changes in Prokopyevsk for the last 100 years.

Climate of the mid 1950 - s. In the middle of 1950th the climate of south of Western Siberia, including Prokopyevsk, was characterized as a continental, with a long, frosty and windy winter and a short, but hot summer.

Enormous spaces dissociated Prokopyevsk from warm seas, Pacific, Indian and Atlantic oceans. In connection with it they had no influence on forming of climatic conditions of South Kuzbass and Prokopyevsk. Influence of cold air stream from the side of the Arctic ocean is more accessible as a result of its openness for north. In addition, mountain relief is circled by more high ridges; from the side of west by Salair ridge, from a south - by the Altaian mountain country and from the east – Kuznetsky Alatau, which are not only water – parting lines but also they are climate – parting borders.

The average yearly temperature of air hesitated from 1,0 °C to 1,4 °C.

The rise of temperature in Prokopyevsk on long – term supervisions began with February and came to the maximum in July (+19,6 °C), and with August, lowering began, thus a fall - off was marked in transition from September to October from 10 °C to 1,9 °C; then temperatures went below 0 °C, coming to the minimum in January (- 19,0 °C).

So, the warmest month was July (+19,6°C), a the coldest was January (-19 °C). Annual amplitude (between middle January and July) equaled 38,6 °C. It was brightly characterized continentalness of climate of south of Kuzbass. The continentalness of district was yet more considerable expressed by average daily temperatures. The daily allowance vibrations of temperatures arrived at 20 – 25 °C.

Analysis of change of climatic terms after 1898 – 2009.

Using material of meteorological observation after 1898 - 1986, i.e. for 88 years, we will set that a rise of average yearly temperature was 0,5 °C from 0,4 °C to 0,9 °C or on 225 %.

From material of meteorological observation for 1986 - 1996 - 2000 (mean values for 5), i.e. for 14 we set that rise of average annual temperature had been 3,4 °C - from 0,9 – 1 °C to 4,4 °C - or on 440 %.

And finally, using mean values after 2001- 2009 year, we come to the conclusion, that rise of average annual temperature was 0,2 °C - from 4,7 °C to 4,9 °C - or on 4,2 %.

In Prokopyevsk major sources of air pollution are industry, fuel industry, housing and utilities, engineering.

According to the materials of public institution of the "Regional committee for the protection of the natural environment" of the Kemerovo area basic contribution to the emissions from stationary sources bring in the companies of housing and public utilities - 54,6 %; fuel industry - 27,8 %; mechanical engineering and metal – working production - 6,7 %. The emissions of motor transport make 25,6 % of anthropogenic emissions.

For a period of 1996 - 2000 emissions from stationary sources declined to the 1997, and then increased gradually.

All these facts tell that in Prokopyevsk there is a growth of middle annual temperature for the last two decades that confirm a process of rises in temperature of climate in Prokopyevsk. Main conclusions:

1. The global temperature grew on 0,5 °C for 88 years period (from 1898 - 1986), when meteorological observation began in South Kuzbass.

2. The increase on 3,6 °C was in the XX century, mainly in the period with 1900 - 2006.

3. 4 of 5 last years were marked as the warmest after 1990 (2002, 2003, 2004, 2007).

4. There is a growth of temperature with – 3,0 °C to - 0,7 °C in the last ten – day periods of 2001 - 2009.

5. The last ten – day period of 2006 became the warmest, and the 2002 year became the warmest for the period of supervisions since 1898.

6. The period of January – March, 2002, became the warmest beginning of a year in the North hemisphere. It is confirmed by a local

meteorological observation.

For the last 100 years the middle annual temperature in Prokopyevsk considerably had grown from 0,4 °C to 5 °C.

Experts believe that in the nearest years the temperature on the territory of Russia, especially in the Western Siberia, will be rising: to 2015 will rise on 0,6 °C - 1 °C, and the amount of precipitation will increase by 4 % - 8 %.

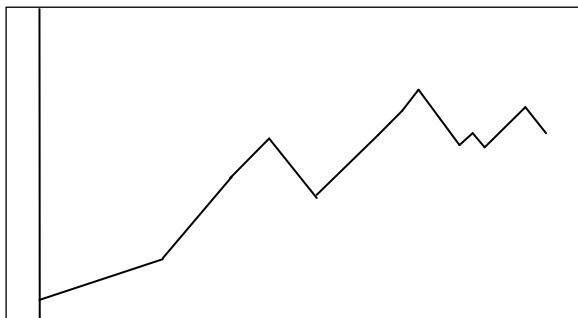


Fig. 1 Schedule Average temperatures in the city of Prokopyevsk 1898 - 2008.

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ANALYSIS OF THE DRYING EQUIPMENT OF PROCESSING EXPLOSIVES

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Drying is the process of removing moisture from the wet solid material by evaporation and formed vapor outlet. In chemical industry artificial drying of materials in special dryers is used.

Drying is a final production stage of most final products articles, often semi-chemicals of pharmaceutical industry, in case they must be stored or transmitted to the next stage of processing in a dry form.

Dryers are classified according to various criteria: action principles, apparatus pressure, heat removal methods.

1. According to the action principle they are:
 - a) continuously active;
 - b) periodically active.
2. According to the pressure in the apparatus, they are:
 - a) atmospheric;
 - b) vacuum.
3. According to the heat removal methods, they are:
 - a) convective dryers operate by means of direct contact of the material being dried with a drying agent. Convective dryers, in turn, are divided according to the type of gas carrier: hot air, flue gas, inert gases, superheated water vapor and organic liquids;
 - b) contact dryers use heat transferred from the coolant to the material through the wall;

c) radiation drying heat is transfer by infrared rays;

d) electrical dryer operates by means of heating in a high frequency current field;

e) freeze-drying is drying in the frozen state in high vacuum.

Vacuum dryers are used relatively rarely and are usually called special ones [1].

Contact dryers

Surface drying is the process of material drying on a heated metal surface when heat required for evaporation and material heat is transferred to the latter directly from the hot surface, moisture is absorbed and evacuated by the environment, i.e. Air-drying shop or a vacuum chamber or another intermediate medium.

Contact drying is much more economical than convective drying, as a very high heat flux density can be achieved. Surface heating is carried out by steam, hot water, oil, high boiling organic coolants, power-frequency currents, electric heaters.

Contact dryers are divided into periodic and continuously active ones. Most widely spread inermittent dryers are vacuum drying cases. Best known continuous working dryers are two-roller atmospheric and vacuum dryers, as well as single-roller casting bed dryers.

Vacuum dryers

Drying under reduced (compared to atmospheric) pressure in confined space (vacuum) is used in case the material is sensitive to high temperature, or oxidized. It is also used to speed up the drying process. Vacuum drying volatile solvents can be recovered by vapor condensation and subsequent use of the condensate in the process.

Recirculation drying

Closed-loop systems as the coolant have two main objectives:

- Ensuring minimum dust and harmful gases with spent coolant to the atmosphere
- Distillation of organic solvents, which are unacceptable as conventional installation due to the explosive vapor phase and the need of full recovery of the solvent.

Technical and economic effects of the use of closed-loop coolant plants instead of conventional ones are very high. There are a partially closed gas cycle completely closed gas and recycle material recycling.

Partially closed gas cycle

The use of drying agent recirculation, when a portion of the exhaust gas is mixed with fresh air is most favorable when intensive removal of moisture from the material is impossible, both in wet and dried state. Adjusting the ratio of mixture components of drying agent, it is possible to obtain necessary constant parameters for various materials drying, regardless of climatic conditions. Recycling of the drying agent can be accomplished by mixing the waste coolant with fresh air both before the process in the heater and after it.

Completely closed gas cycle

Completely closed gas cycle in chemical engineering is usually applied in cases when the product is evaporated from a valuable liquid, which should be fully back in the production, or when the drying material or solvent are toxic substances and their emissions into atmosphere are not allowed. In addition, the closed loop is used for drying flammable and explosive products, when a drying agent is expensive inert gas.

Recycling material

When drying some hard-to-dry materials, having used all possibilities of the gas initial temperature increase, it is necessary to increase the length of the dryer or the number of steps, or to use material recycling. In the latter case dryer dimensions are reduced due to the intensive use of the unit working volume.

Recycling of a dried material can be recommended for non-abrasive, wear resistant materials.

Fire and Explosion dryers

Continuous methods of drying are most dangerous as inside the dryer, even under normal operating conditions, there are dust-air mixtures in explosive concentrations and any source of ignition can cause the explosion. Possible operating conditions in dryers that produce sources of ignition in them and as a consequence, result in fires and explosions are:

1. Overheating of dried material, that leads to self-heating of samples, thermal degradation, corruption and self-ignition.
2. Ignition of flammable solvent vapors. Spontaneously occurring sources of ignition.
3. Violations of production schedules.
4. Equipment fault.
5. Unsteady processes during the start and stop of the drying chamber operation [2].

Optimal method and drying conditions choice.

A variety of materials and several methods of drying require scientifically based selection of the optimal way. When choosing a method one must take into account characteristics of the material as an object of drying and the requirements for the finished product.

A drying method can be considered the most promising when one type of apparatus is used for a wide range of products. Most promising are continuous methods of drying, as only they can create conditions for intense, fine adjustment and organic linking processes of mixing, drying, granulation and automation of the production. In addition, continuous drying methods allow to carry out the process with a minimum time for the material to stay in the reaction zone, and thus to minimize the contact time of raw material with moisture and air at high temperature.

Periodic processes are due to tough economic indicators, communication apparatus and operating conditions over time, leaving the material in the apparatus does not allow to drastically reduce this time.

It is necessary to organize the drying process so that the time when the product is the high zone is less than the induction period and the time of irreversible changes in product quality, but still it would be sufficient to dry the material.

The absence of a systematic approach leads to the fact that some companies try to develop their own measures to ensure fire and explosion safety of dryers.

The most radical way to exclude the safety of the drying process is to prevent the formation of combustible matter inside the equipment. But to implement this method in most dryers without special measures is not possible. This is due to the fact that most of dried organic materials in the state of Air-Suspensions are explosive (in addition, during their drying flammable substances can be removed). Flammability reduction within the dryers can be achieved by using nitrogen or carbon dioxide as an inert carrier and by adding inert powder.

Methodology for the safe conduct of the drying process

The current state of the theory allows drying on a scientific basis to solve the issues of intensification and optimization for the final product with the specified parameters. Not so deep scientific bases Fire-fighting the drying process, many decisions are made only on the basis of experience.

In the practice of industrial use of drying often there are contradictions between the need to improve the performance of dryers, drying, and reduce the cost of safety requirements. Accepted with engineering solutions do not always provide a standard level of security. Statistics show that the drying processes are among the most fire and explosion hazard processes. The causes of accidents on the dryers are a staff error and design features of the dryers, the proximity of the technological parameters to a dangerous level. Fundamentals of fire and explosion safety of technological processes laid down in the design stage, by taking into account the requirements of fundamental standards and regulations for fire and explosion.

The danger of drying plants is determined by the possible presence of combustible matter in them, and sources of ignition. To quantify the level of risk is necessary to have information about the fire and explosion hazard rates of dried materials, solvent, from which there is drying, the data of the type of equipment, technology modes, drying and associated operations [3].

The most radical way to ensure the safety of the drying process could be to prevent the formation of combustible matter inside the equipment. But to implement this method on most types of dryers without the adoption of special measures is not possible. This is due to the fact

that most of the dried organic materials in a state of Air-Suspensions explosive (in addition, during the drying of them may be disposed of flammable substances). On this reduced flammability protection can be achieved within the dryers use as an inert carrier of nitrogen or carbon dioxide, as well as the addition of an inert powder. Security through the creation of non-combustible environment within the equipment is formed by a quantitative characteristic of flammability Air-Suspensions characterizing the conditions of temperature, phlegmatizer and minimum explosive oxygen content. If it is impossible or inappropriate for economic reasons desensitization of the medium inside the drying equipment, fire and explosion safety can be achieved by eliminating sources of ignition. They can be static electricity discharges, deposits processed spontaneously igniting, sparks strike, etc.

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ENVIRONMENTAL MANAGEMENT AS A MECHANISM TO CREATE CONDITIONS FOR SUSTAINABLE DEVELOPMENT OF SOCIETY

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"It is no longer enough to satisfy customers.
You must delight them."
Philip Kotler

Provided that enterprises are used environmental management, the environmental situation will change.

Throughout history, there have always been traces of luxury and symbolic consumption but, in 204

contrast, today's consumer society in which mass consumption becomes the source of identity represents a much newer design of lifestyle. Our satisfaction is measured in quantities of goods and services we consume: enough is not enough! The world is consuming at an unsustainable pace but we often do not take the serious consequences for people and the planet into consideration. Therefore, the values are far from ideal. The

mentality of today's consumer society is going to lead us into an impasse. With enormous speed, the inventions and new technologies more enabled mass production to come into existence and turned people into consumers. Since then, mass consumption has become an essential ingredient of our culture and encouraged an unhealthy lifestyle. Our behavior concerning consumption, therefore, supports an unhealthy lifestyle with various consequences in regard to our personal well-being. With the rise of globalization, many companies have moved on to mass production.[1] It leads to the inevitable exhaustion of resources and pollution. What do every enterprises should do for change situation?

To begin with, the term "quality of life" is used to indicate the general well-being of people and societies. Some politicians and economists use the term "quality of life" to assess the livability of a society. This includes all emotional, social, and physical aspects of the individual's life. We live in a world in which people want improve quality of their life. One must admit that Enhancing and sustaining the quality of human life is a primary goal of environmental, economic, and social policy. If on the one hand it can be said that quality of life has many advantages. The other side of the coin is, however, that we are seeing a consumer society now. [2]

It is generally agreed today that a consumer society is a culture in which consumption of material goods is encouraged, and the economic health of the society is dependent on the spending of the population. Consumer societies are characterized by relatively open exchange, a focus on material wealth, and a belief in progress.[3]

Features of a Consumer Society:

- features of this society are: widespread lack of moral discipline; glorification of greed and material accumulation;
- excessive consumerism leads to pollution, hazardous wastes, exhausted resources, irreversible environmental damage;
- consumerism is manifested in the chronic purchasing of new goods and services with little attention to their true need, durability, country of origin, working conditions or environmental impact.[4]

More consumption of goods that use up resources in their production and generate waste materials also means more degradation of the natural environment. High-consuming countries have an impact on the natural environment that is out of proportion to their populations. The promotion of consumerism, however it is portrayed in the media, leads to increasing pollution, resource scarcity, biotic impoverishment, and other forms of environmental degradation all over the world. Moreover, while a quarter of humanity enjoys the benefits of material plenty, the negative impacts of economic growth contribute to the loss of health and life among the poor in every country.

The economic production process often creates a vastly larger mass of waste than useful product. The packaging, distribution, use, and consumption of the product produce still more waste. Waste becomes pollution when the level of contamination impairs the aesthetic quality or productive capacity of the atmosphere, water, soil, or landscape; that is, when ecosystems are significantly damaged. Of course, as members of a human-centered, materialistic society, we tend to pay the most attention to pollution when it affects our own health or the health of other commercially valuable species. However they are perceived, waste and pollution are the inevitable and sometimes pernicious by-products of a consumer society, and the consumer lifestyle is spreading around the globe. More remains to be done, however, to encourage healthy and sustainable patterns of consumption. [5]

Consumerism has emerged as part of a historical process that has created mass markets, industrialization, and cultural attitudes that ensure that rising incomes are used to purchase an ever-growing output and as a consequence the lack of resources and pollution. Doubtless, it is one of the main problem of the modern world.

Environmental management is first step on way solution this important issue. Today's level of environmental awareness (and fear of liability) has persuaded many organizations to systematically address environmental issues. A number of leading corporations have publicly committed to ISO 14001 certification. Ford of Canada, for example, already has achieved certification for one of its plants. ISO 14000 is a set of international standards for improving the environmental performance of organizations. It includes the new standard for environmental management systems (EMS) called ISO 14001. [6]

There are many ways that an ISO 14000 EMS can improve the operations of a company, thus reducing costs. An EMS can identify instances of redundancy in day-to-day efforts for regulatory compliance. These can be eliminated, thus making the organization more efficient. ISO 14000 requires a common terminology which improves the communication of goals, procedures, environmental impacts, and solutions. Improved communications can mean greater efficiency in decision making.

ISO 14001:2004 can also be used to meet next objectives:

- provide assurance on environmental issues to external stakeholders – such as customers, the community and regulatory agencies;
- comply with environmental regulations;
- support the organization's claims and communication about its own environmental policies, plans and actions. [7]

ISO 14001:2004 is a management tool enabling an organization of any size or type to:

- identify and control the environmental impact of its activities, products or services;
- improve its environmental performance continually;
- implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

ISO 14001:2004 does not specify levels of environmental performance. If it specified levels of environmental performance, they would have to be specific to each business activity and this would require a specific EMS standard for each business. That is not the intention.

ISO has many other standards dealing with specific environmental issues. The intention of ISO 14001:2004 is to provide a framework for a holistic, strategic approach to the organization's environmental policy, plans and actions.

ISO has a multi-faceted approach to meeting the needs of business, industry, governments and consumers in the field of the environment.

It would be unfair not to mention that fact that, ISO it offers a wide-ranging portfolio of standardized sampling, testing and analytical methods to deal with specific environmental challenges. It has developed more than 350 International Standards for the monitoring of such aspects as the quality of air, water and soil. These standards are a means of providing business and government with scientifically valid data on the environmental effects of economic activity. They may also be used as the technical basis for environmental regulations.

Finally, society in general benefits when companies reduce pollution with the help of ISO 14000. Natural resources last longer since less are being used. Landfills receive less waste so they last longer. Air, water and soil are cleaner. These benefits to society indirectly benefits the companies that are a part of it. [8]

To draw the conclusion, one [can](#) say that ISO 14001:2004 is a tool that can be used to solve environmental problems. Environmental management enables organizations to identify the likely effects on the environment of their future products and make effective decisions during the design and development stages to improve their environmental performance.

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THE EFFECT OF MOTIVATION AND ATTITUDES ON THE QUALITY OF LEARNING A FOREIGN LANGUAGE

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Famous American humorist and writer, Finley Peter Dunne, said: "It doesn't make much difference what you study, as long as you don't like it."

Many students often fail to reach their full potential as English language learners due to low motivation and negative attitudes towards English Language and learning the language. While motivation and attitude provide to be the first

impulse to begin foreign language learning and later become the driving force to sustain the long and often tiresome learning process.

Without proper attention to these two factors it leads to ineffective learning. This paper will attempt to seek answers to the following research question: Do motivation and attitudes impact on the quality of foreign language learning? The main aim of this article is: to give a review of recent researches in the field of motivation and attitude to learn foreign language. To clarify the role of attitude and motivation in foreign language learning, author has concentrated on analytical and descriptive methods.

Knowledge of foreign languages, especially English, is an important tool for communicating in different areas, such as the scientific and business world, cultural exchanges, political and economic issues, etc. It is recognized that learning English (and preferably learning more than one foreign language) is the key to successful future. Motivation and attitudes about learning foreign language are among the determining factors that have great influence quality of learning. These factors must be taken into account in foreign language learning.[1]

The basis of motivation is that can be described as a passion. Motivation is closely related to the person's goals and desires. In other words, motivation can be defined as the power that makes people achieve high levels of performance and overcoming barriers in order to change.[2]

Motivation can be divided into two main directions. Learning a foreign language for intrinsically motivated student is a goal in itself. Intrinsic motivation exists within the person rather than depend on any external pressure. On the contrary, extrinsically motivated student learns for rewards such as assessment.[3] Extrinsic motivation comes from outside of the person. Students are intrinsically motivated if they take their educational results under their own control; if they believe to be effective in reaching desired goals; if they are interested in studying a topic, rather than just rote-learning to achieve good grades. At the same time, students are not always internally motivated; they sometimes need external motivation, which can be created by instructor.

Motivation directly influences learning a foreign language. Moreover, motivation is the single best predictor of language learning achievement, all things being equal. In keeping with Lennartsson's research, motivation to learn a foreign language is much more essential than the others. Research has illustrated that the best students are those who are highly motivated, even they are not so talented as students with low motivation.[3] So, without sufficient motivation, even individuals with the most remarkable abilities cannot achieve their goals.

In line with Kurum's research, students, who do not have enough free time, reduce the hours of

language study in order to pass examination only. Also, they do not see the application of fluency in a foreign language in the future. This all leads to the low motivation.[4]

As well as Wolters's research has defined that students' possibility to regulate the motivation has an effect on their achievements.[5]

Recognition of the need to fluency in a foreign language in the future leads to increased motivation to learn it. And the motivated students do their best to learn the language.

As consisted with Lennartsson, if students are confident in their inability to successfully learn a foreign language, it becomes significant obstacle. But a negative attitude can be changed. It becomes positive and leads to improving the quality of education. Having positive convictions towards own abilities is a good start to learn a foreign language.[3]

According to the findings of the study, author makes a conclusion that other than the ability to language learning there are other crucial factors such as motivation and attitudes. And they can influence the quality of learning. Findings of the study provide answer to the research question raised in the beginning of the study. It shows that there is a direct link between the quality of foreign language learning and motivation and attitude.

So, researcher ought to develop appropriate strategies that would help teachers to motivate their students and would help students motivate themselves.

Some strategies, which can be very effective to increase language learners' motivation and to create good attitude among the students toward the foreign language learning, are given below.

Firstly, it is important to create a friendly climate. Pair and group activities can be used for reducing the pressure of instructor–student interaction and allowing students to feel recognized by their peers. Also small-group activities and pair work increase students' self-confidence and are excellent sources of motivation. Group work can give students a chance to express their ideas and feelings on a topic because they find it easier to speak to groups of three or four than to an entire class. The feeling of becoming a part of the whole is one of the strongest motivational factors.[6] Students can invent a nickname (or use a nickname they already have). This fun activity gives students a chance to create a friendly atmosphere. Students who feel safe and comfortable will feel more secure taking chances; they will show greater motivation to read aloud or write an essay without the fear of being criticized by peers or instructor.

Then, it is necessary to create situations in which students will feel a sense of accomplishment. A sense of accomplishment is a great factor in motivating students. Giving a feedback can increase students' satisfaction and

encourage positive self-evaluation. Positive as well as negative comments influence motivation and attitude, but research consistently indicates that students are more affected by positive feedback. Praise builds students' self-confidence and self-esteem.[6]

Some teachers correct students' mistakes without really explaining the reason for doing so. It is very important for instructors to point out the positive aspects of a student's work and to provide a clear explanation of student's mistakes.

Thirdly, students should set their own short-term goals. Language learners can achieve success by setting their own goals and by directing their studies toward their own expectations. Students can help themselves achieve the success by determining their own language needs and by defining why they want to learn the language. Having goals and expectations leads to increased motivation, this in their turn, leads to a higher level of language competence.[6]

At last, it is useful to connect language learning to students' interests. Listening to English language songs, watching English language films or videos, and reading English language web sites can lead students to broaden their perspective on their language learning process.

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OIL CUSTODY TRANSFER METERING SYSTEM

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Quality is an integral part of every production. Today not only giant world-famous corporations, but also small companies make great efforts to improve the quality of their products. It can be explained by the fact that only quality products are able to motivate and retain customers. In other words, high-quality products are the best way for companies to stay afloat and to raise their competitiveness.

It is well known, the quality control is a process to keep product quality at a fixed level. It guarantees the product (service, process) corresponds to the specific requirements. It is important to see difference between the quality control and the quality assurance, although these terms have similar features. Both are directed to maintain and improve the quality in the long run, but the quality assurance monitors the correctness of creation a product while the quality control checks an accordance of the results to the plan. Simply put, the quality control

is associated with the product while the quality assurance is always process-oriented.

Taking into account the above, one should not underestimate the quality control in the process of creating high-quality products. It is tempting to think about how to organize quality control in the best way. It puts two problems:

- operation time of control;
- accuracy of testing results.

Nowadays, the best way to solve these problems is to automate the process. Hereinafter is a description of a system of quality control applied to the objects of the petrochemical industry.

Oil custody transfer metering system (fig. 1) is intended for automatic fiscal metering of commercial oil using direct mass dynamic method and to determine oil quality characteristics to be used in the documents considering commercial oil transportation from a supplier to a consumer at oil refinery sites and used for oil and oil products transportation.



Fig. 1. Oil custody transfer metering system

The system consists of 3 major parts:

- process part;
- data collection and processing system (DCPS);
- utilities control system. [1]

Figure 2 illustrates the structure of typical oil custody transfer metering system.

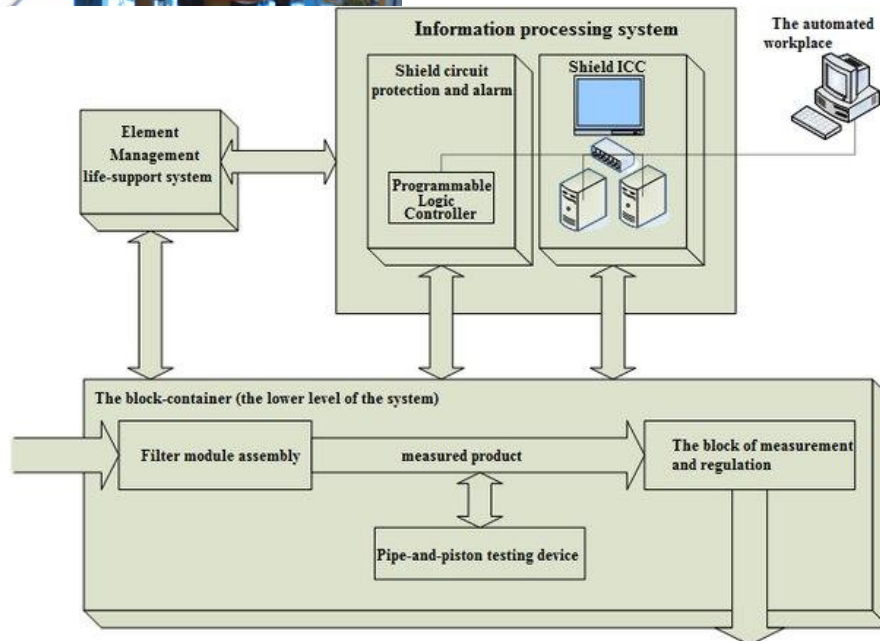


Fig.2. Structure of typical oil custody transfer metering system. [2]

Process part:

- filtering system;
- measuring and control unit:
 - quality measuring unit (QMU);
 - meter run unit (MRU);
 - flow and pressure control units;
 - mobile pipe piston prover (PPP) connection unit.

Data collection and processing system (DCPS):

- information processing unit;
- information-computing system (ICS);
- automatic protection and alarm systems (PAS).
- operator workstation and printer.

Utilities control system:

- power distribution panel.

Main Features:

- acquisition and processing of MRU, FU, QMU sensor signals, calculation and accumulation of oil gross mass, oil volume, average mass

density, temperature and pressure of crude oil;

- indication of the following parameters: crude oil volume since extraction shift beginning; oil gross mass since extraction shift beginning; oil flow through each meter run; actual density, actual pressure and temperature of oil in MRU and QMU;
- automatic and manual printing and logging of the calculation results in the form of two-hour or per-shift reports or reports about oil batch extraction;
- automatic and manual control over the automatic sampler;
- manual input of density, temperature and pressure values in the case of sensor fault or absence;
- storing of constants of DCPS nonvolatile memory;
- possibility to seal controls which can affect measurement results;
- flow and pressure control;

- operating flow transducer verification using the standby reference flow transducer;
- metrological performance monitoring and verification of the operating and standby reference flow transducers.

Its benefits:

- flexibility;
- functionality;
- reliability;
- ease of use.

Flexibility.

The metering system may be installed at the open site or in a movable container house. The sheltered version provides cost savings due to use of components with lesser IP protection.

Ease of use.

All metering equipment is connected to the field bus improving metering accuracy and providing the best bus configuration and ease of cable lines use and service.

Reliability.

High level of system availability and reliability is achieved by using measuring components from

industry-leading manufacturers, redundant servers and data backup software.

Functionality.

The system components provide for additional operation modes (simulation, testing and masking) and other features, such as unauthorized access protection and event logging to monitor personnel actions. [1]

Oil custody transfer metering system makes accurate measurement and quickly translates them to an operator.

Thus, such system allows easy, without wasting time to control the quantity and quality of oil. In turn it helps to prevent the sale or purchase of worthless products.

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THE RESEARCH OF GROOVE REFLECTANCE

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The accuracy and effectiveness are very important in ultrasound testing of welded joints of pipelines and other manufacturing objects. For this reason it is necessary to use proper and precision equipment as well as appropriate standard samples and artificial reflectors for its adjustment and calibration. The sensitivity and tuning of ultrasound defectoscopes used in ultrasound testing can be calibrated by three groups of reflectors: compacted reflectors which sizes are smaller than discontinuities of radiation field of transducer; reflectors that are extensive in one direction (notches, long cylinders) and reflectors that are extensive in two directions (planes, concave surfaces) [1]. Angular reflectors are also used as artificial defects. They are classified in marks, vertical holes, slots and grooves. The latter ones have got the most widespread application according to the actual operating procedures of nondestructive testing.

A groove is a flat angular reflector that is used for inspection of welded joints with one side edge preparation and thickness of 12-15 mm and less. It possesses a good reflectance and perfectly imitates the most dangerous root faulty fusions and cracks [2]. The grooves help to choose the scanning range, moving area of transducer on the surface of incidence and to tune the sensitivity in such a way that it will be possible to estimate the depth of the most frequently occurring defects. The grooves are also used for the ultrasound inspection of thick welded joints. One of the advantages of the groove is that it can be produced directly on the surface of testing object (if it naturally has got a positive width tolerance) [3]. The production of grooves includes the application of different techniques: electroerosion, cold extrusion and mechanical methods. The technology of groove production and its construction are shown in Fig.1.

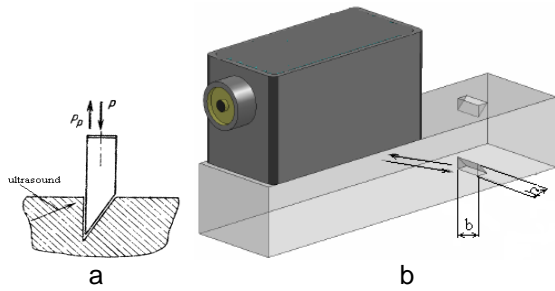


Fig.1. Angular reflector of groove type: a- technology of groove production; b- construction of groove.

The echo-signal from the groove is formed twice by the reflected beams of vertical side of the groove and a part of adjoining back surface. This type of reflectors has got some specific features. Its amplitude changes against the distance in the law R^{-2} . Besides, the amplitude of the groove is proportional to the square of its vertical side $b \cdot h$. In GOST 14782-86 the requirements for the grooves are stated. The height (h) and breadth (b) must be more than the wavelength and the ratio h/b must be at the range of 0,5-4,0. The equivalent square of the angular reflector can be counted in a formula:

$$S_{eq} = N \cdot S_g; \text{ where}$$

N is the scaling factor and S_g is the square of the groove. The scaling factor is used for correlation with the square of flat bottomed reflector that is situated on the same depth as a defect. It also considers the geometry of reflection, nonspecular reflection effect and transformation of waves. This coefficient depends on the depth of the groove and the angle of incidence to the surface of testing object.

In spite of a widespread application of grooves in ultrasound testing and their simplicity, these types of angular reflectors have got some disadvantages. Firstly, there are specific requirements for the geometrical parameters of grooves that can not be sometimes reached during production process and cause incorrect testing results. The production technology should provide the perpendicularity of the hollow front side to the surface of the sample. It is important because the groove reflectance (equivalent square) depends on the angle of sight of ultrasound beam. Secondly, the spread of amplitudes of echo-signals from the groove and the scaling factor (Fig.2) are not determined for the angles of incidence of the transducer of more than 73 degrees.

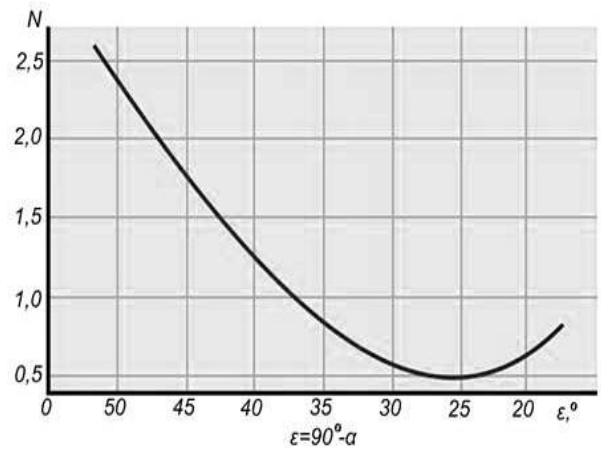


Fig.2. The dependence of the scaling factor (N) on the angle of incidence of the transducer for steel, aluminium and its alloys and titanium.

However, all new transducers for nondestructive testing nowadays tend to be produced with the angle of incidence of 75, 80 and even more degrees but the dependence of the scaling factor is still not determined for them [4].

This is an actual problem that limits the application of grooves and makes one doubt about the correct tuning of defectoscopes for ultrasound testing. The problem can be solved by carrying out an experimental research. For its realization the experimental samples with the grooves were produced. The sizes of the grooves were chosen to be 2, 5 and 7 mm², respectively. The samples were produced on the base of the Russian standard specimens CO-3 in the flat contact area of which we made the grooves with reflecting surface in the centre of cycle with the radius of 55 mm. For measuring the angular dependence we used the direct transducer with contact prism of 55 mm radius and 3 mm breadth of the contact area (Fig.3). The measurements were made in such frequencies as 1,8; 2,5; 5 and 10 MHz for the scanning angles of 0-80 degrees.

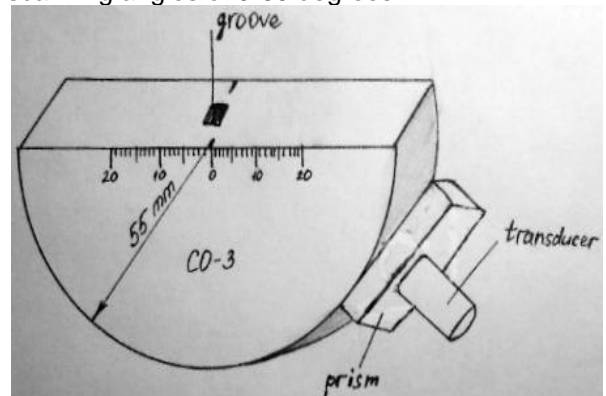


Fig.3. Experimental sample on the base of the standard specimen CO-3 with the groove.

The standard specimen CO-3 is usually used for determination of exit point of ultrasound beam, sensitivity of the transducer and traveling time of

ultrasound fluctuations in the prism of the transducer [5]. We have made the grooves in these specimens and scanned them with the use of direct transducer with the prism. A direct transducer generates longitudinal waves that are formed in the direction of wave propagation. In our particular case they covered the distance of 55mm, reached the groove, reflected from it to the transducer which in its turn transmitted information to the defectoscope. To compare the groove reflectance for different angles we used the Russian standard flat bottomed reflectors from the kit of КМД 4. In such a way, after scanning the standard specimens CO-3 with the grooves in different angles and getting the results of the testing we compared them with the results that we got by scanning the flat bottomed reflectors. This method of scanning allows to directly get the values of the scaling factor for every needed angle.

For scanning the specimens with the use of transverse waves we have produced the kit of prisms which have got a 55mm radius of the contact area and such angles of incidence as 40, 50, 60, 65, 70, 75 and 80 degrees. The results of measurement allowed to get the dependence of the scaling factor N for the angles more than 73 degrees.

Having researched the groove reflectance and its specific features we have come to the next conclusions:

1. A groove is an appropriate angular reflector that can be used for the tuning of sensitivity of the defectoscopes.
2. The production technology of the groove seems to be simple but actually it is a quite delicate procedure the results of which

influence on the accuracy of indication during the adjustment and calibration.

3. There is no information about the scaling factor for the angles of incidence more than 73 degrees. To solve this problem an experimental research was carried out.
4. As a result of the research, the experimental samples with the grooves and the kit of prisms were made. They allowed to determine the values of the scaling factor for the angles of incidence of 0-80 degrees.
5. Constructed samples with grooves can be used in practice of nondestructive testing as good helpers for tuning the sensitivity and calibration of defectoscopes.

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RESEARCH OF THE NUCLEAR POWER PLANTS: SAFETY AT WORKPLACE

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Since, nuclear power plants (further referred to as NPP) appeared, society has asked many questions about safety and security. Information about radiation, nuclear decay, gamma emission was used for disinformation of public.

According to the history, there were 3 accidents, which lead to deplorable results. Among them are Three Mile Island, Chernobyl, Fukushima. Although sad results were observed

only in Chernobyl, it is necessary to keep in mind that NPP are very dangerous objects.

Today there are many regulations and rules of operating nuclear power plants, but it is not enough. The problem of safety is analyzed by many scientists and there are solutions, but surprises are presented by fate.

This work is devoted to the investigation of problems, such as large uncontrolled radiation sources, abandoned medical and industrial

equipment, the problem of the high-accurate direction and impossibility of the fast reaction in the extreme emergency [3].

By definition, nuclear power plants are a major source of electricity in the world. About 20 percents of our nation's total electricity is generated by them. Due to careful planning, detailed engineering and design, stern licensing and regulation, intensive training of operators, and thorough environmental control we can ensure that nuclear power plants operate safely. Although there are security measures at all NPP, in history there are many accidents at NPP with sad outcomes.

In fact, nuclear power plants always maintain strict security to help ensure their operating safety and protect against the loss of nuclear materials or acts of sabotage that could cause an unplanned release of radioactive material.

In relation to nuclear energy, Safety is nearly linked with Security, and in the nuclear field there are Safeguards. Safety focuses on undeliberate conditions or events leading to radiological releases from licensed activities. It relates mainly to intrinsic problems or hazards.

Needless to say, that security is focused on the premeditated misuse of nuclear radioactive substances by non-government elements to cause harm. It relates mainly to external threats to materials or facilities. Safeguards focus on restraining activities by states that could lead to acquisition of nuclear weapons. It concerns principally materials and facilities in relation to rogue state [1].

Actually, only in the late 1970s extensive analyses and large-scale proving began. By 1979 a meltdown of the Three Mile Island reactor occurred, which was the worst possible accident in conventional western nuclear power. It did not cause dramatic social harm. In the nuclear industry scientists and engineers are still working hard to minimize the possibility of a meltdown accident, but it is now clear that no-one needs the phobia of a potential public health cataclysm.

There have been only two major accidents at nuclear power plants - Three Mile Island and Chernobyl, the latter being of little relevance outside the old Soviet bloc. There are the three significant accidents in the 50-years history of civil nuclear power generation:

The first was the Three Mile Island (USA 1979) where the reactor was severely damaged but radiation was contained and there were no adverse health or environmental consequences

The second, Chernobyl (Ukraine 1986), where 31 people died, had significant health and environmental consequences by the destruction of the reactor. The death toll has since increased to about 5.



Figure 1. The nuclear reactor after the disaster in Chernobyl



The third, Fukushima (Japan 2011) where three old reactors (and possibly the fourth) were written off but the effects of loss of cooling due to a gigantic tsunami were largely contained.



Figure 2. Satellite image on 16 March of the four damaged reactor buildings

However, apart from Chernobyl, no workers or members have been killed as a result of exposure to radiation. Most of the considerable radiological injuries and deaths that occur each year are the result of large uncontrolled radiation sources, such as abandoned medical or industrial equipment.

(There have also been a number of cases in test reactors and in one army plutonium-producing pile – at Windscale, UK, in 1957, but none of these resulted in loss of life outside the actual plant, or long-term environmental defilement) [2].

Due to the following measures it is guaranteed that nuclear power plants in the United States are operated to defend the health and safety of workers, the nation, and the environment:

Firstly, government and Federal regulations limit the quantity of radiation that nuclear power plants are allowed to release.

Secondly, Multiplex barriers, protected from the release of radioactive materials, with the final barrier being a hard steel or concrete containment structure that encircle the major part of the nuclear system.

Thirdly, power plant skilled personnel, establishes programs and conducts audits, inspections, and environmental monitoring to ensure that the plants are operating safely and are in conformity with the limits on radioactive substance releases.

Fourthly, reactor skilled operators are licensed by the NRC. They are carefully trained and periodically retrained on operating procedures.

Fifthly, strict security must be always maintained to prevent the loss of nuclear materials and acts of sabotage.

Sixthly, the transport and storage of spent nuclear fuel are severely regulated.

Eighthly, every nuclear power plant that could affect public health and safety have emergency plan.

Ninthly, periodic exercises and drills are also conducted by utilities to ensure that all personnel knows what to do in case of an onsite or offsite

emergency. These activities are coordinated with other Federal, state, and local agencies [1, 2].
Figure 3. NPP Protective barrier – external protective shell

Consequently, it has the following results. First of all, it may be seen, that NPP are very technologically hard objects with many invisible problems of safety and security.

In the reviewer's opinion, solution to these problems is creating new technologically high qualified specialists, which help to improve safety. Also, it is required to build NPP at great distances away from big cities and create them in closed towns or cities.

In conclusion, now there are many types of the security rules, laws and so on. Rules, described in this report, are the most useful in industry. With a help of these rules people do not need to worry about disasters.

Finally this work shows that in the world there have been only three bad accidents at nuclear power plants. One of them caused many human victims.

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IMPROVEMENT OF TECHNOLOGY WASTEWATER TREATMENT OF “GRAMOTEINSKAYA MINE”

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Environment protection is the most important problem of a society at the present stage of development. Its solution based on the establishment of industrial production of low-and high-performance processes. For industries that make a significant contribution to the pollution of Kuzbass natural resources, coal industry is the one which creates a large solid and liquid wastes in the extraction and enrichment of coal. Most environmentally dangerous are the enrichment of liquid and solid flotation tailings, contaminated

foreagentami (relating to Class II and III risks petroleum or petroleum products) and the fine fraction of coal (which is carcinogenic).

Liquid wastes in underground coal mining includes mine water containing finely dispersed coal dust, coal related aromatic organic compounds area washed out at contact with water and aliphatic humic compounds (which give color mine waters), particularly in D and GJ coal grades, which presence can increase the chemical oxygen demand in water and oil to create a film in fish

ponds. Wastewater getting into natural water bodies, the earth's surface and destroying natural ecosystems, inhibit flora and fauna, drinking water pollution and contaminated agricultural products increased morbidity and mortality.

Open Joint Stock Company "Mine Gramoteinskaya" was formed as a result of the OOO " Mine Gramoteinskaya" transformation in 1999. On December 20, 2002 "Mine Gramoteinskaya" became a branch of the Open Joint Stock Company" United Coal Company "Yuzhkuzbassugol.

The main industrial site of the mine is located in the village Gramoteinskaya. Gramoteino is surrounded by residential buildings on the northern outskirts from 2 sides. This site includes: office building of the mine, the building of ABA, electrical shop a boiler room, a swimming pool and Ice Palace for sport events.

The company applies a two-stage cleaning system of mine waters from suspended solids, which is presented in Figure 1.

The first stage is 3 primary purifiers.

Table -1 Composition of mine water before and after cleaning.

| | Indicator Unit | Mesurements | Before cleaning | After cleaning | MPC of discharged water | MPC pit. |
|----|--------------------------|-------------|-----------------|----------------|-------------------------|---------------|
| 1 | Temperature | °C | 20 | 21 | - | - |
| 2 | Transparency | Sm | 8,0 | 15,5 | - | - |
| 3 | Suspended solid | mg/l | 1880,0 | 36 | 34 | 2,6 |
| 4 | pH Value | pH | 8,14 | 8,06 | - | 6-9 |
| 5 | BPK full | mg/l | 13,53 | 1,12 | 6,72 | 6,72 |
| 6 | Oil | mg/l | 0,35 | 0,25 | 0,30 | 0,1 |
| 7 | Phenols | mg/l | 0,003 | 0,002 | 0,001 | 0,001 |
| 8 | Chloride | mg/l | 97,0 | 95,20 | 350,0 | 350,0 |
| 9 | Sulphates | mg/l | 353,56 | 353,10 | 500,0 | 500,0 |
| 10 | Solids | mg/l | 1849,5 | 1400 | 1500,0 | 1500,0 |
| 11 | Iron | mg/l | 0,09 | 0,05 | 0,29 | 0,3 |
| 12 | Nitrogen ammonium | mg/l | 1,569 | 1,569 | 1,5000 | 1,5000 |
| 13 | Nitrite | mg/l | 0,008 | 0,02 | 3,3 | 3 |
| 14 | Nitrates | mg/l | 9,72 | 8,17 | 45 | 45 |

The table shows the excess of maximum permissible concentrations of suspended solids, phenols, and ammonia nitrogen.

The existing process of mine water purification contains a number of disadvantages and one of them is:

- low purifying effect of mine waters;

The presence of defects indicates the need to improve the technological scheme of of mine waters purification.

Thus, a new scheme of waste mine water purification using primary and horizontal purifiers is proposed. It is presented in Figure 2. After settling,

After purification waste water get into septic tanks of the 2nd stage through a gravity collector, which consists of two horizontal purifiers.

After purification waste water is discharged into the Meret river through a closed collector.

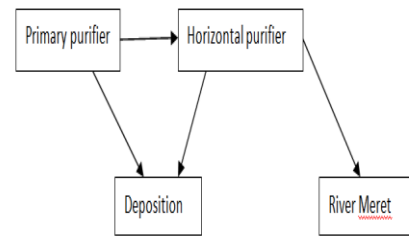


Figure 1 - Scheme of mine waters purification.

There is an analysis of mine water treatment at the Gramoteinskaya mine. The results of the analysis of mine water treatment at the mine is presented in Table 1.

the water gets into the mixer, where it is mixed with a solution of sodium hypochlorite and alumina $Al_2(SO_4)_3 \cdot 18H_2O$. Having been passed through faucets, water with suspended sediment gets into the clarifier of the corridor type to be discoloration. After that water runs to the clarifier filters that provide the required quality of treated water according to Sanitary requirements 2.1.4.1074-01. Purified water flows into the tank with clean water.

Remaining water volume is supplies to the mixer, where it is mixed with sodium hypochlorite. After mixer water run to the tank along the private collector and then it is dumped into the Meret river.

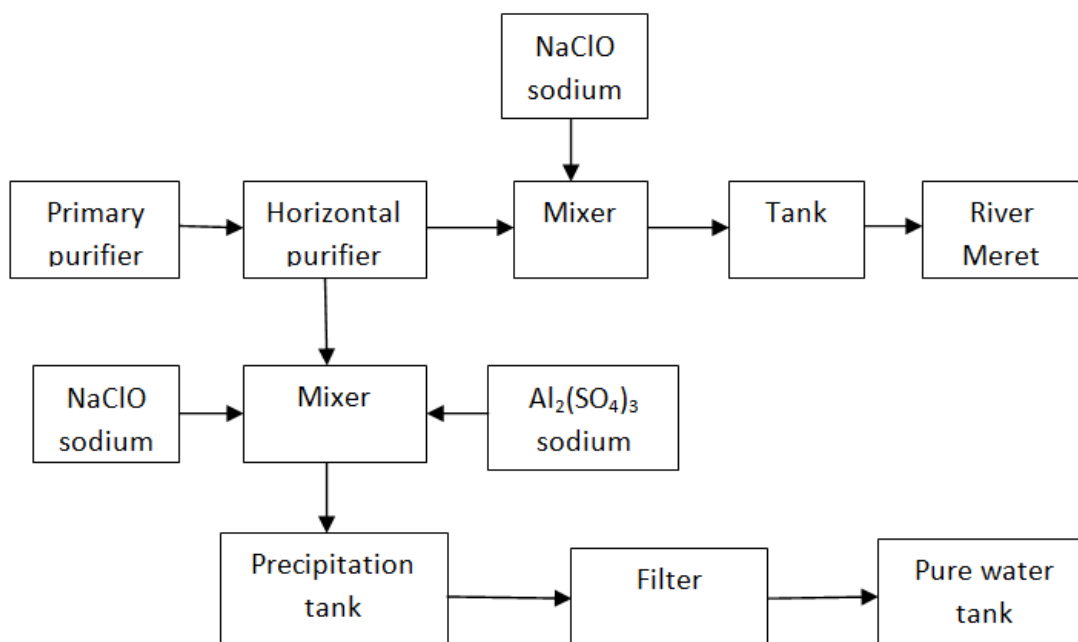


Figure 2-The system of mine wastewater treatment.

Wastewater treatment plant for this process is used for cleaning water of suspended solids and disinfection of neutral mine water for its subsequent use in the production needs of the mine and adjacent businesses, as well as for preventing water pollution resulting from the excess mine water sewage.

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MENTALITY INFLUENCE ON EFFICIENCY OF SQM INTRODUCTION IN RUSSIA

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It is often call into question the expediency of implementation of systems of quality management (SQM) on the basis of ISO 9000standards series because of their low efficiency recently in Russia.

Introduction of SQM is not only maintenance of qualitative manufacturing of production and economic stability of the company, reputation improvement, but also the process of constant improvement which is the basic source of benefits from the functioning of the SQM.

At present quality of production and services in Russia causes well-founded alarm: there are no

qualitative goods of a domestic production in the Russian market. 80 % of systems in the Russian organizations are incapacitated and useless, though provided by certificates of conformity [6].

What is the reason of this situation? Consider the internal and external reasons in relation to the organization [6]. The internal reasons include formal introduction of SQM; backwardness of the Russian companies in a hardware; out-of-date approaches in management; a pursuit of immediate results; isolation from financial and economic processes. The external reasons:

historical preconditions to the scornful relation to quality, qualitative work; features of the current legislation; a raw orientation of the Russian economy, a difficult economic situation of the majority of the Russian companies.

Within the limits of the given work we can't consider all reasons set forth above. For the further consideration we choose «formal introduction CMK». Default of principles CMK in the Russian companies, as a rule, connect with mentality of our people. For this reason we have decided to contemplate a problem of an inefficiency of introduction CMK at the enterprise in our country through a prism of the Russian mentality.

«Mentality - a certain views, set of intellectual skills and the spiritual installations inherent in the separate person or public group» [8].

The mentality is inherent in almost each people. For example, such lines as compulsion, the collectivism [9], specificity of the American approach is maximum operation are inherent in Japanese, at them business process is perfectly registered, all duties are accurately registered, at Germans - the discipline and isn't welcomed imagination [4].

Lines both western, and eastern type of thinking are inherent in Russians. In many statements of known scientists possibility of Russia to become the intellectual bridge between the East and the West, in force historically existing interactions with set of the states, deep understanding of mentality and an ethnic variety of the people living in limits of the borders [9] is even more often underlined.

For revealing of the basic mental characteristics of Russians and an establishment of communications between these characteristics and principles CMK we had been developed the questionnaire.

As a result of statistical processing of the received data we have received following results: students don't trust in career and professional growth at the domestic enterprises (fig. 1) and as consider low quality of formation and culture of Russians (fig. 2).

On the basis of questioning inconsistent opinions on the relation of Russians to work have been revealed: they don't associate work with reception of fast result, but at the same time aren't capable long and to work persistently over the task in view decision, often communicate on abstract themes on work and arrange "smoke breaks" (fig. 3). So, according to an information portal Subscribe.ru [7], labor productivity in Russia makes only 26 % from labor productivity of the USA.

The majority of the interrogated is considered extended in the Russian society by non-observance of moral standards and rules (73 %).

Positive line of Russians interrogated named their initiative (that strange in the light of absence in sew to the country of active struggle for the rights and huge administrative pressure on which Russians aren't capable to render due repulse).

Under answers it is visible that our compatriots with condemnation concern management actions (83 %), don't respect the heads (66 %). The current situation reason is prevalence of authoritative management style (75 %).

Russians, as a rule, don't have pride of an accessory to the organization in which work (75 %). It is possible to assume that such situation has developed because of low paying of attention to corporate culture the Russian enterprises. During research respondents have disagreed about presence of the unwritten rules regulating the relations in collective, thus confirming about far not to friendly atmosphere in collective (81 %).

Answers of the questioned haven't generated single representation about the basic forms of encouragement for work (51 %/49 %).

Respondents don't consider as characteristic feature of the Russian organizations introduction of the new productive forms of government (on the western type) (66 %).

During research of 72 % interrogated have agreed with the statement that Russians strictly observe various norms, rules, standards and laws.

On the basis of the received results it is possible to draw a conclusion that in Russia there are the objective reasons lying in the field of mentality, for non-observance of fundamental principles CMK, in particular «management Leadership» and «personnel Involving».

On the basis of answers it is possible to assume that or Russians really regress, or it is a question of a low self-appraisal, about so-called «domination of myths».

In favor of the first version tells much: low level of morals and ethic in Russia, distribution of the bad habits, falling level of erudition and culture, as has proved to be true by results of the questionnaire, and legal nihilism of citizens though answers of respondents disperse from this obvious fact (probably, it is connected with features of interrogated social group).

We consider the second version as more plausible because reviews about Russian-workers and successes in work of the Russian experts abroad speak responses of foreigners about high level of professionalism and self-return [1,3].

Our compatriots living in Germany, at carrying out of sociological poll especially underlined that «... the Russian worker is distinguished by the universal qualification got in the Russian education

system, unlike highly specialized skills of German experts» [1].

The professor of the Swiss institute, arrived to work to Russia, marks: «... you, Russian, always search for sense in the activity. Herewith you never believe that the authority(heads) know more. Therefore, if the chief speaks to you: go and make that and so, you necessarily will tell that it can be made in another way or it is not necessary to do at all. But it is not from laziness. On the contrary, you are very focused on result and want to raise efficiency of work». [3]

Thus, we perceive ourselves through a prism of myths, and it prevents to use us our potential.

Owing to the above-stated, there are hopes that CMK, based on the western style of thinking, has good chance to get accustomed in the Russian organizations and to be the effective tool of management, instead of a burden.

For this purpose developers of CMK should consider features of our mentality and adapt modern foreign methods for working conditions of the concrete organization. The mentality is a substance enough inert, its change occurs for long time, it is necessary to increase quality on level of national idea. It is important to develop the concept leaning against merits of Russians (diligence, purposefulness, ability to be mobilized, incur responsibility) which is provided as "while-joke" leveling of our negative lines (hope on "perhaps", neglect to people, love of power, disrespect of professionalism).

In conclusion we would like to say the words of Russian philosopher Ivan Ilyin, "We trust and know: the time will come, and Russia will rise from disintegration and humiliation and will begin an epoch of new blossoming and new greatness. But it will revive and blossom only after the

Russian people understand that it is necessary to search for rescue in quality!.»

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MANUFACTORY STANDARDS' CONTENT QUALITY MANAGEMENT ON THE BASIS OF ONTOLOGY MECHANISM

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A key feature of any consumer product is its quality. It is especially important to the development of high-tech systems such as aircraft and spacecraft, robotic systems and complexes, etc., because a systems approach is important and comprehensive assessment of the reliability of all subsystems [1]. It is particularly difficult to control quality of production in the circumstances where new solutions and technologies ahead of regulations governing the design of the apparatus

(sectoral recommendations, Standards, guidelines). There is a problem of timely and quality of standards' content management. Let's consider one of the approaches to the problem solution via intelligent information systems consulting, in order to be exact - ontology mechanism.

At first we should note the characteristics of standards that impede their operational update:

- passage of a formal bureaucracy and expert bodies (the more documents are re-approved, the more time and strength it takes),
- it is not clear that operational changes in different parts of a document are necessary but new technical solutions are appearing,
- solutions descriptions in standards are structured feebly and are not estimated to perspective of updating,
- low degree of technological design assessment of the effect of the new changes on the final product [2].

These reasons show that task solution is nontrivial and special approaches are required. It is obvious that the development of an information system with a traditional database is inadequate to the occasion and it is necessary to apply more sophisticated technology. Some of them are decision support systems (DSS) based on the method of expert evaluations and artificial intelligence algorithms. Similar systems operate information and knowledge of the subject area which is standard's support, also that systems operate metadata which describe the interaction of various subsystems regulated product, and rules for their evaluation. Thus, a knowledge base is formed, and there are a range of topical recommendations in the updated standard which is synthesized on the basis of this knowbot and which is formalizes estimation of manufactured high-tech products' quality procedures.

What did we propose ontology mechanism as a basis in this paper for? Because in a complex technical object combines various scientific and, therefore, working groups of experts which may expertise primarily only on their narrow field of knowledge. For example, when satellite is being designed power engineering specialists, programmers and mechanical engineers, signalers, and many others are working, and to evaluate the impact on a product making up individual employee's mind is understandable job for that employee only. This reduces the quality control and development of integrated tools for assessment of the product becomes conditional. Then the benefits of integrating knowledge of various expert groups into a single knowledge base are obvious.

An integration method and knowledge description is governed by ISO 15926 and has found wide application in modern high-tech products [3]. Therefore, an ontology mechanism best suits the concept of systems engineering [4] and its best use, not only for the design of individual products, but also in the preparation and updating of standards for the creation a lot of complex mechanisms types. And this is a must have informatization at design process which is provided by modern intelligent decision support systems. Ontology technology, expert systems and cognitive graphics are consolidated into a single

information environment that will bring the process of quality control at a more advanced level.

Ontologies, as a describing and combining different areas of expertise mechanism, allow to form a meta-level description of the object. Then the information which is specific to one area is processed in the relevant part of the knowledge base, and then transferred to the level of metaknowledge, where the result is translated into system-wide terms and can be translated to another part of the knowledge base. Specific solutions can always be evaluated in terms of integrated indicators with assessing their impact on the performance characteristics of the final product.

What is included in the meta-level? Firstly, meta-level includes baselines, which are assumed as a basis for estimating the quality of the technical object and for describing of all subsystems in the usual form for the experts of relevant fields. Secondly, the meta-level contains a set of axioms that restrict the calculation of area characteristics of the device, and a lot of problematic issues, focused on evaluation and optimization of high-quality final product. Thirdly, it contains special rules for displaying information in the co-called common language, and, if necessary, it can easily be transferred to other special form. Thus, the integration of data, summarized in a single knowledge base, is a solution to the problem of operational information update of organization scope or industry scope standards.

It is a pertinent question if it is so easy to make supplement in a regulatory document with new information, it won't be a standard. The answer is clear that supplements should not touch the basic principles and tenets of the theory, and should set specific technical solutions (including the method of calculation and evaluation of performance) and the table of decision-making options. But the rules for choosing a particular technology from the existing options must initially formulated as an optimal choice, based both on particular and integral objective characteristics of the projectible system estimated elements. To minimize changes in the standard when a new part, chip or algorithm appears there is no necessity to review all standard, only single applications. Then the main (fixed) part of the standard includes information about the structure of the object and its environment, as well as integrated indicators of quality. Revised part of the standard (the application) describes the existing technological solutions, evaluation method (with access to integral values), reference examples and tests, the comparison table to automate the process of decision-making and evaluation.

Then the life cycle of work on amending standard will be as follows:

1. to gather information about a new method or technical solution that is necessary for further

consideration and possible use in new product development,

2. to select criteria for new solutions and linking them with the integral parameters of the meta-level,

3. to develop methodology for assessing the need for the object relative to the criteria found (including a description of test methods of the object and rendering on standard models),

4. to change the table of decision-making through addition of data that will confront with the effectiveness of this method and methods previously recorded in the knowledge base,

5. to add a meta-ontology that allows to include new knowledge fragments in an automated process for the synthesis of solutions and quality control of the final product.

In case this organization structure exists in this way, each modification of the standard document, regardless of the direction in which the change is a subsystem will be reviewed only partially affecting any additions to the list of technologies and the comparison chart on the basic criteria. Everything else will be considered in the synthesis of DSS solutions of a system configuration that meets the requirements and limitations of technical tasks and optimizing the selection of individual technical solutions in the sub-systems, to make full use of the ontologies possibilities.

Let us turn to the following principal advantages of using ontologies in the synthesis of specific performance of complex technical device (aircraft, satellite, bathyscaphe, etc.):

- an ability to describe the system products, parts, principles of operation and the specifics of the environment,

- an ability to integrate the knowledge of experts in various subject areas, with subsequent synthesis of generalized knowledge to calculate the integral parameters,

- a possibility of formulation of the optimization problem for forward and backward derivation of knowledge (the strong ontology concept).

Technical elements that allow DSS to organize the proposed architecture must implement a complete data processing. Therefore, they should include a storage subsystem knowledge (as in the form of databases and knowledge description languages), analytical processing subsystem, an I /

O information and knowledge (test modes, control, debug), the synthesis of advanced forms of graphical display of information, explanations of decisions. It is efficiently to realize such an information system architecture as a software package, built on a modular fashion [5], where each module is designed for the class of work: working with the standard (the study and synthesis of technical solutions), modifying of meta-level knowledge base, forming of knowledge on specific methods and decisions, preparing accompanying data (criteria for describing a fragment of knowledge, methodologies for evaluating solutions, reference examples, and so forth).

Obviously, the work on the mechanism of the formation of such a DSS should be performed by a knowledge engineer [6], not by a technologist, an engineer or a programmer. The proposed approach to forming of industry standards has high potential, high efficiency, and decisions controllability on the basis of both the branch of industry and the choice of the specific configuration of projectible technical system.

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QMS IN UNIVERSITY

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Introduction

In the conditions of the fast development of the higher education, the creating of the formalized systems assuring the fulfillment of the academic standards became indispensable part of our society.

More and more requirements put for the higher education, especially from the point of view of the demand on the job market. That's why the necessity of implementing the quality management systems (QMS) arisen.

The purpose of my study is to research the process of implementing the Quality Management System (QMS) in universities. This paper presents detailed description of the process of implementation quality management system according to ISO 9001: 2008 standard, which has the significant influence on improving the quality of education. The various factors, which decide on the quality of the university have been described.

Research

From J.M. Juran's the general quality definition, it can be initially accepted, that the quality of the university (the quality of educational service). It is regarded as the degree. It fulfills the growing requirements of surroundings and helps the students' development, at simultaneous care about the solid development of didactic and scientific personnel [1].

The care about the quality of education in the universities is one of the basic process. The process creates the present market of educational services. The quality of education becomes the basis working out and implementing the strategy of the development of educational units. Concerning the designing and implementing the quality management system at the university it is regarded as the long-term process. This process should be realized in stages, and should be supported by the university.

The implementation process of the Quality Management System includes the following stages [2]:

1. Making the decision about the implementation of the system by the highest management of the organization.

2. Establishing the Quality Representative at the University.

3. Establishing the working teams of the implementation of the Quality Management System.

4. Preliminary audit.

5. Working out the detailed plan of implementation works.

6. Training of the university management and workers creating the structure of the system.

7. Defining processes realized at the university and their ratios.

8. Working out the documentation of the Quality Management System

The university documentation includes:

- Quality Manual,
- Procedures,
- Instructions,
- Other documents (drafts, forms, records).

9. Training of the internal auditors.

10. Implementation of worked out system and its checking.

11. Certification audit.

12. Control audits and improvement activities.

Whether the institutions develop their own quality assurance system or adopt the international standards. The key point is that the institutional quality assurance system has to be —established - documented - implemented - maintained and continually improved.

Experiment

Currently, a general model of QMS of educational institution in Russia is in the process of its development and evaluation. I have carried out a sociological study of students TPU. Questionnaires filled with about 55 students from various institutes of TPU. I made the following conclusions. About 75 percent of students TPU don't know about the existence of the QMS. About 50 percent of the requests to the university as a provider of services are catered. About 33 percent of students are not satisfied with the evaluation system of training. More than 41 percent of students think that the university is not measured by the quality of education (fig.1).

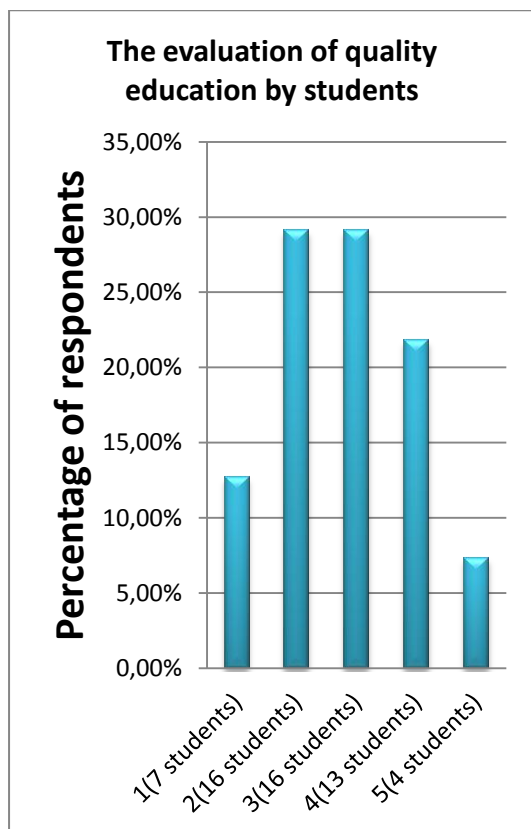


Figure 1. The evaluation of quality education by students

As a rule, all existing approaches to the establishment of QMS in educational organizations are aimed at enhancing the degree of standardization processes. However, they are not devoted to the development of creativity and diversity in their application. This fact appears to be the main drawback limiting the application of different quality management systems in universities that have academic freedom. This problem can be solved by introducing of the integrated approach to quality management of educational activity[4].

Conclusion

The research results are the clue that the quality management system, became implemented, documented and certified. Assures the supervision over the whole university and makes possible the efficient management,

monitoring and improvement of all processes and elements.

The universities which implemented the quality management system according to ISO 9001 standard stay in eyes of their customers as credible, reliable and well organized. This raises the prestige and the assumption of better position in the ranking of universities. The advantages of QMS are the additional impact to its development [5]. Those are:

1. The assuring the system management for the resources and knowledge,
2. Starting the constant process of improving the university,
3. Guaranteeing the efficient flow of information about each task and their realization,
4. Improvement of functioning the university and its management,
5. Quick and effective solving problems,
6. Avoiding the mistakes (instead of repeating them),
7. The change of approach to the quality of education,
8. The improvement of planning and budget discipline,
9. Increasing the productivity and effectiveness's of the university,
10. The growth of responsibility, motivation and commitment of the workers .

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THE CONTROL OF THE MICROWAVE PLASMA CHEMICAL REACTOR THERMAL MODE

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The problem of deep processing of hydrocarbon raw materials requires a search of new approaches and solutions. One of them is conversion of natural gas (methane) into carbon and hydrogen.

The staff of Institute of Physics and Technology of National Research Tomsk Polytechnic University have developed a technique and created the installation for conversion of natural gas (methane) into carbon nanomaterial and hydrogen[1]. This method is based on the combined effect of the catalyst and the plasma of the microwave reactor to gas. This physical-chemical effect allowed to obtain a high degree of natural gas conversion equal 76 % [2].

An important part of the nanomaterial reception process is the control of the microwave plasma chemical reactor thermal mode. When conducting temperature monitoring, we can draw a conclusion about the beginning of natural gas decomposition reaction. At the first stage the metallic catalyst (Fe, Ni, TiNi) is heated in the installation by means of ultra-high frequency (UHF) energy within the nitrogen current up to temperature $\sim 560^{\circ}\text{C}$ thanks to dissipative losses. Then cold natural gas ($\sim 30^{\circ}\text{C}$) is provided to the reactor, nitrogen supply is cut out and microwave discharge appears in the discharge chamber. Thus, the temperature of the catalyst is decreased to $450 - 480^{\circ}\text{C}$ depending on the methane flow. Fixing the temperature changes we can make a conclusion about the beginning of the decomposition reaction.

The control of temperature is carried out with the help of the pyrometer "Kelvin". There are three quartz windows throughout the height of the reactor for controlling catalyst temperature. Pyrometers do not require any contact of a measuring device sensor with the body whose temperature is measured. Therefore, a pyrometer can be used to measure very high temperatures. The pyrometer " Kelvin LCM 1300" has good metrological characteristics.

In real conditions the pyrometer doesn't always accept all radiation of the controlled object. Such objects as vapour, dust, sight glasses, or, for example, installation elements can cause decrease of radiation captured by the pyrometer. The intermediate medium found on the way of the pyrometer rays are shown in Fig.1

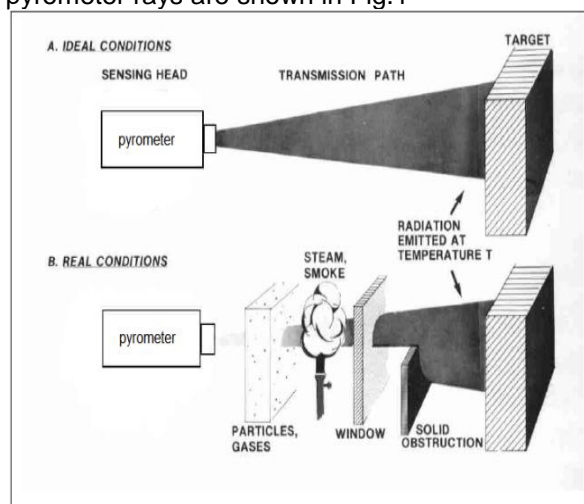


Fig.1. Intermediate medium found on the way of the pyrometer rays.

To identify and evaluate temperature measurement error/accuracy of the catalyst the experiment was carried out. In the experiment a nichrome spiral was used as a control object. At first, the spiral temperature was measured through the air gap, and then through the quartz window (two samples of different thickness are used) with the help of the pyrometer "Kelvin" installed at a distance of 80 cm from the spiral. The quartz window was placed on the way of the pyrometer rays at a distance of 14 cm from the spiral. At first, the spiral temperature was measured through the air gap, and then through the quartz window (two samples of different thickness are used) with the help of the pyrometer "Kelvin" installed at a distance of 80 cm from the spiral. The quartz window was placed on the way of the pyrometer rays at a distance of 14 cm from the spiral.

Table 1. Results of experiment.

| Sample | T, °C (measured through the air gap) | T, °C (measured through the quartz window) |
|--|--------------------------------------|--|
| One sample, thickness is equal to 4 mm | 577 | 385 |
| Two samples, common thickness is equal to 8 mm | 577 | 266 |

From the table 1 we can see that the temperature measured through the quartz window and the temperature measured through the air gap are different. It is so because the radiation registered by the pyrometer includes the following components:

$$\Phi_{\Sigma} = (\varepsilon \times \Phi_{Obj}) + (\rho \times \Phi_{Amb}) + (\tau \times \Phi_{Back})$$

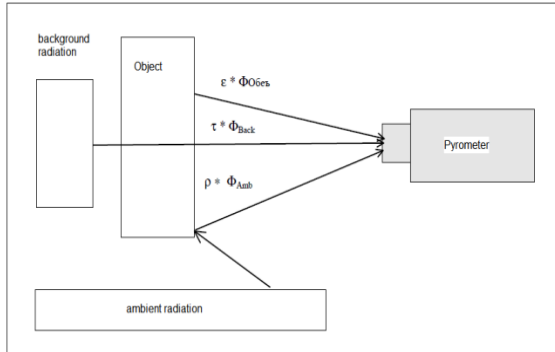


Fig.2. Structure of radiation registered by the pyrometer.

According to the energy conservation law the sum of the coefficients of the emitted (ε), reflected (ρ) and transmitted (τ) energy must be equal to 1.

$$1 = \varepsilon + \rho + \tau$$

For opaque measuring objects the equation is simplified:

$$1 = \varepsilon + \rho$$

So, when registering radiation by the pyrometer, we should consider not only the coefficients of emission and reflection of a spiral,

Where

ε – emission coefficient of the measuring object
 ρ – reflection coefficient of the measuring object
 τ - transmission factor of the measuring object
 We can see structure of radiation registered by the pyrometer in Fig.2:

but also the emittance, reflectance and transmittance coefficients of the quartz window.

The experiment has shown that when the catalyst temperature is measured in the microwave plasma chemical reactor in real conditions, we should take into account that the quartz window located on the way of the pyrometer rays causes a decrease of the captured radiation. Thus, there is significant difference between temperature was measured through the air gap and temperature was measured through the quartz window (~ 192 ° C) and we should take this into account in future experiments.

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| Section X | |
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**HEAT AND POWER
ENGINEERING**

COMPARATIVE ANALYSIS OF LED LIGHT SOURCES AND MIRROR INCANDESCENT LAMPS

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There are many wrong or outdated views on the LEDs. In Table. 1 you can see the main results and reality.

Table 1. Valuation of the main opinions on LED lights

| |
|---|
| I. LED lighting indicators |
| Myth |
| LEDs blind eye |
| Actual situation |
| High power LEDs can blind the eye, it depends on the design of the luminaire as well. Fixtures use a special diode matrix and lenses, and as a result do not have a blinding effect. |
| Myth |
| White LEDs shine not brightly enough to be used in lighting. |
| Actual situation |
| Nowadays, white LEDs are the best light sources in effective light output. There is wrong opinion about their lack of brightness because of the experience of their wrong using and comparison: for example, we can't compare traditional halogen lamp 30 W LED with its analogue because this lamp consists of an assembly of 18 or 21 LEDs with a total consumption of no more than 1.5 watts, and by the way, there are not advanced diodes [1]. |
| Myth |
| LEDs flicker |
| Actual situation |
| It is said, that this problem is concerned about LEDs, but that's absolutely not true, because LEDs operate at a constant current, and do not flicker, creating more comfortable lighting. |
| Myth |
| LEDs provide ultraviolet radiation |
| Actual situation |
| This problem is concerned about fluorescent lamps. The radiation of the LEDs is close to the solar spectrum and does not contain UV lines, in contrast to fluorescent lamps. |
| II. Performance indicators |
| Myth |
| LEDs can't work in a cold weather |
| Actual situation |
| When there is a reducing of temperature, the flow of LEDs and their lifetime increases. |
| Myth |
| LEDs contain harmful substances |
| Actual situation |
| White LEDs are grown on a sapphire |

| |
|--|
| substrate, not on the gallium arsenide, and it is used inert gases in their production, therefore, there are no any harmful substances – in contrast to the fluorescent lamps. |
| Myth |
| LEDs contain gold |
| Actual situation |
| That's true, that it is used gold for obtaining metal contacts in diodes. |
| Myth |
| White LEDs are not heated up |
| Actual situation |
| If we turn on one or more diodes of low power, we will not be able to see their heating. But if the same assembly of 50-100 pc. work for about ten minutes, the heating will be noticeable. It is necessary to cool off diodes of high power (0.5 watts or more) by passive heat sink or active cooling. |
| Myth |
| White LEDs work for 50000 hours (100000 hours) |
| Actual situation |
| Firstly, it is mathematically calculated values and it wasn't checked. Secondly, these values are given for different conditions but in general it is a drop in intensity up to 30 % of the initial value. And thirdly, these values are given for very comfortable working conditions: the temperature of diode should be 25°C (the temperature in closed lamp and closed window is much higher, therefore, working hours are much less) [2]. |
| Myth |
| White LEDs - all cool shade, 6000K |
| Actual situation |
| It is experience of wrong comparison: most not expensive Chinese LED lamps, which can «substitute» ordinary lamps, are collected on these LEDs with color temperature of 6000K or 7000K. In fact, there are white LEDs of all sorts of colors, even with color temperature of 3500K, when the bulb has 2850K. |

In spite of advantages of LED lamps, they can replace incandescent bulbs only in the future. Also lighting with LED light sources must be regularly cleaned and checked, which may reduce the potential savings in maintenance.

Let's analyze LED light sources (LS), comparing them with mirror incandescent lamps.

Table 2a. Lamp's comparison characteristic

| | Mirror incandescent lamp (U=220V) | | |
|--------------------------------|-----------------------------------|------|----------|
| | standard | | infrared |
| Power, W | 60 | 100 | 150 |
| Luminous flux, lm | 710 | 1330 | 2200 |
| Unit cost., rouble. | 35 | 35 | 51 |
| Life time, hour | 1000 | 1000 | 1000 |
| Luminous efficacy n_v , lm/W | 11,83 | 13,3 | 14,27 |
| Light energy unit cost, G | 0,17 | 0,14 | 1,105 |

Таблица 2b. Lamp's comparison characteristic

| | LED Geniled (U=220V) | | |
|--------------------------------|----------------------|-------|-------|
| Power, W | 6 | 11 | 15 |
| Luminous flux, lm | 510 | 950 | 1300 |
| Unit cost., rouble. | 890 | 1170 | 1350 |
| Life time, hour | 40000 | 40000 | 40000 |
| Luminous efficacy n_v , lm/W | 85 | 86,36 | 86,67 |
| Light energy unit cost, G | 87,27 | 61,59 | 51,94 |

Nowadays, prices of LED light sources are very high, but if you set up the production of LED lamps on the automated line, prices will drop. However, a significant reduction in price can be achieved by using its own LEDs, (if you buy an assembly line, you can get a price reduction more than 30%). Thus, the price will be significantly reduced, but you should remember that LED light can be much cheaper [3].

Let's find adjusted prices of LED, talking into account the comparison of the light flux incandescent lamp and the stream of LED lamp, using the formula (1):

$$C_{led_{new}} = \frac{\Phi_{inc} \cdot C_{led}}{\Phi_{led}}$$

(1)

Table 3. Adjusted price of LED lamps

| $C_{led_{new}}$ 6W | $C_{led_{new}}$ 11W | $C_{led_{new}}$ 15W |
|--------------------|---------------------|---------------------|
| 1239 rub. | 1638 rub | 2222 rub |

Table 4a. Rates for economic analysis of light sources [4].

| Rate | Formula |
|---|---|
| 1. Clock cost LS (for any number variant) | $C_i / t_i + P_i q / \cos \varphi_i = tg \alpha_i$ search $\alpha_i = \min$, or $tg \alpha_i = \min$ |
| 2. Time of cost's compensation on LS1 and LS2 ($K_i=1$) | $t_B = C_2 (C_1 / t_1 + P_1 q / \cos \varphi_1 - P_2 q / \cos \varphi_2)^{-1} =$ $= C_2 (tg \alpha_1 - P_2 q \sec \varphi_2)^{-1}$ |

(3)

| | |
|---|---|
| 3. Time of managing LS1 the whole level of cost LS2 | $t_{II} = (C_2 + P_2 t_2 q \sec \varphi_2) (C_1 t_1 + P_1 q / \cos \varphi)^{-1} = t_2 / K_{t_2}$ |
| 4. The ratio of costs to the LS at the moment t | $K_t = (C_1 / t_1 + P_1 q / \cos \varphi_1) \cdot (C_2 / t_2 + P_2 q / \cos \varphi_2)^{-1} =$ $= tg \alpha_1 ctg [\alpha_2(t)]$ |

(4)

(5)

Table 4b. Rates for economic analysis of light sources LS1 – reflector lamp filament, LS2 – LED-analog

| | 60W/ 6W | 100W/ 11W | 150W/ 15W |
|--------------|-------------|--------------|--------------|
| α | 89,36 | 89,62 | 89,74 |
| t_B | 10,91 | 8,7 | 6,62 |
| t_{II} | 5007,8 9 | 5506,47 | 5004,83 |
| $K_t = f(t)$ | 9,98 | 9,08 | 9,99 |

CONCLUSION:

Nowadays, innovative LED lamps are the most relevant product of new technologies, embodied in a high quality, reliable, electro technical products which will last for a long time, but prices are still very high. The using of LED light sources, which was considered will improve an apparent quality of lighting and safety for human health and the environment, but will not reduce the cost of coverage.

Analyzing the figures for economic analysis of light sources, we can note that incandescent lamps will cover all costs of LED lamps, but no earlier than in 5000 hours.

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| Section XI | |
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**DESIGN AND TECHNOLOGY
OF ART PROCESSING
OF MATERIALS**

THE PROCESS OF MAKING PIECES FROM METALIZED FABRIC

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Nowadays the necessity of making and using metallized fabrics is becoming of current interest. The fabric made with the help of this unique technology is acquiring metallic luster, keeping it is ability to transmit air and moisture.

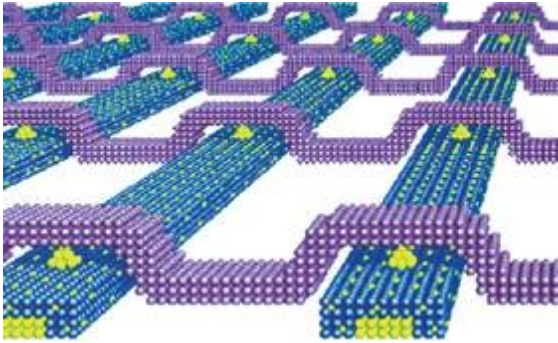


Fig.1. Surface $\sim 10^{-9}$ mm

The inception of high technology scientific developments of this type makes it possible for designers to create unique products, that is why the aim of this article is to present the product that can show the whole spectrum of possibilities of this method.

The uniqueness of this fabric is comprised in the its surface, which cover was produced by magnetron sputtering in Ivanovo, Russian Federation. Under supervising of the head of the Laboratory of ion-plasma processes in Ivanov State Chemical Technology University by Ph.D. Gorberg B.L method of such atomization was discovered for textile industry which previously was applied in microelectronics.

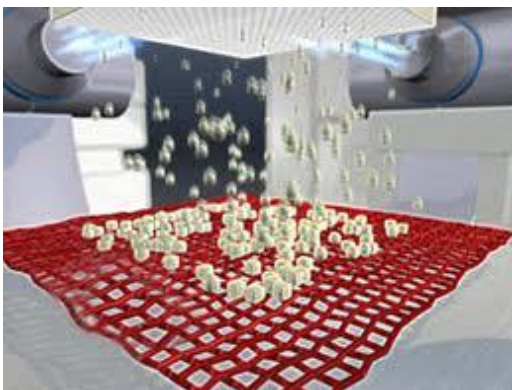


Fig.2. Method

This method is based on usage of abnormal glow discharge in an inert gas with an overlay of a ring-shaped zone of crossed electric and inhomogeneous magnetic fields localizing and

stabilizing gas-discharge plasma in the cathode area. Positively charged ions accelerate in cathode direction and bombard its surface in erosion area embossing particles of iron from it. These particles leaving the surface of target deposit as a film on the substrate (fabric). Large amount of kinetic energy provides high level of adhesion of forming film to substrate. Method of magnetron sputtering is realized in deep vacuum of $5 \cdot 10^{-5}$ mm Hg.

Using this method one can cover the thin films of aluminum, copper, brass, bronze, silver, titanium, stainless still and other metals, alloys and also their connection with oxygen and nitrogen. For instance, titanium nitride in the process of getting "gold like" or pearl surface colored fabric.

Since processing of fabric appear in soft conditions of so called low temperature plasma fabric save structure, breathability, moisture permeability, drapability and strength characteristics.

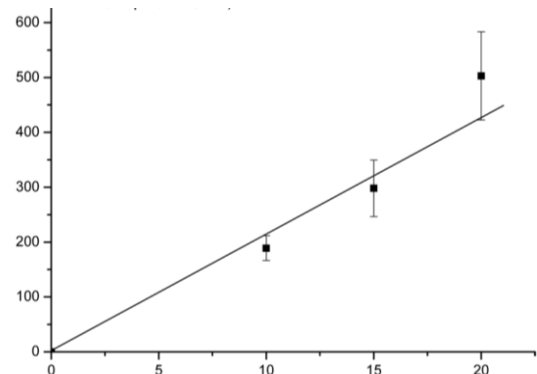


Fig.3. Film thickness (nm) depending of type of deposition time

Spraying of metal layer leads to appearance of electrical conductivity in fabric. Conductivity adds synthetic or non-woven fabric antistatic abilities.

In addition, magnetron sputtering is economical enough. For certain parameters of processing application of ultra-small metal amounts is possible, for example, while powdering high-cost silver, small amount of which can add bactericidal properties to metals or platinum group metals, used as catalyst.

It is essentially important to highlight the fact that presented method is almost ecologically friendly since there is no use in applying chemical materials.

Installation of equipment does not require special engineering communications: wastewater treatment plants, steam generators and chemical

stations. All that makes it possible to use such equipment in small manufacturing.

Metallized material is widely used by designers in manufacturing clothes.



Fig.4. Metallized silk

But we cannot exclude the possibility of applying this kind of fabric while creating accessories, though application of lace in this art and craft area is not an innovation, it has still some essential differences. This type of products tied as a scarf, for example, for bystanders will look exactly metallic. Obviously it is “metal” that can be draped, what is more, it also may be changed at any moment.

Although it is possible to enrich the item avoiding forging in the process of making jewelry, by embroidering it. One should also point out that fabric metallized by magnetron sputtering has noble metal lust and with high-quality sewing it will be respectable to any image. This technology is truly revolutionary. And also such necklace or ribbon in ones hair do not cause inconvenience to the owner because these decorations are as light as the tissue they are made of.



Fig.5. Author's sketch of necklace scarf with a clasp, embroidered with dark beads. Flax, gilding.



Fig.6. The picture of sketch. Example of embroidery.

In conclusion, the author of this article designed an item, based on applying of metallized tissue as one of the way of material processing.

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METHODS AND WAYS OF 3D PRINTING APPLICATION

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Computer technology is increasingly fused with real life. However, the distinction between ordinary reality and computer or virtual reality remains and many spheres of daily life continue to exist without computers or any information devices.

But people have always dreamed of a wonderful easy life where the most of their actions are performed by robots or complex machines. It must be said that modern technology especially IT helps to bring us closer to such life.

It is not a secret that it is easy to move text or picture from personal computer to paper with the help of a cheap laser printer. And about the technology reproducing the model in real material most readers will not even think about. At best, somebody has vaguely heard. These technologies will be the subject of this article.

The most developed technology of prototyping at the moment is Three Dimensional printing. It is a process of real objects creating from some material based on virtual 3D models. 3D-printing can be done in different ways and using different materials, but the basis of any of them is the principle of layered creation (growth) of a solid object. Main device providing this process is 3D printer.

There are two principal technologies applied in 3D printing:

- ✓ Laser technology
 - Laser sintering
 - Laser printing with photopolymer
- ✓ Ink-jet Technology
 - Printing with hot material
 - Powder sintering

The most common material for 3D printing is plastic, but also other melted materials can be used, even chocolate.

A 3D fluid printer is a machine with 3 axes. The print head is mounted on the machine coordinate system. When a head moves to the coordinates X / Y molten plastic is extruded from a thin (0.3-0.5mm) nozzle and solidifies. Typing a single layer, the printer changes the coordinate Z (down platform / raises head) and prints the next layer.

The main differences between the 3D printers are:

- ✓ How the movement is implemented on 3 axes
- ✓ How material is submitted
- ✓ Is the table under material heated or not
- ✓ Support of printing with two materials

Different manufacturers use these characteristics in their devices. Nowadays only a few popular companies produce 3D printers. There are RepRap printers and Ultimaker printers. [1] Also one of ink-jet methods – printing by powder is becoming widespread. This technology is used in professional printers by company ZCorp. The 3D prototyping center of Tomsk Polytechnic University is equipped with machines of this company. Laboratory of 3D prototyping uses Rapid Prototyping System Z Printer 310 Plus (fig.1), which can produce 3D products based on gypsum powder, mold-based hard rock and sand, different elastic products using modern plastics. Also there is a portable Z 800 3D scanner which provides accurate 3D models of any real-world objects at any angle and in any location. Thus the scanned object can be changed by a designer in the CAD-related program and implemented in the true sense of the word - printed in three-dimensional view with a 3D printer. Common steps of process of rapid

prototyping with Z printer are considered more detailed below.

1. Creation of computer 3D-model in the CAD-environment

3D printer Z310 is compatible with BIM (Building Information Modeling - Development of construction

documentation) and CAD (Computer Aided Design) tools. It is possible to work with the following software products: AutoCAD, Revit, Bentley Triforma, FormZ, Sketchup, Archicad, 3D Studio Max and others. Despite such distinction of programs all trademarks came to usage of one common format of 3D models. It is called *.stl.

2. Process of 3D printing

Printer Z310 Plus uses, as it was mentioned earlier, ink-jet technology. Print head causes the adhesive to the gypsum powder material, which sticks it together and forms a pattern. Printing proceeds layer by layer. This printer can use a liquid adhesive to the addition of pigment dyes - and, therefore, to print color model. The resulting model may reproduce not only the shape but also the color (texture) of the virtual prototype.

3. Drying the product

After printing the prototype must be dried in a special chamber and the excess of powder should be removed from the object. The model becomes smoother.

4. Application of the anchor solution

For greater strength product can be covered perpetuate solution (industrial lacquer, epoxy resin), or water from the dispenser.



Figure 1. Z printer 310 Plus in 3D laboratory of TPU

In this way developers and students of Institute of Cybernetics of TPU printed many different objects from prototype of car transmission to buildings models. (fig.2) In addition to visualization also various tests can be carried out before they will be ready as the final product. The industry of Rapid

Prototyping is exactly designs and uses 3D printing technologies for these goals. [2]

Figure 2. Powder house by students of TPU



Appearance of 3D printing has made it possible to create different useful items in many spheres of

today life. It is easy to guess that the largest application this technology finds in manufacturing, especially in engineering: car industry, fast prototyping, air crafting. Also 3D printing is used in foundry, architecture. Separately new technology is developing in design: people print what their inspiration wishes from original buttons to colorful toys and vases. Landscape designers can print their projects and take the decision about correction of projects faster and more effectively.

The largest modern 3D printers allow printing the details which are higher than a human is. Not surprisingly, the technology of rapid prototyping is used in medicine, namely, - to recreate those parts of the body that have been damaged or deteriorated. Thus, dentures and other prosthesis can be printed and then patients would be treated with their help. Perspective of this technology cannot be in doubt. For example laboratorial investigations in the University of Missouri reach a permit to put on Bio-Gel clumps of cells of a given type. The development of this technology is growing of high-grade organs.

3D printing technology is not only useful but also interesting. Popular 3D company RepRap is currently working on a new project. The main idea is a creation of 3D printer, which can print itself. It

is a huge step of the technical progress and it is becoming clear that in the next century it will be possible to print the entire house and the city. But 3D market is not formed and organized and prices are very high. The cheapest machine costs 3000\$ and can print only monomaterial objects. Abilities are very limited on size, difficultness and color. Powerful printers of course have another price and characteristics. Prices may vary from 20000\$ to 50000\$. Obviously not everyone can afford to buy such a device. But IT and mechanical technologies don't stay still. It seems that in the future any housewife would print washing machine, TV or computer

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DESIGN AND MANUFACTURING OF OPENWORK MANNEQUIN-HANGER

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These days, hangers and mannequins have become one of most common ways for presentation of goods. They can also be used as decoration, not only in stores, but also at home and office.

In this article will be discussed the process of creating a mannequin, its advantages and disadvantages in comparison with some analogues, reasons for selection of production technology.

There is a plenty of decorative and at the same time functional mannequins and hangers. Each of them has its own application area. And with such diversity there is a desire to find the optimal combination of price, design and functionality. Let's consider some of them.



a) b)
Figure 1. Hangers: a) standard, b) shovel coat hangers by David Olschewski

Figure 1a shows the common hangers, which can be seen almost in any office or home. This model is made of strong steel, which allows hang any number of clothes, and have simple design. In

fact, this exhibit is not a design project or a top engineer's idea: it is the most common hanger - a compact and easy to use.

Figure 1b shows another version of the hanger designed by David Olschewski, which is a model of the well-known tools with wooden handle base and metal shovel top. [1] From a design point of view the idea is not bad and well suited in country sites. However, from a utilitarian point of view, it is not easy to use: as we see, there is no carcass that supports the shoulders, results inconvenience while storing clothing for a long period of time.

The purpose of this article is to study the process of creating a metal openwork art object (mannequin-hanger). To reach the goal the number of the tasks should be done:

- Creation of conceptual design;
- Determination of joints (constructions or fragments that should be joint);
- Production of scale model;
- Selection of materials and technologies for production.

Creating the mannequin begins with creation of sketch. At the same time the designer must think over the future location of welded joints, because it considerably affects the appearance and aesthetics. Therefore at the stage of the design of project recommended consulting technologist.



Figure 2. Mannequin-hanger.
Designed by Anna Pogotskaya

Figure 2 shows the design of mannequin-hanger made by the student of TPU Anna Pogotskaya. It is based on the outline of female figure, that gives (as opposed to shovel hangers) comfortable arrangement of clothes on hanger. This mannequin is also designed to hang umbrellas, hats, scarves, shawls and etc. Besides, unlike the standard hangers (shown in Figure 1a), this object, even without any clothing is an artistic interior decoration - an art object.

The next stage of work – making of the scale model of mannequin to define the proportions and technological aspects of the joints.

According to the sketch in figure 2 the scale model of mannequin-hanger is being made of wire

(see figure 3). The assembly can be done by soldering, gluing or with use of thin wire (or thread). Besides it is desirable to display all the constructive joints for future welding.



Figure 3. Scale Model

In the mannequin can be marked out separate fragments. It will be necessary to make the butt and tee welds. The following shows the conditional connection of the future model. Conditional - because during the production of full-scale model they can be change due to the requirements of assembly technology. This can happen when not all aspects of the production of art objects was discussed with technologist [2, p. 295].

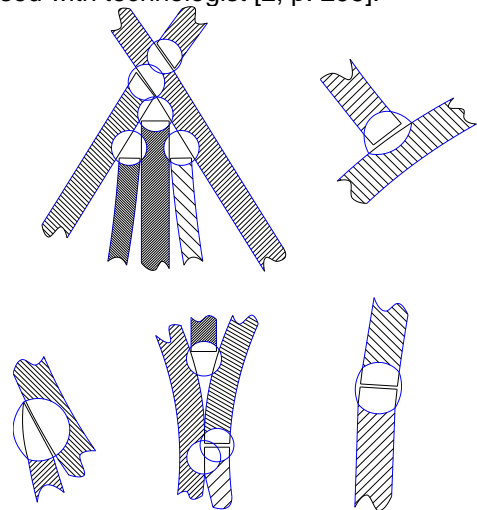


Figure 4. Types of weld joints
of mannequin-hanger

Proceeding to the process of assembly and welding of mannequin it is necessary to choose an accessible and economically appropriate material. In our case, a constructional steel wire. It should be flexible enough and strong at the same time, and have a good weldability. We should also take into consideration the distortion of the metal during welding, as this will greatly affect the appearance of the structure.

In the manufacture of parts we use cold hammering. This is quite cheap method, because it doesn't require a special equipment. However, the manufacturing accuracy depends entirely on the experience of the worker, as well as time-consuming. [2, p. 259]

Due to the small diameter (about 12 mm) it is better to use consumable electrode welding. The final stage will be cleaning, grinding and painting of the mannequin.

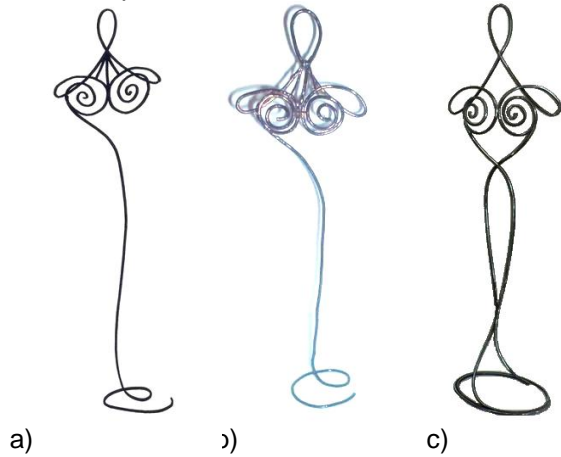


Figure 5. Evolution of forming mannequin-hanger: a) sketch, b) model, c) finished mannequin

Figure 5 shows the dynamics of changing the shape of a mannequin-hanger. The sketch of the model (figure 5a) shows only the image of an object without considering the features of technology. Figure 5b shows the layout of the wire, made in 1:10 scale. In figure 5c you can see photo of the full-scale object, made from a sketch. We see that for implementation of hangers required the following changes:

- Removed three decorative element in the neck
- Reinforcement of basis for improvement of safety and stability of exploitation.

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TRIPARTITE – NUDE – MOSAIC

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Resulting from the analysis of Ernst Ludwig Kirchner's nude drawings, a colorless mosaic made out of stitched papers, combined like a jigsaw puzzle with the area of 2 x 2 m, depicts a consideration of the own body. It is a composition which illustrates different images, depending on the spectator's position and distance from the artwork. Furthermore, these images vary with regard to their intensity. A quote by Kirchner reflects this message: "In thousands of drawings, graphics and pictures these bodies educated my sense of beauty so that I could build the body of the contemporarily beautiful woman."

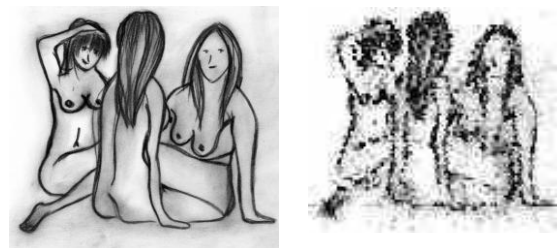
Picture 1: model on a scale of 1:10



We chose different nude drawings, prints and graphics by Kirchner and transformed them into grayscale. The object was supposed to be colorless since it enabled a better representation of the mosaic. The nude drawing on the left is a draft of our own (however, we were still three students

during the previous semester) and we decided to contemplate our own bodies in this case. Looked at from a distance, the object should mirror the outline of the drawing in a mosaic-like fashion. The picture on the right imitates this intention.

Picture 2: drafts of nude drawings



In order to present the finished object we produced a smaller version of it (1 x 1 m) – half the size of the original. For that reason, we combined the small and previously printed images to form a mosaic. Here you can see the smaller version in the process of development. It was very important to measure exactly how many images could fit on one mosaic card.



Picture 3: smaller version

After that we prepared the smaller version with the help of the “tripartite nude-drawing-mosaic-draft”. We divided the necessary segments and photographed them. About 81 components were needed and had to be sewed together.

Picture 4: components

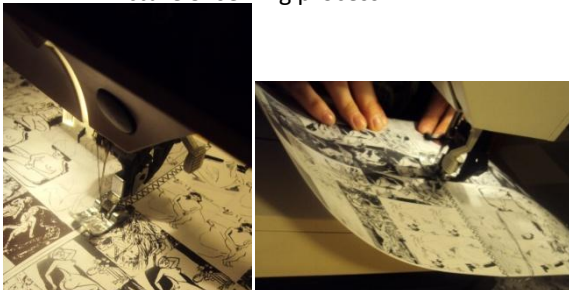


As you can see, all the elements are even. We worked with the computer and used the photographs to produce the individual elements without abandoning the original measurements. The depicted works by Kirchner, which had been taken off the “Prometheus Picture Library”, were printed out after they had been inserted into a specifically developed grid.

The pieces of paper we used for the prints weighed 160 grams each. This was necessary since the material had to be thick enough to “sustain” the process of sewing. In order to choose the ideal texture, we had tried out several types of papers in advance. We cut the prints according to the original measurements and left out a small margin for the seam, which was essential because the “mosaic curtain” should be flexible and by no means static.

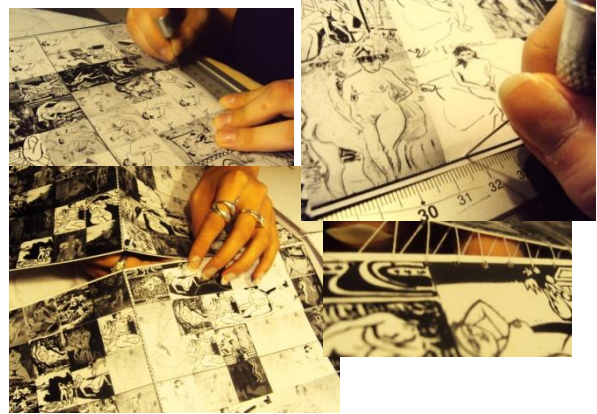
After we had arranged all of the 81 elements in the correct order, we could start with the sewing. At first, we used a sewing machine to merge the various pieces together.

Picture 5: sewing process



However, as the object with its size of 2 x 2 m was too large for further mechanical sewing, we switched to handicraft. We pricked holes for the seams at an interval of 5 mm and afterwards sewed 9 horizontal strips together.

Picture 6: start of the handicraft



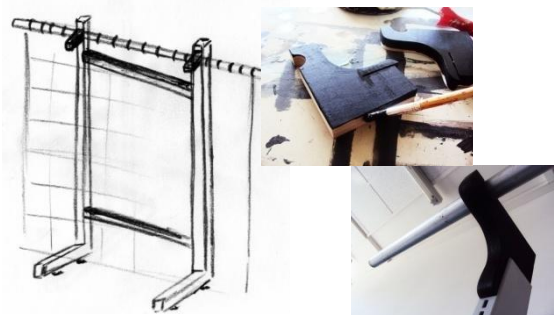
After several hours of work we were gradually approaching our aim. Moreover, we decided upon establishing the artwork as a curtain. First of all we sewed hooks on the curtain so that we could attach plastic rings to them later. Due to the object’s heaviness, we applied a self-adhesive strip of fabric to stabilize the construction. On top of that, we strengthened every single hook with several stitches.



Picture 7: fastening of hooks

The finished curtain is easily foldable because of its flexible gaps. Our curtain rail, made of aluminum, was exactly cut according to the length of the artwork. The wooden as well as the plastic rings perfectly fitted together with the rail and even stayed flexible. Therefore, the curtain could be moved and could easily be set up or dismantled. The framework was made of solid metal.

Picture 8: the framework



This is our framework for the “mosaic curtain”. We very accurately constructed the wooden mounting for the aluminum rail and painted it black. Both of the lateral sections were held together by two connecting elements, which guaranteed

stability since they firmly locked in place with the metal. Thus, the framework stood steadily and was provided with the required balance.

In order to be transported the framework had to be dismantled. However, a plug-in system simplified the repeated set-up. The height-adjustable feet of the framework could be adjusted differently, depending on the floor conditions or the

slope.

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Picture 9: the finished object

INNOVATIONS IN MARQUETRY TECHNIQUE

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Marquetry is the art of inlaying different woods and other natural materials to create a picture. Inlaying is setting a material onto another surface to create a pattern that is recessed in the same material but with the other surface. Most of the time the inlaid material is wood but it could be ivory, mother-of-pearl, tortoise shells, bark, straw, stone, metal, gems, etc. All the peculiarities of grain, knots, defects, etc. are used to create the overall effect of the picture. Marquetry is often found on the finest furniture. It has been around for thousands of years and today it is considered to be something like a dying art.[2]

Techniques of wood marquetry were developed in Antwerp and other Flemish centers of luxury. Cabinet-making was widespread during the early 16th century. The craft was imported full-blown to France after the mid-seventeenth century, to create furniture of unprecedented luxury being made at the royal manufactory of the Gobelins, charged with providing furnishings to decorate Versailles and the other royal residences of Louis XIV.[3]

The appearance of marquetry became possible only after invention of the lathe for producing sawn veneer in the second half of the XVI century. Since that time the furniture made of locally available inexpensive species of wood became paneled with

veneer sheets sawn of imported and more valuable wood species (e.g. ebony, redwood, rosewood).

Marquetry combines two processes. The first one is intarsia, the process of cutting the certain tracery out on the background veneer sheet and inserting the pieces wood of other species or other color. The second one is called banding; it is gluing the mosaic set on the surface of the workpiece. There are also other ways to perform marquetry.

Wood mosaics have high scenic qualities. It attracts attention delivering esthetic pleasure by the warmth of the colors, rich natural pattern, mellow tints of wood.[1]

Investigating the evolution of marquetry art we can see that pieces of art stand out from applied ornamental craft to fine art step by step. Everything this allows to recognize marquetry as a new stand-alone area of art. In comparison to other forms of art marquetry deals with a unique material which has its own character of ductility and artistic qualities. Various tints can be obtained by mixing wood colors, thus, achieving gentle transition from one color to another. The image in marquetry appears because of using natural palette – the colors of textures and veneer sheets of different species of wood. The nature itself gives us a rich pattern of wood as a Great Master. These colours can turn into marvelous oeuvre in the hands of

experienced craftsmen.[4]

The technical process consists of several steps. Firstly, the concept of the design is created. After these sketches are made the outline is drawn with the help of vector graphics editors CorelDraw or Illustrator. In our project we decided to use two concepts: realistic (fig. 1) and decorative (fig. 2) styles of the same image. Secondly, the pieces of the puzzle based on this outline are cut from the veneer sheets of different colors by the laser lathe. After cutting all the details the last ones are laid out in a set by gluing their facing parts with a special scotch tape.



Fig. 1. Realistic sketch

The background is mounted first, then the smaller pieces are cut in the prepared surface. It is important to avoid leaving space between the details during this process. After perfectly gluing all the seams initial quality control is performed. The following problems are not allowed: overlapping edges, gaps between pieces, texture shifting, cracking of veneer, weak contact between veneer and scotch tape, its shifting and wrinkling.[4]



Fig. 2. Decorative sketch

An enormous amount of different wood species are used to reach the maximum effect in the marquetry art. Veneer made of the Karelian birch, nutwood, pearwood, or redwood is used most frequently. It is remarkable that wood with defects

gives a touch of individuality and singularity to each workpiece. [4], [5]

Natural color palette is not always sufficient to create sophisticated ornament. In such a case there are several tricks for achieving the desirable tint of wood. Etching veneer with the solution of ferric chloride gives light-blue or light-green tint to the surface. Red color can be reached by soaking in a solution of copper sulphate and ferrous potassium.[1]

The basis for the workpiece is either plywood or hardboard, or any other board which is not responsive to external factors. The surface of the basis is prepared for the finishing work by removing dents, scratches, chips, etc. According to the common standards the basis roughness should not exceed 50 microns.[4]

The designed picture is sticking to the basis by PVAC dispersion, because it does not leave stains on the wood and dries to colorless film. When sticking a large set to big basis, in order to avoid warping, the back of the piece is glued to the compensating layer of veneer. The direction of veneer annual fibers of compensating layer should be the same as the dominating direction of fibers in the picture. Being glued on the base the image is wrapped with waxed paper and placed under a hot press until drying.[4]

When the mosaic set dries the scotch tape is removed; the set is sanded and polished. After complete setting (which usually takes about a day) the mosaic is sanded again with a broad knife (in order to remove scotch tape) and polished. [1]

The polished workpiece is covered with lacquer (from three to eight layers). The first layer of lacquer is applied undilutedly, but subsequent layers are diluted. The last layer should have the consistency of water. Each layer except the last one is cleaned by soft sandpaper after hardening. [6]



Fig. 3. Laser lathe

Among new techniques applied to marquetry one can mention laser cutting (fig. 3), where the design is drawn or imported as a CAD file and each piece is cut separately; each different species

of wood -and thickness- may need a specific adjustment of the beam's power; the offset will determine the gap between the pieces and, in some cases, the beam will leave a dark edge due to the very high heat required by the process.[3]

We faced the following obstacles in the process:

- The fragility of veneer, its sensitivity to moisture (possible size changing and damage while laser cutting);
- Inaccuracy of detail outlines;
- The assemble process requires high skills;
- It is a time-consuming and long-term process;
- The processes and materials are quite expensive.

The advantages were:

- Replication is available;
- Wood gives a touch of exquisite, seclusion, special effect of matching tones and shades to the workpiece;
- Opportunities for the implementation of design ideas;
- Saving time by using an automated cutting process (it took the machine less than an hour to cut all the details);
- The process itself requires synergy of the creative and technical processes.



Fig.4.

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THE CREATION OF TECHNOLOGY FOR REPLICATING SYMBOLS OF KULAYSKAYA CULTURE

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Kulayskaya culture has become famous thanks to bronze casting. Ancient people were able to make not only perfect hunting weapons, but also create a lot of religious artifacts - figures of people, arms and faces, animals (mostly elks), birds, mythical creatures, etc.

The images of elks, deer, and horses were connected with the Heaven. Not without reason the Selcup called Great Bear as Heavenly Elk. They were hunted and worshiped as the highest good sent from the Heaven as food for human life. Elks, deer and horses symbolized the fertility of the Earth. In addition, these strong beautiful animals were peculiar mediators between the Heaven and the Earth.

Among the kulaysky images birds took the first place. And it is no wonder, because in the world mythology they symbolized the idea of plurality, abundance, fertility. (Fig.1)



Fig. 1 Samples of kulaysky birds

Images of people were the figures in full-length with a very sketchy outline of the trunk and limbs. But their heads, as well as casting of some masks, are given with many details. (Fig. 2)



Fig. 2 Samples of kulaysky figures of people.

In the beginning of the 21st century kulayskaya theme became very popular in Siberia. Items based on kulaysky symbols are widely used in jewelry.

One of the largest world's collections of kulaysky heritage is funds of Tomsk Regional Local History Museum. Since 2004 year the Kulay is a historic brand name of Tomsk Oblast. [1]

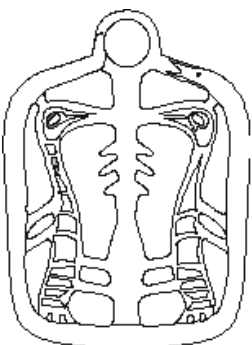
In our project we apply the ideas of artistic production (amulets) based on kulayskaya culture and offer the technology for its replication.

For the manufacture of these amulets we use a technological process of investment casting, as this type of casting is used in cases of manufacturing high precision parts. The principle of this method consists in the following: the model of cast and its gating system are made of low-melting materials (lamp-wax, stearin, wax) by pressing or pouring them into moulds.

The first step of this work is creating designs of an amulet, namely modification of existing kulaysky items. (Fig. 3)



a)



b)

Fig. 3 The image of an amulet: a) an original b) after processing

The three-dimensional model of the amulet (Fig. 4) is created by using ArtCAM program which allows to automatically generate spatial models from a flat picture and get items on numerically controlled machine tools.

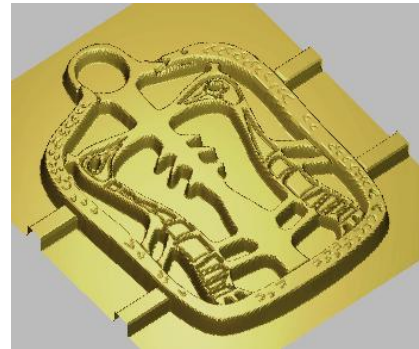


Fig. 4 The 3D model of an amulet

The wax model (Fig. 5) is made on the milling and engraving machine named Roland MDX-40A. This is a desktop system of a rapid prototype production from a wide range of materials with high accuracy and high quality of surface finish.



Fig. 5 The wax model of an amulet

On the present machine tool it's possible to install a 3D scanner as well as a rotation axis. That allows to digitize three-dimensional objects and their subsequent four-sided process and makes it a more convenient machine tool for prototyping.

Next the wax model is placed in a mould which is filled with a homogeneous mixture of ceramics. Then to remove air the mould with the ceramic mixture is treated under vacuum during 2 - 3 minutes on the vibration - vacuum table.

Simultaneously model units are set in the metal moulds. After that moulds are placed into the installation, filled with sand mixture and treated under vacuum again during 2 - 3 minutes.

Further on the form is baked for 1 - 3 hours at a temperature of 90 - 100 °C; the model solution is melted. The wax is usually collected in a stainless steel pan that is placed on the bottom of the muffle furnace, the pallet is removed, the wax is used

repeatedly.

After melting the wax the moulds are baked in the furnace by special regimes: heating from 20 to 150 °C during 30 minutes, holding at 150 °C during 3 hours, heating from 300 to 700 °C for 3 hours, holding at 750 °C for 3 hours.

Then the mould is filled with metal. The temperature of the molten metal must be higher than the melting temperature by 50-200 degrees depending on the alloy and forms of items. The low temperature does not let the metal spill; overheat and oxygen make pores. Bronze is used as an applied metal because it has high fluidity, low shrinkage and also provides a cast with good artistic qualities.

After cooling the cast is removed from forms, and cleaned from sand mixture. [2]

The obtained cast (Fig. 6) is processed with grinding tools.

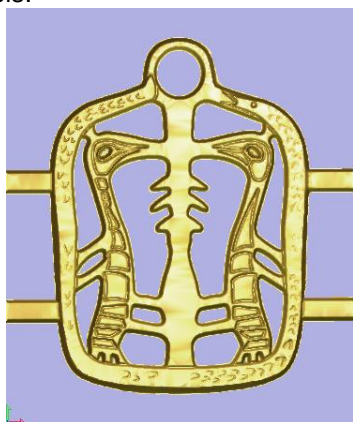


Fig. 6 The obtained cast

The replication of amulets is made as follows:

- the finished cast is pressed in the metal mould with rubber and set in the oven for vulcanization of rubber and the formation of a press- mould;
- the cast is removed from the press-mould in which later the molten wax is pressed;
- the assemble of wax models is made by building on a common standpipe; the standpipe with the attached models is established in the mould; [2]
- then the process is similar to getting the first cast.

We believe that with the introduction of European culture the traditions and rich heritage of our ancestors, which were formed over the centuries, were forgotten. Kulaysky bronze casting is quite a unique phenomenon, without equivalents in the world. Today no other source does not so fully reflect the spiritual culture, philosophy, artistic style of the Siberian population of the Iron Age, as the expressive, emotional, informative and very aesthetic bronze figures of animals, birds, humans, mythical creatures.

The proposed method allows to promote kulayskaya culture in the modern art, and it becomes possible to obtain high-precision casts.

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VARIOUS LOGOS GENERATION METHODOLOGY

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Logos – invented signs and images which are easy to recognize and used by different organizations around the world – from international corporations to charitable foundations, from political parties to local communities and schools. They can also symbolize the certain goods and services. Undoubtedly, a logo is a central part of the identification system and a key factor in its perception of people. A symbolic image creation is usually considered as the most important element of the designer's graphic art. The meaning transmission in a few lines, the transformation of the large and complex into something simple is one of the main difficulties for modern artists (fig. 1).



Fig. 1. Logos symbolism: Shell (left), Michelin (right)

Logo is like a magnifying glass looking through which the organization allow consider itself. If you can see through the glass shine of success in the form of outstanding products, memorable reminiscences of shopping and excellent relationship with the supplier, the glass will shine

by itself; brand will become pervasive beam of positive associations [1].

The main task of logos take informational and emotional meaning about a product, service or company without requiring refer to something specific. Hence it follows the obvious level of responsibility for the shoulders of designer: creating a recognizable, original and meaningful logo.

The customer play one of leading roles in a logo creating, because the success of the creation process and logo follow-up is depend on his desires, motives and opportunities. That's; why, most importantly, to achieve a high level of mutual understanding with the client by the designer: get the most complete information about the requirements for the logo (the preferences of the customer, the firm info etc.). If there is no the required mutual understanding the difference between sufficient and expended time for the creation logo by professional designer will increase rapidly. And this fact would entail a decrease of each the parties involved income in market economy conditions: customer loses money because of the logo commissioning period has been changed, and the designer will be obliged pay the penalty.

In addition, there is a contradiction between the required time and the required number of logos variants, in the conditions of powerful computing resources (computers and specialized software (SW)) presence. Because, may be designer have no a sufficient level of professional skills and can't provide the desired volume of variants.

So if customer individual preferences, experience and design skills connect with computer technology and computer-aided design, there is a need to develop various logos generation methodology. Its meaning is in optimization of the logos creating process by collecting and information about the psychological and aesthetic preferences of the customer processing on base of software module that generates a certain number of the logo variants.

Most designers use disparate tools, which can be combined into the methodology: preparation of briefs, technical tasks customer social research interviewing. But as a rule, their actions do not have a systematic approach.

The analysis of existing data collection tools for the logos development and their material embodiment allowed to identify three main approaches to solving this problem:

1. Applying the results of companies activity areas and organizations with different professional orientation systematic analysis [2].

2. Questionnaire of the customer to obtain the initial data [3]:

- branch of company activity;
- scale of business;

- product, project or service for which you plan to develop a logo and target audience, which will use the future logo;
- associations with the future logo;
- the meaning of sign;
- preferred color;
- unacceptable color, etc..

3. The arrangement of ready-made images and fonts type selection with the use of generating logos according to specified parameter software (fig. 2). Such software usually consist of collections a large number of templates, logos, images and fonts created by professional designers. It allows to save obtained logos in vector format for further development [4].

In such a way the selected three approaches solve some separate subtasks. Questionnaire helps to determine the preferences of the customer, but you cannot automatically create a logo variants of design; system for creating logos design (p. 1) allows to formulate questions for the questionnaire (p. 2); software such as Quick Logo Designer, ignores the psychology of perception and not able to automatic generation related requirements specified in the questionnaire.

On the base of the foregoing, it is proposed to use as the basis for all three approaches within one methodology for automatic generation of graphics based on the psychology and aesthetics of perception.



Fig. 2. The program Quick Logo Designer interface

In other words, to create a plug-in or standalone software module (SM), allowing the designer to carry out the client questionnaire, automatically generate variants of the logo and make their adjustment.

In this case in the program:

- it's should considered "hidden" requirements of the customer: features of perception, needs, interests, desires and feelings [5]; considering influence of color and shape on information efficiency and visual comfort of the logo (fig. 3);

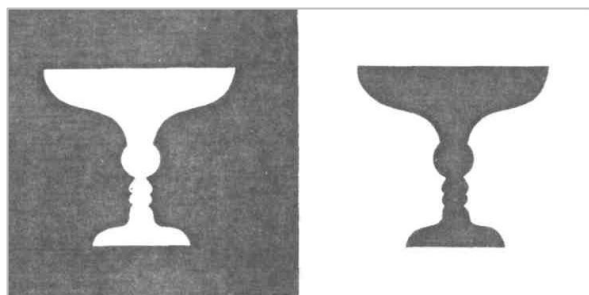


Fig. 3. Duality of perception: faces and vases

- it's should considered the requirements of the designer: the principles of composition and technical realization;
- questions for collecting data about psychological and aesthetic preferences of the customer should be presented;
- vector cliparts into a single database and sorted by type of activity;
- vector primitives to construct simple geometric abstract logos should be collected.

Principally the work of the software module can be described such way (fig. 4): input data are performed by the customer answers on the specially selected questions about logo (color, shape, font, sphere of activity, etc.), which going through the body of the program allow to obtain the following results (output data):

- full information about the desires of the customer as a text document, which designer can use for self- elaboration and discussion with the logo customer;
- generated set of logos that requires discussion with the customer and further adjustments through re-generation with the amended revisions.

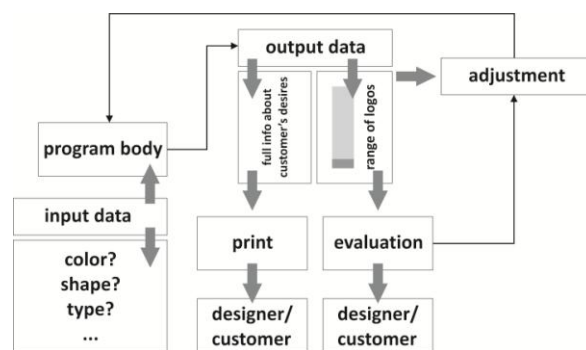


Fig. 4. The algorithm of SM work

Therefore it can be concluded that the creation of a psychological portrait of the customer and the using of automatic generation graphics (logos, in particular) computer systems allow to create in a short time successful logos, with the required quantity and without loss of income of each parties. In addition, such software can allowed to create quality logos by person who has no design skills independent, without help.

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| Section XII | |
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**NANOMATERIALS,
NANOTECHNOLOGIES
AND NEW ENERGETICS**

ALUMINUM OXIDE AND ZIRCONIUM OXIDE NANOPOWDERS SYNTHESIS BY CHEMICAL PRECIPITATION AND SPRAY DRYING METHODS

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Nanostructured materials exhibit superior properties such as excellent strength, toughness, and hardness, due to the presence of refined grains. At present many scientist want to find methods to get nano powders. But the problem is, how to get them, and what methods will be used. One of the more promising technological methods for obtaining fine-grained powder is the sol-gel technology. The sol-gel process is a wet-chemical technique (chemical solution deposition) widely used in the fields of material science and ceramic engineering. The precursor sol can be either deposited on the substrate to form a film (e.g., by dip coating or spin coating), cast into a suitable container with a desired shape (e.g., to obtain monolithic ceramics, glasses, fibers, membranes, aerogels), or used to synthesize powders (e.g., microspheres, nanospheres).

Nanostructured oxide powders are used in the field of ceramics and can be produced by chemical synthesis, mechanical or physical methods, e.g. Chemical Precipitation and Spray Drying Methods. Chemical synthesis is simple. Aluminum oxide or zirconium oxide can be easily converted into a powder with the help of chemical reactions.

Aluminium oxide is an amphoteric oxide with the chemical formula Al_2O_3 . It is commonly referred to as alumina (α -alumina), or corundum in its crystalline form, as well as many other names, reflecting its widespread occurrence in nature and industry. It is widely applied in the production of aluminium metal, although it is also used as an abrasive owing to its hardness and as a refractory material owing to its high melting point. There is also a cubic γ -alumina with important technical applications. Al_2O_3 (alumina) powder has been selected for the present study because spherical nanostructured alumina powder is an excellent starting material for near-net-shape formation, spray powders for coatings and soft abrasives, surface adsorbents in chemical industries, biocompatible coatings, and as carriers for a catalyst. This powder can be also potentially used in thermal insulation as well as in inertial confinement fusion of nuclear materials.

Zirconium Oxide is an extremely refractory material. It offers chemical and corrosion inertness to temperatures well above the melting point of alumina. The material has low thermal conductivity. It is electrically conductive above 600°C and is used in oxygen sensor cells and as the susceptor (heater) in high temperature induction furnaces.

Key properties of zirconium oxide are with standing temperature up to 2400°C, high density, low thermal conductivity (20% that of alumina), chemical inertness, resistance to molten metals, ionic electrical conduction, wear resistance, high fracture toughness, High hardness.

Aluminum oxide and zirconium oxide sol with different compositions, including the addition of various stabilizer can be used : Polyethylene Glycol (PG) and metal salts. The scheme of this process can be seen in fig.1. Sols received from the sulphate of aluminium and oxide chloride of zirconium with addition of stabilizers are salts of metals and polymers.

In fig.1. the process of obtaining aluminum oxide sols, at room temperature for 2 hours and 3 days, as well as sol, sustained for hours at 80 C is shown. In this case, as a stabilizer we use polyethylene glycol (PEG). We get deposition of NaOH . The precipitate is filtered and washed with water.

Then the obtained powder is treated with heat. At the initial stage powders are kept at a temperature of 150 °C, for 5 hours.

Part of the powders were subjected to drying at a temperature of 450 °C for 3 hours, and part-at temperatures of 250 °C, 350 °C and 450 °C.

The obtained powders were investigated by the method of X- ray Phase Analysis. The X- ray Phase Analysis showed that all powders, regardless of the production conditions are in the amorphous state. As a part of this work we have also tested the possibility of obtaining powder using a method of spray drying.

Spraying method is one of the methods used to get nano powder and to form nano composite structure. In this case we use spray drying. The type of spray dryer is Nano Spray Dryer B-90. Nano spray dryer B-90 was developed to obtain the particles size from 0.3 microns to 5 microns from solutions or suspensions. The drying process takes place inside the spray of the cylinder. The formation is stable, gas flows through the nozzle and then the solution is sprayed.

In figure 3, have a same process like aluminum oxide, but in case with zirconium oxide we use polyethylene glycol (PEG) and $CaCl_2$ as a stabilizer. The deposition of the obtained solutions, conducted with the addition of ammonia. Then the obtained powder is heated.. At the first stage the drying of powders lasted for 5 hours at a temperature of 120 °C. Further heat treatment of

the obtained powder was carried out, as in case with aluminium, in different conditions. Part of the samples were subjected to drying at a temperature of 420 °C for three hours, and part-at temperatures of 220 °C, 320 °C, 420 °C.

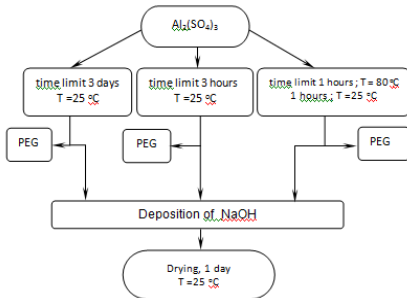


Fig.1. Process of Alumina oxide sols with addition of various stabilizers

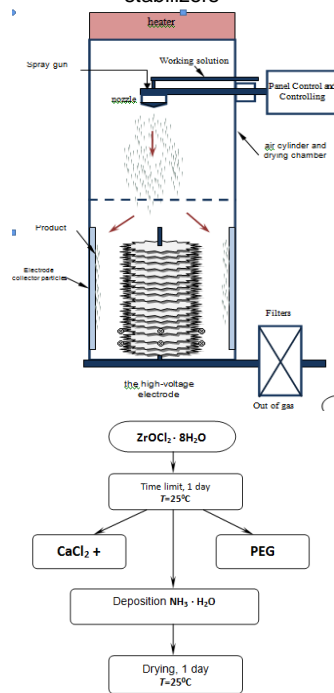


Fig.2. Work Scheme of Nano Spray Dryer B -90
Fig.3. Process of zirconium oxide sol obtaining with addition of various stabilizers

| The conditions of synthesis | Composition phase |
|---|--|
| Al ₂ O ₃ Chemical Precipitation Methods T = 1250 °C | Size (CSA)* = 60 nm |
| Al ₂ O ₃ Spray Drying Methods T = 1250 °C | Size (CSA) = 48 nm |
| ZrO ₂ without the stabilizer T = 220 °C T = 320 °C T = 420 °C | Size (CSA) = 9 nm Monoclinic phase (69,54%); Tetragonal phase (30,46%) |
| ZrO ₂ With the stabilizer PEG T = 220 °C T = 320 °C T = 420 °C | Size (CSA) = 10 nm Monoclinic phase (100 %); |
| ZrO ₂ With the stabilizer CaCl ₂ T = 220 °C T = 320 °C T = 420 °C | - |

* CSA (coherent scattering areas)

In table 1. we can see the result of X- ray Phase Analysis for Al₂O₃ and ZrO₂. The Scanning Electron Microscope (SEM) shows nano particles of Aluminum Oxide in the 1 μm size range with different temperature and methods.

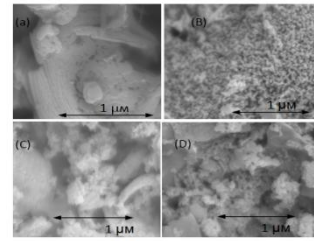


Fig.4. Nano particles of Aluminum Oxide in the 1 μm size range with different temperature and methods

In this picture we can see that (a) Al₂O₃ powders were obtained with the help of a spray dryer at a temperature of 550°C and 1200°C. In (B) to (D) powders Al₂O₃ were obtained with a chemical deposition at temperature 150 °C, 250 °C, 350 °C, 450 °C, 1250 °C. In addition, in (D) we used stabilizer PEG with temperature 150 °C, 450 °C, 1250 °C.

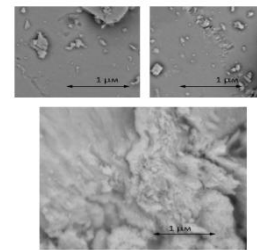


Fig.5. Nano particles of Zirconium Oxide in the 1 μm size range after thermal processing in 420 °C

In figure 5 and 6, scanning Electron Microscope (SEM) shows nano particles of zirconium oxide obtained by the method of chemical precipitation, after thermal processing at 420 °C. In (a) and (b) we used stabilizer CaCl₂. In (c) we used stabilizer PEG. We were not able to get the powder zirconium oxide in the existing configuration of the machine for spray drying. Zirconium oxide precipitated out of the solution in the form of very small particles, which are prone to aggregation and after the first cycle on the spray nozzle is clogged, the elements of the equipment with spray drying corrode.

As a result we can see that :

1. During heat treatment at 420 °C powder ZrO₂, obtained by chemical deposition, has the composition: monoclinic structure is 70%, particle size 9 nm; tetragonal structure is 30%, particle size 11 nm; in a consistent heat treatment at 220 C, 320 C, 420 C, monoclinic structure is 79%, 9 nm; tetragonal structure is 21%, with particle size 11 nm.
2. ZrO₂ when PEG is used has monoclinic structure, the particle size is 10 nm.
3. When CaCl₂ is used, powder zirconium oxide is amorphous and its structure does not depend on the regimes of heat treatment.

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PHYSICAL-CHEMICAL PARAMETERS ACTIVITY OF NANOMATERIALS.

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Introduction

Basic characteristics of metal nanopowders, namely, the shape, particle sizes, the metal component content, chemical activity parameters, electrochemical characteristics, and thermodynamic state of nanoparticles and nanopowders, are considered. Experimental results of standard analysis methods and features of their use when determining the above characteristics are given, shown that, for certifying nanopowders as metastable systems, a whole range of analysis methods are required.

The objects of study were metal nanopowders of aluminum, iron, molybdenum, wolfram and copper produced by electrical explosion of wire in an argon medium.

Nanopowder Properties and produced

Nanosized powders due to their specific properties are widely used as basic materials for ceramics and composites, filters, lubricant additives, production ecological problems solution as catalysts, sorbents, etc.

One of the ways of nanopowder production is electrical explosion of wires (EEW). It is a process of explosive destruction of a metal wire under the action of great density current ($>10^6 \text{ A/cm}^2$) [1]. EEW is characterized by the following peculiarities:

- time of explosion is 10^{-5} - 10^{-8} s;
- temperature at the moment of explosion can be more than 104K, pressure - 10^9 Pa;
- velocity of product recession is from 1 to 5 km/s;
- material of the wire transmutes into particles of nanosize range (10...100 nm) in accordance with certain conditions. Extremely nonequilibrium conditions of EEW cause some unusual properties of nanopowders.

Electroexplosive nanopowders have as a rule a spherical form of particles, they are resistant to oxidation and sintering at room temperature and characterized with high diffusion activity heated. The three modal particle size distribution is formed at the process of EEW. A dispersed composition is one of the most important parameters that determine technical characteristics (packed density, flow rate, slope angle, and others), and, hence, their use range [1].

The dispersed composition and other characteristics of nanopowders depend on all conditions of the explosion – firstly, on electrical parameters before explosion, energy of the arc stage, velocity of energy input or power density. The nature of the wire metal and its geometry (length and diameter of wire), microstructure and substructure of the wire metal, environmental properties – pressure and gas type, introduction of

chemically active gases in to inert gas also have influence on the depressiveness and other properties of nanopowders.

An important advantage of EEW technology is the adjustability of properties of EEW products by means of electrical parameters. Low energy consumption ($< 10 \text{ kWh/kg}$) is due to direct heating of the wire by electric current without heat source carriers and due to high heating rate ($> 10^7 \text{ K/s}$) that provides adiabatic conditions of γ transmission to the wire. Yield of nanopowders on the basis of aluminum is 50 g/h, on the basis of tungsten is 300 g/h under production using one set. This technology is environmentally safe: the process of nanopowder production is carried out in a closed chamber, there is no technological emission.

EEW in inert gases or hydrogen is used to produce powders of metals, alloys, and intermetallic compounds. EEW in chemically active ambient is used to produce nanopowders of chemical compounds of metals: oxides, nitrides, carbides, etc. The phase and chemical compositions of nanopowders produced by the electrical explosion of wires in water and industrial oil are presented [2].

The principal scheme of the experimental installation for producing electroexplosive powders is shown in the Figure 1.

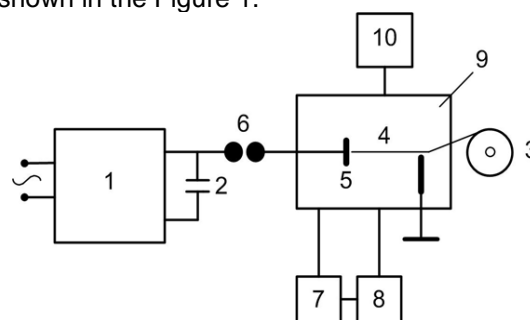


Figure 1. Principle Scheme of Experimental Setup: 1 - high-voltage power source, 2 - capacitor battery, 3 - wire supply unit, 4 - exploding wire, 5 - high-voltage electrode, 6 – commutator, 7 - powder collector, 8 – ventilator, 9 – explosion chamber, 10 – gas filling system

Physical and chemical properties of nanopowders

For fast determination of powders reactivity the following parameters can be used:

- Temperature of the beginning of oxidation ($t_{bo, \text{ } ^\circ\text{C}}$);
- Maximal oxidation rate ($v_{ox, \text{ mg/s}}$);
- Degree of transformation (degree of oxidation) of aluminum in certain temperature interval ($t_f, \%$);

- Relative thermal effect defined as the peak area under the DTA curve divided by weight gain ($A/\Delta m$, relative units).

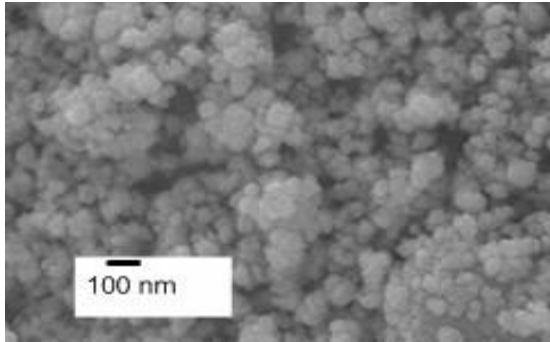


Figure 2. Micrographs of the powders produced by electrical explosion of aluminium

These parameters for powders reactivity estimation can be obtained during the processing of thermal oxidation results under conditions of programmed heating (the air being oxidizer) [3].

Parameters determination of non-isothermal oxidation under standard conditions of programmed heating in air is well developed and is experimentally justified so that it can ensure the comparability of results and allow to determine the reactivity of powders using several parameters.

Conclusions

Nanotechnology is a rapidly expanding technology in which existing and novel materials are engineered at the nanoscale, typically in the range of 10 to 100 nanometres. Engineered nanomaterials include uniquely manufactured products with unique shapes and enhanced physical and chemical properties, compared with conventional materials of the same composition.

In the recent years the demand for nanopowders are increased drastically because of its wide range of applications by producing Nanopowder with metals like aluminum, iron and copper. This Novel technology is used in the production of aluminum powder which has applications in aviation industry.

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INFLUENCE OF LOW-TEMPERATURE ANNEALING ON MECHANICAL PROPERTIES AND GRAIN-SUBGRAIN STRUCTURE OF SUBMICROCRYSTALLINE NICKEL SAMPLES

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Mechanical properties of submicrocrystalline (SMC) materials produced by methods of intensive plastic deformation (SPD), are due to their special grain-subgrain structure. SMC materials have shown, in particular, high strength properties, and in some cases, after the low-temperature annealing, the capacity for high-temperature and high-speed superplasticity.

In the process of low temperature annealing structure changes occur. They are of scientific and practical interest.

At the present to study the surface morphology of materials obtained by IPD, methods of scanning probe microscopy (SPM) are used. These methods have high spatial resolution, they do not require any special sample preparation and provide a large-scale and representative picture of the structure [1].

This paper deals with the development of distribution evaluation method of the grain-subgrain structure (GSS) in SMC of simple metals according to the size and assessment of disequilibrium degree of their boundaries with scanning tunneling microscopy (STM).

The purpose was to investigate the influence of low-temperature annealing on the GSS and mechanical properties of SMC nickel.

For research SMC nickel which possesses the good conductivity necessary for STM is chosen. Samples are received by a method of equal-channel angular pressing (ECAP) on a route of Bc (N=4 passes) at room temperature. The interface corner between channels is 90 degrees. The received whetstones, of about 4 mm thickness, were subjected to rolling up to ~ 1 mm thickness.

The samples were cut by electroerosion cutting across the rolling direction. Surface samples were prepared by standard technology. Thermal annealing of the samples was carried out for 15 minutes at temperature $T = 60^\circ$, $\sim 120^\circ$, $\sim 180^\circ$, and $\sim 240^\circ\text{C}$ in argon atmosphere. GSS revealed by chemical etching. The mechanical properties were examined with IMASH 7078 equipment by active stretching of the samples up to the destruction at a rate of $\sim 0.0003\text{ mm/sec}$ with recording charts stress - strain « $\sigma - \varepsilon$ ». Microhardness was measured by a microhardness tester PMT 3 with $P=100\text{mN}$ load.

GSS samples were examined by using a scanning tunneling microscope SMM-2000, operating in a constant current mode. All measurements were performed in air at room temperature.

STM scans were analyzed using Gwyddion, which allows to measure the dimensions of the surface topography elements and present results in a format which is compatible with the program Origin, that allows subsequent computer processing.

Fig. 1 shows the stress-strain diagram « $\sigma - \varepsilon$ » of SMC nickel samples after annealing at different temperatures. It can be seen (Fig. 1) that for all curves a short stage III, followed by a stage of near-zero rate of strain hardening $\theta = d\sigma / d\varepsilon$ is observed.

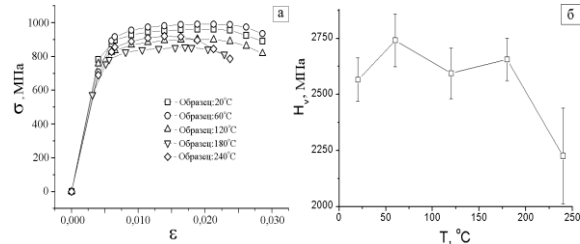


Fig. 1. a) stress-strain diagrams « $\sigma - \varepsilon$ » SMC nickel after annealing at various temperature and b) the dependence of microhardness on the annealing temperature of samples.

After annealing at $T = 60^\circ\text{C}$, the increase of microhardness (Fig.1b) and tensile strength of $\sigma_y \sim 990\text{ MPa}$ is observed (Fig. 1a). A similar effect of hardening by annealing microcrystalline material obtained by methods IPD was observed in [2]. After annealing at temperatures $T = (120 \div 240)^\circ\text{C}$, there is a decrease of microhardness. However, after annealing at $T = 240^\circ\text{C}$ the tensile strength increases. The plasticity of the samples during annealing varies slightly and the total strain up to failure, on average, is $\sim 0.025 - 0.03$.

On the surface of SMC nickel samples subjected to chemical etching, structures formed during the IPD were observed. The block structure is formed by two systems of localized deformation bands (BLD) with a period of about 600-800 nm in two directions intersecting at an angle of 15° to the vertical and $\sim 45^\circ$ to the horizontal axes.

Results of preliminary research have shown that the average size of grains is about 200 nanometers. Therefore for the research of grain sizes by means of STM (scanning tunnel microscope), $1.752 \times 1.752\text{ mm}$ scans, and for the research of subgrain structure $876 \times 876\text{ nm}$ and $438 \times 438\text{ nm}$ scans were obtained.

Grain-subgrain structure size measurement was carried out in two directions: parallel and perpendicular to the longitudinal axis of the sample. Figure 2 a, b, c, as an example, shows the histogram GSS SMC nickel in size along the rolling direction after annealing at $T=60^\circ$, $\sim 180^\circ$ and 240°C .

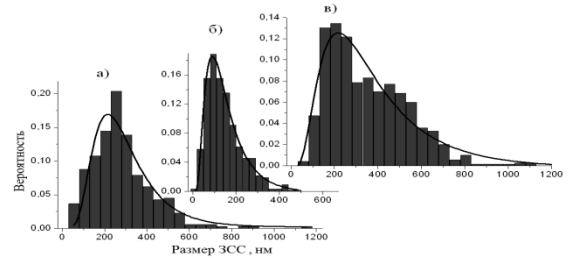


Fig.2. Histogram GSS size along the rolling direction of the SMC Ni after annealing at a) $T=60^\circ$, b) $\sim 180^\circ$ c) $\sim 240^\circ\text{C}$.

It can be seen (Fig. 2b) that annealing at $T = 180^\circ$ results to a decrease in the distribution dispersion of GSS in size, and annealing at $T = 240^\circ\text{C}$ (Fig. 2c) – leads to the appearance of a well-defined bimodal distribution. This indicates the beginning of a new process resulting in the size change of GSS nickel. The analysis showed that all the measured distributions can be described by log-normal function, as shown with a solid line in Fig. 2a, b, c, its parameters - the median size and dispersion-depend both on the direction of rolling and annealing temperature. Fig.3 shows the average nickel size dependence along the GSS ($\langle XL \rangle$) and across the rolling direction ($\langle XT \rangle$) on the annealing temperature.

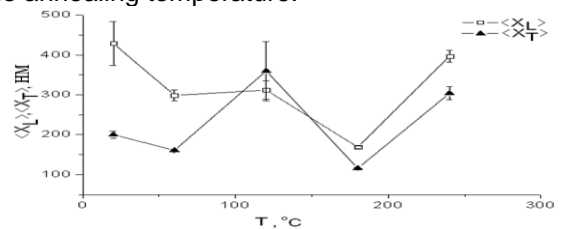


Fig.3. Dependence of the mean size along the GSS ($\langle XL \rangle$) and transverse ($\langle XT \rangle$) to the rolling direction on the annealing temperature.

It can be seen (Fig. 3) that the average size of the longitudinal SPR SMC nickel in the initial state ($\langle XL \rangle$) is greater than average transverse dimensions $\langle XT \rangle$, indicating that a non-equilibrium structure, which can be characterized by a non-equilibrium coefficient $k \sim \langle XL \rangle / \langle XT \rangle \sim 2$. After annealing at $T = 60^\circ\text{C}$ the average size of the longitudinal GSS $\langle XL \rangle$ decreases, and its transverse dimension $\langle XT \rangle$ is almost unchanged. In this case, microhardness increase

of the samples is observed (Fig. 1b). A similar effect of the average longitudinal grain size reduction was observed in [3]. TEM showed that in the process of ECAP nickel of technical purity a non-equilibrium shaped structure with $k \sim 3$ is formed.

As it can be seen (Fig. 3) after annealing at $T = 180^\circ$, a decrease in the size and extent of GSS non-equilibrium SMC nickel occurs. Since microhardness of the samples is decreased, it can be concluded that the observed reduction in the size and extent of SMC nickel non-equilibrium structure reflects the evolution of subgrain structure. Annealing at temperature $T = 240^\circ$ leads to the increase of average grain size (Fig. 2), which is revealed by STM, and probably is due to the migration of large-angle boundaries. Grain growth results in the decrease of microhardness (Fig.1b).

In the study of the subgrain structure (Fig.4) the decrease in the non-equilibrium structure white temperature increases, the presence of a peak in the annealing temperature $T = 120^\circ \text{C}$ and subsequent reduction of the average size of GSS with increasing annealing temperature up to $T = 180^\circ \text{C}$ are observed. The average size of the subgrain structure along the rolling direction is smaller than the corresponding average size across the rolling direction. Annealing at temperature $T = 240^\circ \text{C}$ leads to the decrease subgrains average size.

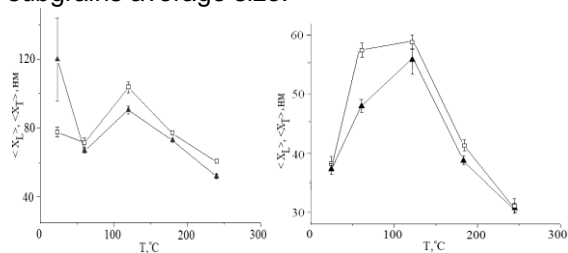


Рис. 5. Зависимости средних размеров ЗСС вдоль Fig.4. Dependence of the average size along the GSS ($\langle XL \rangle$) (\square) and perpendicular ($\langle XT \rangle$) (\blacktriangle) to the rolling direction on the annealing temperature, obtained by analyzing the STM images the size of: a) $\sim 0,876 \times 0,876 \text{ mm}$ b) $0,438 \times 0,438 \text{ mm}$.

Thus, these studies suggest the following conclusions:

1. It was established that during the low-temperature annealing, at the return, stage return, there is a decrease in the GSS non-equilibrium and size of the structure of the SMC nickel produced by ECAP.

2. Annealing of SMC Ni at temperature $T=60^\circ$ leads to the samples microhardness increase, and annealing at $T > 180^\circ$ leads to a microhardness drop.

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THERMAL CHARACTERIZATION OF COATED NANOALUMINUM

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The usage of Al nanopowder (nAl , nominal size 50-200 nm) is basically connected with improvement performance of energetic formulations [1, 2]. Since Aluminum has high combustion enthalpy it is widely used in propellants, pyrotechnics, explosives and SHS systems; moreover, nAl loaded formulations permit to have faster burning rate compared to micron-sized Al loaded formulations.

The large-scale production technology for nAl is represented by the electrical explosion of wires (EEW). The passivation layer on the surface of Al nanoparticles determines their reactivity, stability, ignition delay, etc. Without passivation, nAl tends to oxidize significantly (at worst to self-ignite) immediately after the contact with oxidizing media. For this reason, commercial powders are passivated under a controlled slow dry air stream or chemically under inert atmospheres. An

alternative to the coating process done on crude metal (passivation) exists and it consists in coating already-air-passivated *nAl*. Such process is safer and it is expected to provide easier interaction between coating and propellant binder.

Two *nAl* powder batches with nominal particle size of 100 and 50 nm were produced by EEW technique and then passivated by a slow dry air stream under a controlled environment [3]. Both batches of air-passivated *nAl* were then coated by hydrocarbons or fluorohydrocarbons: octadecanoic acid, hexadecanoic acid, 1H,1H-perfluoroundecanol (10:1 fluorotelomer alcohol), Fluorel™ (a fluoropolymer by 3M®) plus ester from esterification of 1H,1H-perfluoroundecanol with 2,5-furandione. For each type of chemical, the mass fraction of coating was chosen to obtain 5-10 % wt. of dry *nAl*. In order to compare qualitatively the difference between chemical-passivated *nAl* vs. coated air-passivated *nAl* powders, a 50 nm sample of stearic acid-passivated L-ALEX™ (hereinafter, *L-ALEX_{NPS}*), and 50 nm and 100 nm ALEX™ were also examined and tested. The active Al content was evaluated by a volumetric method.

According to TEM images, the cohesion of particles is clearly recognizable and this is a common feature of all powders, from ALEX™ to *VF-ALEX* and *L-ALEX* series. Most of the TEM images clearly exhibit clusters of particles. In fact, as a general rule for metals, aerodynamics of the particles inside the EEW machine during explosion and coalescence of molten Al droplets immediately after the explosion promote cohesion among particles. Such a characteristic is even more recognizable in Fluorel® and ester-coated powders (*VF-ALEX*). This fact could be justified by the chemical nature of coating – a fluoropolymer – which could act as a glue between single particles.

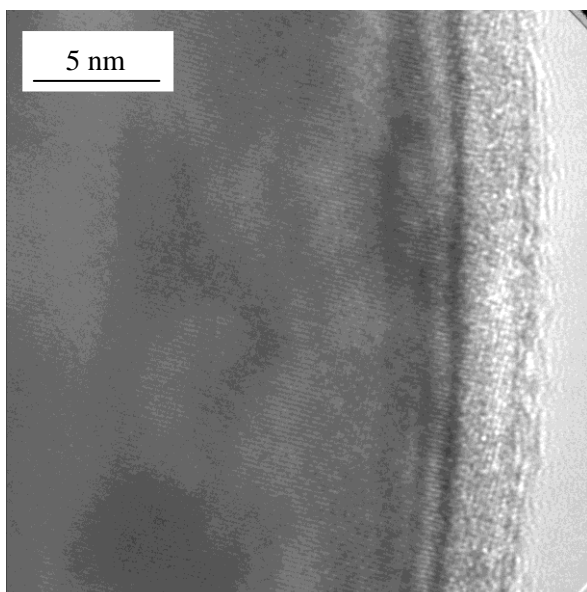


Figure 1: TEM image of electro-explosive *nAl* passivated by air

Regarding the X-ray diffraction patterns, peaks of Al are the only recognizable phase of all samples, due to the very thin coating layers (Fig.1) on Al particles, irrespective of whether coated or uncoated Al particles are examined.

BET specific surface area is higher for the 50 nm ALEX™ rather than the 100 nm sample if correlated with the nominal particle data provided by the producer. The 50 nm and 100 nm *VF-ALEX* samples show the lowest BET specific surface area.

The considerable difference in C_{Al} between 50 nm *L-ALEX_{NPS}* and 100 nm *L-ALEX_{APS}* is justified considering that the latter has a smaller quantity of fresh metal due to the presence of a double shell structure. The *F-ALEX* sample has the second highest values of BET and C_{Al} in 100 nm group. The 50 nm *P-ALEX* sample exhibits a lower C_{Al} with respect to 100 nm *P-ALEX*.

The integral of oxidation peaks (ΔH_{ox1} , ΔH_{ox2}) measures the energy release related to the two oxidation stages of *nAl* (DSC and TGA). ΔH_{ox1} of the first oxidation peak is the highest for 50 nm *L-ALEX_{NPS}* (powder not passivated by air). The sum of ΔH_{ox1} and ΔH_{ox2} is the highest, too. This evidence might be explained with the absence of the oxide shell and thus the large active Al content. The presence of a double-shell structure surrounding the particle (passivating oxide layer plus coating) reduces the heat release of coated air-passivated *nAl* powders with respect to both ALEX™s and 50 nm *L-ALEX_{NPS}* (Fig. 1). Moreover, the ratio between ΔH_{ox1} and ΔH_{ox2} shows how fast the first oxidation stage is, even higher than ALEX™. The 50 nm *VF-ALEX* has the lowest enthalpy release probably due to the fluoropolymer coating performs a protective action over the metal core. The energy release of the second oxidation stage exceeds the value of the first one; that is the one and only case for both 50 nm and 100 nm groups.

Regarding the oxidation degree in 100 nm powders, stearic acid coating is less effective than Fluorel™ in terms of surface protection against oxidation, as shown by ΔH_{ox1} . The 100 nm *VF-ALEX* powder exhibits the maximum T_{onset1} , which is the temperature of the sample at the beginning of the first oxidation stage; it also features the highest temperature of peak of the first oxidation stage and the lowest mass increase at the end of the second phase of oxidation (Fig. 2). In addition, the initial loss of weight for this sample is higher than for the other powders. Fluorel™ coating performs a protective action over the metal particle. This property is surely interesting in the perspective of a large scale use of *nAl* as energetic additive, because it would ensure more favorable ageing characteristics of the powders.

The initial mass decrease of the fluorotelomer alcohol-coated *nAl* (*F-ALEX*) is nearly the same of ALEX™. This may be an evidence of ineffectiveness of coating procedure; in any case,

the metal core is not protected from intense oxidation. The ΔH_{ox1} is the highest among the 100 nm samples and comparable with the heat release of ALEX™.

The 100 nm palmitic acid-coated *nAl* (*P-ALEX*) has the third highest ΔH_{ox1} . The 50 nm *P-ALEX* exhibits similar values as the other DSC-TGA physical parameters; the reason of that could be the small-scale coating process that may be responsible for reduction of BET value of coated *nAl* and formation of clusters of particles.

In the perspective of using coated *nAl* for a variety of high energy formulations, the stearic acid-passivated L-ALEX™ seems to be quite interesting due to its high and fast energy release. On the contrary, fluoropolymer-coated *nAl* (*VF-ALEX* series) protects the metal core of *nAl* particle, even at high temperatures, thus yielding the lowest degree of conversion of Al into Al_2O_3 . An incomplete oxidation of Al occurs even at high temperatures, due to a sort of barrier effect given by the residuals of polymer decomposition. As a

general rule, a polymeric coating promotes the formation of clusters of particles and hence an increase in mean surface particle diameter correlated with BET specific surface. The alcohol coated *nAl* behaves similarly to uncoated ALEX™. Fatty acids are not so efficient in protecting the metal core from oxidation. In any case, the difference between single- and double shell-structure are very recognizable. Stearic acid-passivated L-ALEX™ oxidizes very fast and strongly, even more than air-passivated ALEX™. Regarding the possible use of these coated *nAl* powders in energetic formulations, L-ALEX™ seems to be quite promising.

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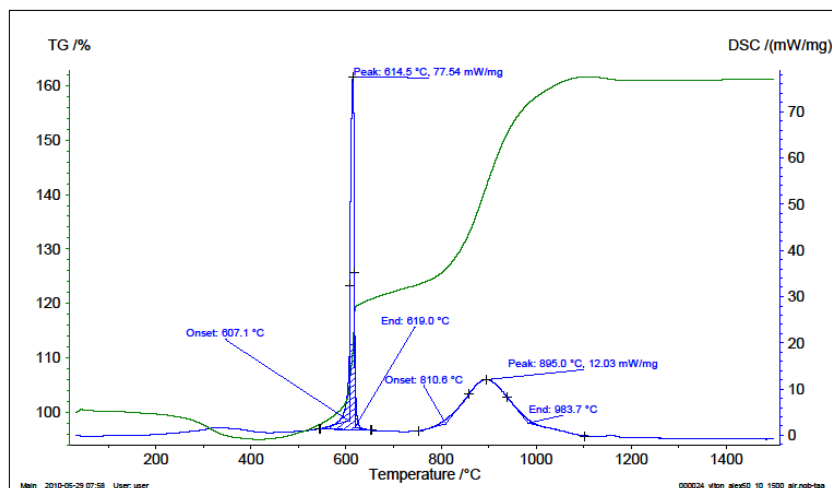


Figure 2: DTA-TGA analysis of *nAl* 50 nm (*VF-ALEX*)

INFLUENCE OF THE NONEQUILIBRIUM ELECTROCHEMICAL SYNTHESIS CONDITIONS ON THE PHASE COMPOSITION OF THE PRECURSOR OF NANODISPERSED Cu–Al–O SYSTEM

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Metal oxides and metal oxide systems are widely used in various branches of industry. One of them is catalysis. Here the copper-aluminium oxide

system is a universal base of the various process catalysts [1, 2].

At present the processes for synthesis of metal oxides and metal oxide systems under

nonequilibrium conditions have the greatest interest to scientists. One of them is the alternating current electrochemical oxidation process.'

Carrying out a non-stationary electrochemical oxidation under different conditions allows to obtain a copper-aluminum oxide system as a product of heat treatment of the precursor. However, the composition of the precursors, which influence the properties of the obtained oxide system, depends on the synthesis conditions.

Based on the above mentioned the aim of this work was to study the influence of synthesis conditions on the phase composition of the precursor in a copper-aluminum oxide system.

The electrolysis under the influence of alternating current of industrial frequency was used for the synthesis of the copper-aluminium oxide system in a sodium chloride solution. Copper and aluminium plates were used as soluble electrodes.

According to the X-ray results the products of the electrochemical copper and aluminium oxidation consist of copper (I) oxide and aluminium oxyhydroxide (boehmite). Basic carbonates are formed during hydrolysis and drying process (fig. 1). It is established by the X-ray method for the samples with a high copper content obtained in the solutions of sodium chloride with the concentrations of 3 and 25 wt%. But in accordance with the X-ray results there is only boehmite in the composition of the samples obtained in low concentration solutions. As it will be shown below the basic carbonates are formed by means of carbon (II) oxide contained in the air. Since the air-owned carbon (II) oxide is sufficient to form basic carbonates at high copper content in the sample, it is unlikely the absence these compounds at low copper content in the sample.

In order to avoid the formation of basic carbonates, it is necessary to conduct hydrolysis and drying processes in the vacuum. However, the process being conducted in the vacuum complicates the process flowsheet. It predetermined the feasibility study for obtaining the copper-aluminum oxide system directly from the basic carbonates.

According to the X-ray results the double basic copper-aluminium carbonate with hydrotalcite-like structure $[M_{1-x}^{II}M_x^{III}(OH)_2]^{x+} [A_{x/n}^{n-} \cdot yH_2O]^{x-}$ (Cu-Al/HT, 000-46-0099) and basic copper carbonate like malachite ($Cu_2(OH)_2CO_3$, 000-10-0399) are formed during hydrolysis and drying process.

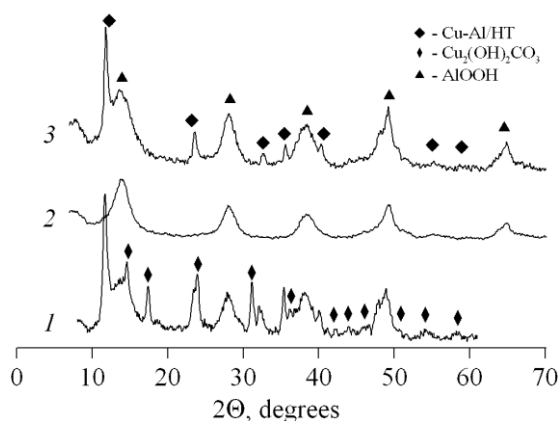


Fig. 1. XRD pattern of Cu–Al–O system precursors obtained by alternating current electrolysis in the solution with the concentrations of sodium chloride 3 (1), 15 (2) и 25 (3) wt %.

Since any carbon compounds were not used for the synthesis, therefore basic carbonates were formed by means of CO_2 in the air. At atmospheric pressure carbon (II) oxide has a low solubility in water and a lower solubility in aqueous solutions, particularly, of sodium chloride [3]. However, according to the literature, the amount of CO_2 contained in the air (0.03-0.04 %), is sufficient for the formation of basic copper carbonates in the air without introducing any carbon compounds in the system.

The product of aluminium oxidation obtained at the same conditions is a single phase: in the XRD pattern there are only the reflexes of boehmite. Indeed, it is not typical of aluminium to form carbonates since aluminium carbonates are unstable compounds. On the contrary copper carbonate belongs to the difficultly soluble compound as its solubility product is $2.5 \cdot 10^{-10}$ [4]. In a neutral medium copper carbonate undergoes partial cation hydrolysis with formation of basic copper carbonate.

Since aluminum is not characterized by the formation of carbonates, the possibility of double basic copper-aluminium carbonate apparently is due to the intense interaction of co-oxidation products of copper and aluminum. The decomposition products of hydrotalcite-type structure are the mixed metal oxides which have a number of textural characteristics which are favorable for the catalytic and sorption materials [5].

In general, copper and aluminum satisfy the specified requirements [6], under which the formation of hydrotalcite-type structures is possible. However, according to the literature hydrotalcite-type structure are less stable than malachite, therefore the decomposition of basic copper-aluminium carbonate to malachite takes place in the process of hydrolysis. In this regard, it should be noted the absence of the malachite phase in the sample synthesized in a sodium chloride solution with the concentration of 25 wt %. At the present time it is difficult to explain the

stability of Cu-Al/HT in the solution of the indicated concentration. There are some assumptions that require further researches to be able to speak confidently about the reasons for the stability of Cu-Al/HT in concentrated solutions.

Current density is another parameter that influences the composition of the precursor of copper-aluminium oxide system (fig. 2). At the current density more than 1.5 A/cm² copper (II) oxide is formed apart from Cu-Al/HT and basic copper carbonate. Since the reflections of copper (II) oxide are overlapped by these of Cu-Al/HT, therefore the presence of this oxide in the samples indicates the color change of samples to grey and black with increasing current density. As shown in the table, the ratio of oxides in the samples obtained at the current density of 1.5 A/cm², differs no more than 1 %. The colour change depending on current density for the similar composition samples 3–5 is caused by a high content of copper (II) oxide in the sample. In the table 100 % is taken as the total amount of copper and aluminium oxides under the conditions, provided that the total amount of reacted copper and aluminum were completely turned into CuO and Al₂O₃. It is reasonable that only these compounds are formed at heat treatment.

Table. Influence of the current density on the composition of copper-aluminium oxide system

| № sam. | Current density, A/cm ² | Amount, wt % | |
|--------|------------------------------------|--------------|--------------------------------|
| | | CuO | Al ₂ O ₃ |
| 1 | 0.5 | 0.8 | 99.2 |
| 2 | 1.0 | 26.4 | 73.6 |
| 3 | 1.5 | 37.5 | 62.5 |
| 4 | 2.0 | 38.8 | 61.2 |
| 5 | 2.5 | 37.8 | 62.2 |

At the moment it is not possible to say definitely about the reasons of composition changes. It is supposed to be due to a high reactivity of the compounds in the composition of the samples obtained by nonequilibrium electrochemical oxidation at high current density. Moreover the high amount of copper compounds in the oxide system may influence the stability of some phases.

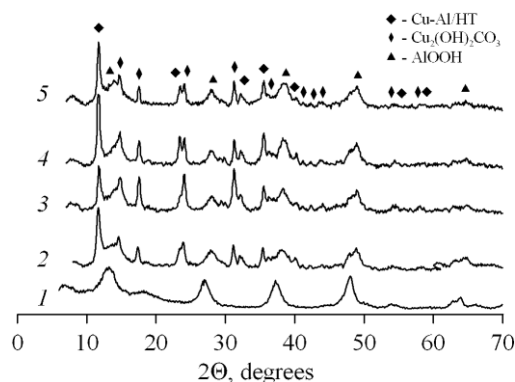


Fig. 2. XRD pattern of Cu–Al–O system precursors obtained by alternating current electrolysis at current density of 0.5 (1), 1.0 (2), 1.5 (3), 2.0 (4) и 2.5 (5) A/cm²

In general it was estimated that independently of the synthesis conditions the products of the simultaneous nonequilibrium electrochemical copper and aluminium oxidation have the same composition under the action of the alternating current. Basic carbonate being the main copper-containing phase does not exert a negative impact on the properties of copper-aluminium oxide system obtained from heat treatment. On this basis we can conclude that it is not necessary to carry out a drying process under the conditions which avoid the basic carbonate formation.

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| Section XIII | |
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**ROUND TABLE
«TECHNIC PHYLOSOPHY»**

THE INFLUENCE OF TECHNOLOGY ON MODERN SOCIETY

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Due to the fact that technology is the thing which helps people to adapt environment for themselves with saving their own efforts and making life easier, the technology takes huge role in life of society. All existing civilizations on the Earth are divided into: [1]

- Traditional;
- Technogenic.

In the technogenic civilization scientific-technical progress constantly changes modes of communication, personality type and lifestyle. [1] Technogenic type of civilization becomes the global way of human's existence.

This article considers the technology importance for the modern society. Concept of technology and positive and negative technology influencing people should be determined for achieving this goal.

The concept of an instrument goes back to ancient times, when ancient people used sticks and stones as tools to facilitate the work commission. These were first axes, spears and gavel. Nowadays the technology is related to people's life; it develops and influences the society.

According to the K. Marx's opinion technology and a person should complete each other. This means that an individual doesn't have opportunities without having some devices. However, the other side of the coin is that the technique cannot work without an employee. K. Marx explains that only in combination with a human the technology has its own sense and achieves the desired effect. [2]

When scientists began to investigate the influence of technology on people's lives and to assess this impact, results were ambiguous. On the one hand some people were delighted and proud of the technical achievements of their time, technical innovations inspired by a sense of people's optimism. They were confident that if they subjugate nature with the help of technique people will satisfy all their needs. On the other hand people had sense of pessimism, fear of "technological demon". They were afraid of being enslaved by machines and that the era of robots would replace humanity. Doubtless, we cannot ignore the fact that both opinions have a right to exist.

One argument for is the fact that the post-industrial society emerged due to the technological advances, including the emergence of intellectual technologies. These technologies significantly affect the society development as a whole. Over

time, with the introduction of new technology, the development of new technologies economies has reached incredible heights in its development thus improving the financial situation of the country. However, the processes observed in a small deceleration in relation to any incidents occurring in the country or the world, for example, World War II. Another good thing about it is that quality of human's life improves. For the great majority of people different types of technique are integral part of existence, for example today it is difficult to imagine a person without a mobile phone or a computer. Using these devices greatly simplifies the workflow and communication process, in some cases, these things are an entertainment. We can access to the Internet, find some music or photos, and communicate with different people even from other countries; we can shop without leaving home, view satellite map of the Earth, read books and news online and etc with the help of computers.

Military technology advances, especially in the area of unconventional weapons, can radically change the methods of waging war, make a large scale collision of the world's leading nations. Development of "Non-lethal" weapons is going very fast. As a consequence, it can strongly influence the strategy and tactics of future wars. In spite of the positive side that was mentioned above, in recent years the development of new industries and areas requires huge financial resources and intellectual costs. This leads to a broad international cooperation, for example, in the area of fundamental physics research and energy.

Let's consider this problem from another point of view. In general, public tend to believe that technological progress is the cause of degradation of human's capabilities. Moreover, people are free from the strict natural necessity; they become prisoners of side-effects of technology such as environmental degradation, resource shortages and others. We are forced to adapt to the laws of the functioning of technical devices connected with the division of labor, rationing, punctuality, shift work, to put up with the environmental consequences of their action.

Techniques replace human labor and lead to productivity increase, create the problem of leisure time and unemployment. We pay for comfortable life by people's disunity. For people the opportunity to have their own transport means and therefore to be a mobile person is bought at the cost of noise pollution and ruined nature. Medical equipment, which significantly increases lifetime, puts the

developed countries to face the problem of demographic explosion.

Despite the fact that introduction of new technologies and machines leads to increase of productivity on the other hand there is increase of unemployment and underemployment. It is the structural unemployment which focuses on structural problems in the economy and inefficiencies inherent in labour markets including a mismatch between the supply and demand of laborers with necessary skill sets. Much technological unemployment due to the replacement of workers by machines might be counted as structural unemployment. [3] For example we can see the decline of jobs in UK manufacturing industry during the period from 1978 to 2006 in the next chart (Figure 1).

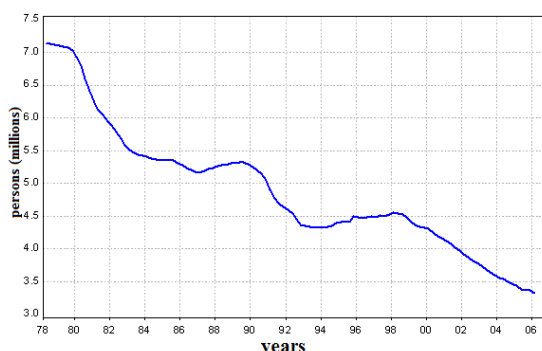


Figure 1 – Employment in the UK Manufacturing Industry

Chart shows the decrease of employment which is connected with development of technologies and techniques. It is obvious that unemployment increases susceptibility to malnutrition, illness, mental stress, and loss of self-esteem, leading to depression. Also an economy of countries is not using all of the resources, such as labour, and it is operating below its production possibility. As a result, society is dissatisfied with it and civil unrests, revolutions and totalitarianism can appear.

If it is examined on the other hand a technique, which interferes into the nature, becomes a threat to human individuality, human dignity and individual uniqueness. Modern computerization intensifies mental labor increases (the "resolving power" of the human brain) by affecting the intellectual and spiritual life of an individual and society. [4]

"Algorithmic" way of thinking, based on the formal-logical methods of concept formation provided the transformation of the mind in a cybernetic pragmatically oriented mind, graduating

imaginative, emotional coloration thinking and communicating.

Global computerization hides the danger of dialogic communicating with other people increasing the "deficit" of humanity, the emergence of early psychological society and human loneliness and even decline of physical health. There is no doubt that computer technology plays a significant role in the professional development of a people. It has a great influence on the general cultural development of the personality. It develops creativity, moral responsibility, multiplies the intellectual wealth of the individual and sharpens the understanding of human meaning and life's purpose in society. But it is also true that it becomes a threat to the spiritual homogeneity, which is expressed in the formation of technical personality type. However, we should not forget that people influence the technology as well. As a result, everyone can change his/her present and even future. Society should change its views on the role of technology in people's lives in order to reduce the deleterious effects of techniques and its production. It must not replace the spiritual and cultural spheres of life; people need to develop themselves using these spheres despite the powerful influence of computers and other equipment.

To draw the conclusion, we can say that technology does not have significance without human intervention, technology affects the society differently. Firstly, development of technology increases productivity, quantity of products. It comes along with financial situation of the country and improves the quality of human's life. However, the other side of the coin is that engineering development is the reason of an increase of unemployment, environmental pollution. It reduces depths of the human intellect. It is obvious that a technique has impact on society both positively and negatively, but the fight with these effects is real. So it's up to everybody to decide whether to be influenced by technogenic civilization or not.

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18th International Scientific and Practical Conference
of Students, Post-graduates and Young Scientists

MODERN TECHNIQUE AND TECHNOLOGIES MTT' 2012

April 9–13, 2012, Tomsk, Russia



Подписано к печати 01.06.2011 Формат 60x84/8. Бумага «Классика».

Печать RISO. Усл. печ. л. 13.43. Уч._изд. л. 12. 15.

Заказ 424. Тираж 100 экз.

Национальный Исследовательский Томский политехнический университет

Система менеджмента качества

Томского политехнического университета сертифицирована

NATIONAL QUALITY ASSURANCE по стандарту ISO 9001:2000