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ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

МЕТОДОЛОГИЯ ПРОЕКТИРОВАНИЯ МОЛОДЕЖНОГО НАУЧНО-ИННОВАЦИОННОГО ПРОСТРАНСТВА ДЛЯ РОССИЙСКОЙ ЭНЕРГЕТИКИ

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Сборник содержит труды участников Международной молодежной научной школы «Методология проектирования молодежного научно-инновационного пространства для российской энергетики». Включает пленарные лекции, материалы семинара, мастер-класса, доклады студентов и молодых ученых, представленные на секциях «Ядерные технологии как неотъемлемая часть инженерной науки в современном мире», «Единство традиций и инноваций как основа развития современной инженерной науки», «Общие проблемы и перспективы развития инженерного дела в условиях глобализации». Сборник представляет интерес для студентов, аспирантов, молодых ученых, преподавателей в области естественных наук.

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СЕМИНАР
NUCLEAR TECHNOLOGIES AS INTEGRAL PART OF ENGINEERING SCIENCE IN THE MODERN WORLD

STRUCTURAL MODELING OF TECHNOLOGICAL OBJECTS: LIFE ACTIVITY SYSTEM

S.D. Babkin, V.V. Kiriyenko
Scientific advisor: Senior teacher A.V. Godovykh
Language advisor: Teacher A.V. Tsepilova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: BabkinSergey38@mail.ru

Annotation

The investigation of life activity systems of nuclear fuel cycle objects was performed with methods of classification in this work. The hierarchical tree structure that shows the structure of life activity systems of nuclear fuel cycle objects has been obtained as a result. The variety of connections between the structural components of the life activity system were investigated. The possibility of creating of a mathematical model to evaluate the effectiveness of the life activity system based on obtained data was analyzed.

Keywords: Object, life activity system, classification, structure, features, security, performance, intelligence.

This work is a part of research aimed at the creation of the universal model for evaluating the performance of the object of nuclear fuel cycle by researching of the interaction systems responsible for life activity of the object.

So several tasks have been performed in this work. First, the classification of life activity systems of objects in the form of a structural scheme form has been presented. Second, the relationships "element" - "system", "system" - "system" have been identified. Third, the possibility of creating of a mathematical model, based on the obtained classification, has been analyzed.

Nuclear dangerous objects, with their hard-coded organizational requirements were selected for the initial phase of the classification of life activity system. Unstable functioning is not allowed for such objects. Therefore, the state operator of a nuclear dangerous object should ensure its safety. It is therefore necessary to take into account all possible threats to facilities of the nuclear fuel cycle and to direct all efforts to ensure the security of facilities of the nuclear fuel cycle from the abnormal situations and threats, both external and internal. [1]

The term "object" in this work means a facility or institution, which is associated with human activity and performing one or more technological processes. Any technological process aimed at an object or technological process, which is carried out by the object, is within the framework of the life cycle of the object. Life cycle is the period of time that includes the designing, commissioning, exploitation and decommissioning of an object.

Security is an object property, which characterizes sustainability of the object to the influence of factors that impede the normal functioning of the object throughout the life cycle. Economic and technological efficiency of the object are in direct relation to its security.

The most important way to ensure security is the implementation of life activity system (LAS) in the object. Therefore, the designing and implementation of effective LAS are priority directions of science and technology in the Russian Federation for the moment. Efficiency of the system is the main indicator of the quality of the system work that characterizes the system ability to perform its function as intended. Efficiency of LAS is a comprehensive indicator, which characterizes the system's ability to reduce the level of threats to securable object. Threat to a securable object is an existing possibility of accidental or deliberate damage (harm) to the protected object. [2]

Threats to objects are changes together with continuous development of technology in the modern world, and therefore the requirements for LAS of objects also change. Therefore, performance evaluation is a crucial step of designing, implementation, exploitation and upgrading of effective LAS. All defects and vulnerabilities of LAS are identified at this stage by comparing the efficiency and the requirements for it. Requirements for LAS depend on the characteristics and use of the object. Requirements for LAS depend on the characteristics and appointment of the object.

In practice LAS is a complex of various subsystems. Mathematical models are used to evaluate the performance of LAS. But these models are based on the features and needs of a particular object. Universal model for evaluating the effectiveness of LAS of the nuclear fuel cycle object does not exist. Detailed research of the structure of LAS is needed for creating a universal model. The use of classification approaches is suitable for this purpose. Tree structure was selected for visualizing the structure of the selected LAS. The structure of the LAS is an organized collection of a number of components, with some components in the subordination of others.

The first stage of studying the structure of LAS was the realization of a set of typical components. This stage included the analysis of the structures of realized LAS, government normative documents, scientific publications and identification of typical components of LAS, and the synthesis of a set of typical components of LAS.

The set of typical constituent components of LAS, which was gained in the first phase, is not structured. For determining the internal structure in this set it is necessary to classify all components in this set. Classification is a process of assigning an object to a particular division of the classification which is created by determining the presence or absence of a given feature in the object [3]. In this case, a classification means a system of subordinated concepts (classes of objects) of a field of knowledge or human activity, which is made with the general features of objects and natural connections between them and allowing to navigate in a variety of objects.

Hierarchical classification method was used for the classification of constituent components of LAS. This method consists in consecutive division of a given set of research subjects on subordinate subsets accompanied by gradual concretization of the object classification. The resulting set of subsets forms a hierarchical tree structure in the form of a branching graph.

LAS was taken as the object of classification in this study. A set of typical constituent components of LAS was adopted for a given set of objects of the study, the activities carried out by the constituent components of LAS, were adopted as the basis of the division.

Hierarchical tree-like structure was obtained as a result. This structure is a simplified graphical representation of the decomposed system. Here, each system consists of separate interconnected subsystems, which can also be broken down into separate parts. There are seven levels of classification in this structure. Each level combines subsystems carrying out a certain level of activity.

1. The upper level. This level is called the "object." The object of the study is selected and described at this level.

2. The level which is called "Features". A set of features specific for the object is researched at this level. Each of the properties of the object reflects the features of the analyzed object. The two main features were identified in this work: functioning and intelligence. Functioning is a property represented by a set of components. The set of these components sets the orientation of the object function. Then we have five levels, representing a set of systems and subsystems forming them. Each successive level specifies the functions performed by the system of the previous level.

The second stage of the study of LAS structure is the study of relations between the constituent components of LAS in the classification. Relations between the components in the resulting classification are vertical and horizontal. Vertical relations (subordination) of components in the classification systems describe the activities of a higher-level system as a set of activities of a lower level. Horizontal relations characterizes the integration of systems that belong to the same level of classification. In other words, the horizontal links between systems describe mutual approach of systems and determine the flexibility of LAS.

The resulting structure can be used to analyze the efficiency of LAS of objects if graph theory is applied to it. It will make it possible to describe the structure of LAS using a system of equations.

Such feature of the system as intelligence was mentioned above. Intelligence is a property of the system, which is an attribute of a certain level of complexity. Intelligent system - is a system or device with the software having the ability to customize its parameters depending on the condition of external environment with built-in processor. [5] Intelligent systems are highly sustainable. This means that they are able to objectively respond to changing external and internal conditions, thereby maintaining their original condition. Intellectual LAS has many benefits, including: reducing administration costs, high safety, high sustainability of LAS to abnormal situations, etc. [6]

LAS object model of the structure has been formed during the study. This model is implemented in a hierarchical tree. This hierarchical tree will be used as the basis for creating a mathematical model for measuring the efficiency of the object. This mathematical model will highlight vulnerabilities of the LAS of an object. It can be used to improve the level of protection of the object.

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REMEDIATION OF ARTIFICIAL WATER BASINS OF URANIUM ENTERPRISES

S.A. Chalov, D.Sh. Faizulaev
Scientific advisor: Ph.D., As. Professor N.B. Egorov
Linguistic advisor: Senior teacher Ya.V. Rozanova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: chalov@mail.ru

Annotation

In the given paper the technology of one of the stages of slurry storage basins conservation - cleaning decantates from slurry storage basins of uranium production, which reduces uranium content to the value below the MPC level (0.1 mg / L) is proposed.

The process of galvanochemical treatment of decantates from slurry storage basins of uranium enterprises is considered. The main features of the galvanochemical treatment are determined. Comparison with direct alkalization of the decantate is made.

This research work will be useful for nuclear industry workers involved in preservation and radioactive waste management, as well as for scientists working on environmental safety and at engineering complexes processing all types of waste.

Key words: decantates from slurry storage basins, uranium, radionuclides, galvanic couple, galvanochemical treatment.

Introduction

Today the majority of enterprises of atomic industry neutralize industrial wastewaters containing nonferrous, heavy, and radioactive metals and discharge the resulting slurries into open slurry storage basins. Basins for accumulation of liquid radioactive waste (LRW) are potentially hazardous, because in the course of their operation radionuclides migrate beyond the storage basin. Furthermore, accidents at protecting and filtering dams can lead to considerable pollution of the adjacent territories and of underground and surface waters. The life of slurry storage basins is limited. The Environmental Safety section of the Concept of the Development of the Atomic Industry in the Period of up to 2010 indicates that it is necessary to develop measures for step-by-step conservation and liquidation of radioactive slurry storage basins and to construct industrial complexes for reprocessing of all kinds of wastes [1].

Here we suggest a process for one of the steps of conservation of slurry storage basins: treatment of the decantates from slurry storage basins of uranium production to decrease the uranium concentration below the MPC level (0.1 mg l^{-1}).

Experimental

In our experiments of treatment of the decantate from slurry storage basins of a uranium enterprise (the decantate composition is given below), we performed both direct alkalization and galvanochemical treatment. In the initial decantate and in the filtrate after the treatment, we determined U_{tot} by the procedure from [2-7], using Arsenazo III as indicator. The galvanic sludge precipitates were examined by thermal gravimetric and X-ray phase analysis and by IR spectroscopy.

Thermal gravimetric analysis of galvanic sludge samples were performed with an SDT Q600 combined thermal analyzer in the temperature range 20-1000°C in a nitrogen atmosphere. X-ray diffraction patterns were taken with a DRON-3M diffractometer (CuK_{α} radiation). The IR spectra of galvanic sludge samples in KBr pellets were recorded with a Nicolet 5700 IR Fourier spectrometer in the range 400-4000 cm^{-1} at room temperature.

Composition (mg l^{-1}) of the decantate from the slurry storage basin of the Novosibirsk Plant of Chemical concentrates, Joint-Stock Company

NH_4^+	11.9-21.9	NO_2^-	6.7-18.7
Ca^{2+}	320-350	CO_3^{2-}	До 400
Na^+	375-445	Cl^-	80-150
Mg^{2+}	50-55	F^-	3.0-3.4
Li^+	6.1-7.8	Dry residue	До 3500
NO_3^-	1345-1520	pH	7.1-7.8

In the course of operation of slurry storage basins, the discharged alkaline indusdtrial wastewaters undergo acidification due to dissolution of atmospheric carbon dioxide. Acidification of decantates leads to partial dissolution of the precipitate and to an increase in the uranium concentration.

An interesting approach is alkalization of the decantate from slurry storage basins to decrease the uranium concentration via formation of both insoluble uranium compounds and a precipitate (calcium and magnesium hydroxides, calcium carbonate) acting as uranium collector. Treatment of basins with calcite-containing reagents to decrease their acidity was reported in [3].

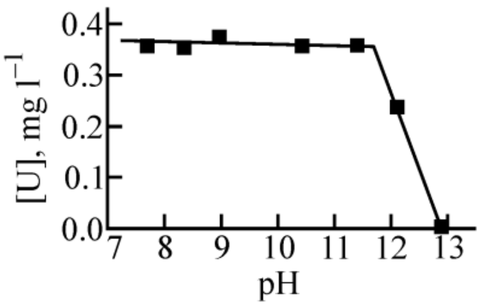

Fig.1. Effect of pH on the residual concentration of uranium [U] at direct alkalization of the decantate from a slurry storage basin.

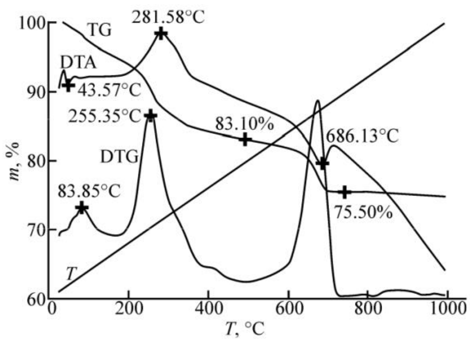

Fig.2. Derivatogram of the galvanic sludge precipitate obtained by treatment of the decantate containing 30 mg l-1 U_{tot}.

Experiments on capturing uranium by the forming precipitate were performed as follows. The decantate from a slurry storage basin, containing 0.393 mg l^{-1} U_{tot}, was treated with lime milk [10% *$Ca(OH)_2$*] in the pH range 7-13. The results of the experiment are shown in Fig. 1.

Efficient trapping of uranium is attained by alkalization of the decantate to pH > 12.9, which corresponds to complete precipitation of magnesium hydroxide (pH 12.4) [4]. In the process, the decantate from a slurry storage basin exhibits pronounced properties of a buffer solution.

The most efficient and cost-saving method of wastewater treatment, as noted by UNESCO, is galvanochemical method. This method was suggested for treatment of the decantate from slurry storage basins to remove uranium without strong alkalization [5, 6]. The method is based on anodic dissolution of iron in the galvanic couple Fe–C owing to internal electrolysis, with continuous formation of precipitates of hydrated iron polyforms (galvanic sludge) in the volume of the solution being treated.

The major advantages of the galvanochemical method are simplicity and reliability, highly efficient removal of nonferrous, heavy, and radioactive metals from highly saline water systems, the use of metal working wastes as galvanic packing, the possibility of combining with other treatment methods, magnetic properties of precipitates, and high performance [5].

For the treatment of the decantate from a slurry storage basin, we used a laboratory vibration coagulator of vertical type having the productive capacity of up to 50 l h–1, with the Fe (St.3)–C (graphite) galvanic couple [7]. The decantate was treated as follows.

After pH adjustment at 20°C, the decantate was fed to the vibratory galvanic coagulator, which was followed by pH adjustment and separation of the galvanic sludge precipitate by filtration.

In our experiments we studied how pH of the decantate, contact time, and vibration frequency affect the amount of the generated iron and the residual uranium concentration. We found that, by varying pH of the initial and treated decantate, it is possible to control the generation of the galvanic sludge precipitate and the uranium concentration in the filtrate.

The residual concentration of uranium correlates with the content of the galvanic sludge precipitate. To attain MPC of U_{tot} (0.1 mg l^{-1}) at the initial U_{tot} concentration of 0.393 mg l^{-1} and adjustment with lime milk, it is necessary to generate no less than 0.5 g l^{-1} of the galvanic sludge precipitate (treatment time $\tau = 5$ min). When the amount of the galvanic sludge precipitate exceeds 1.6 g l^{-1}, the uranium recovery is virtually complete.

The phase separation is satisfactory: complete clarification is attained within 20 min (rough clarification, within 2-3 min). Introduction of Praestol 2530 flocculant substantially improves the process parameters (phase separation time ~10 min). The precipitates have magnetic properties and can be removed by magnetic separation.

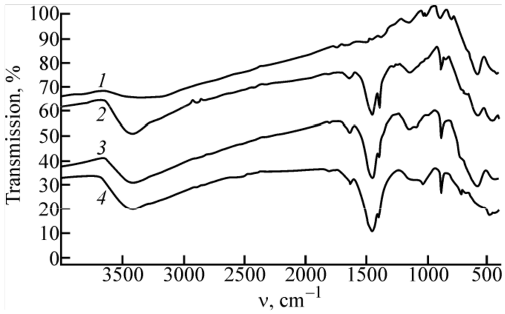

Fig.3. IR spectra of galvanic sludge precipitates obtained by processing of the decantate with various uranium concentrations, mg l^{-1}: (1) 0 (initial), (2) 5, (3) 10, and (4) 30.

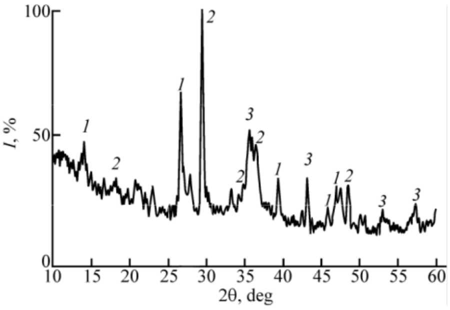

Fig.4. X-ray diffraction pattern of a galvanic sludge precipitate obtained by treatment of the decantate containing 30 mg l^{-1} U_{tot}. (1) Magnetite, (2) iron carbonate, and (3) lepidocrocite.

Figure 2 shows the results of thermal analysis of the galvanic sludge obtained by treatment of the decantate containing 30 mg l-1 U. Exothermic processes are recorded in the interval 200-400°C. These processes are associated with the decomposition of uranyl carbonate compounds and hydrated iron polyforms. At 690°C, an endothermic effect it observed in the DTA curve. It is associated with the decomposition of intermediate uranium compounds and formation of uranium dioxide.

Figure 3 shows the IR spectra of galvanic sludges obtained by treatment of decantate samples with different uranium contents.

In the IR spectrum of the initial galvanic sludge, there is a broad band of stretching vibrations ν(OH) with a maximum at 3346 cm^{-1} and a band with a maximum at 572 cm^{-1}, characteristic of Fe_2O_3 [8]. In the IR spectra of galvanic sludges containing uranium, the stretching vibration band ν(OH) changes shape, and the vibrations characteristic of Fe_2O_3 gradually disappear.

It is known [9] that, in the presence of excess carbonate ions in solutions, uranyl ion forms a very stable uranyl tricarbonate complex $[UO_2(CO3)_3]^{4-}$ (K_{st} = 2 × 1018). The decantate from a slurry storage basin contains a large amount of carbonate ions (see above). Therefore, it can be assumed that uranium occurs in the solution in the form of this complex compound. The fact that the IR spectra of galvanic sludge samples contain bands with maxima at 1439-1440 and 1123-1143 cm^{-1}, belonging to the absorption of carbonate ions, counts in favor of this assumption.

X-ray phase analysis showed that the major phases in the initial precipitates of hydrated iron polyforms are magnetite, goethite, and γ-FeOOH. In the X-ray diffraction pattern of the galvanic sludge obtained by treatment of the decantate containing 30 mg l^{-1} U, we detected the phases of magnetite, lepidocrocite, iron carbonate, and others (Fig.4).

Conclusion

Our results show that the contact of hydrated iron with uranium decantates involves a chemical reaction with the formation of new chemical compounds.

The developed galvanochemical treatment process can be used for treatment of the decantate from a slurry storage basin, of surface and mine waters, and of uranium-containing process solutions. Direct alkalization of the decantate from a slurry storage basin is not efficient because of high reagent consumption.

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SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS AND MECHANICAL ACTIVATION AS A WAY OF GETTING FUNCTIONAL MATERIALS

S.S. Chursin
Scientific advisor: Assistant M.S. Kuznetsov
Language advisor: Teacher Y.V. Ermakova
National Research Tomsk Polytechnic University, Physical Technical Institute
634050, Russia, Tomsk, Lenina Avenue, 2
E-mail: chursinss@tpu.ru

In our time energy sources are very important and people must develop new energy sources and materials, which will be used in these sources. In this work you can see one of some perspective methods of making new materials. It's boron carbide.

Energetic is one of the most important branches of national economy that includes energy resources, generation, transformation, transfer and using of different types of energy. In our days a lot of natural easily accessible resources are confined. It seems that limited supply of gas and oil in the world can place humanity under threat of energy crisis. However, using of nuclear energy gives humanity a chance to avoid the crisis. But we need to develop new functional material. Investigation of lots of different research and sources, connected with different structures materials and obtaining of new structural materials, leads to a result that one of the most perspective materials for nuclear energy.

We found one perspective methods of making material, It's Self-Propagating High-Temperature Synthesis or SHS. SHS - is a method for producing inorganic compounds by exothermic reactions, usually involving salts. A variant of this method is known as solid state metathesis. Since the process occurs at high temperatures, the method is ideally suited for the production of refractory materials with unusual properties, for example: powders, metallic alloys, or ceramics with high purity, corrosion–resistance at high–temperature or super-hardnessity. The modern SHS process was reported and patented in 1971, although some SHS-like processes were known previously

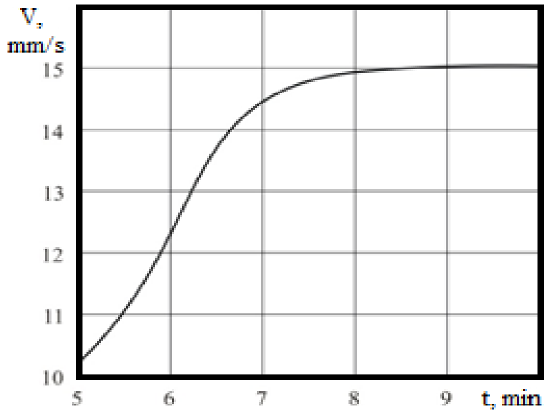
The SHS is based on the principle of maximum utilization of chemical energy of reacting substances for obtaining inorganic compounds, materials, and items of various application purposes and also for organizing highly efficient technological processes.

We made our experiment on system B-C. Industrial method of obtaining boron carbide is currently the hot pressing at temperatures of 2500K. This method is highly energy-intensive, so it is necessary to work out a new way of obtaining this material. One of the possible ways to obtain a boron carbide is self-propagating high temperature synthesis (SHS). This is the one of the most promising methods of obtaining materials for various applications.

In the course of work, the experiments to obtain boron carbide by SHS were conducted. The reaction was carried out by the next chemical equation: $\boldsymbol{B + 4C \rightarrow B_4C}$.

The experiments were conducted in the following order: after mechanical activation in a ball mill and vacuum drying initial mixture was pressed into cylindrical samples of diameter 30 mm and a height of 12-15 mm and density values in the interval $2*10^3 – 7*10^3$ kg/m^3.

According to our data was plotted the change of the speed of the combustion front of mechanical activation on the time of the initial components of the mixtures presented at the graph.



This graph shows that the mechanical activation has a positive effect on the process of synthesis flow and, as a consequence, on the quality of the final product. But it also shows that the mechanical activation has a threshold of saturation. Therefore established that mechanical activation processing of the initial components of the mixture allows changing modes of SHS and thus controlling the phase composition and properties of the final product, which is confirmed by experimental data.

Picture 1. The change of the speed of the combustion front by mechanical activation on the time

Next step was to study the effect of reactive additives Ni-Al in the synthesis of BC_4. To prepare the mixes have been used industrially produced powders of nickel grade ПНК-ОТ 1, aluminum grade ПА-4. During a research amount of additive varied from 5% to 25% by weight of the mass of the original mixture.

The samples were burned in a vacuum. After the introduction of additives, it was found that the temperature of initiation of synthesis below 1000K. And the temperature is being developed in the synthesis process, reaching values of about 2700 K. After completing the synthesis, sample cooled to ambient temperature. The experiments showed that the combustion temperature depends on the amount of nickel-aluminum additions to the original mixture of reagents. So, if they contain additional components in the sample in an amount of about 15% of weight observed a significant increase in process temperature (2700 K), and about 25% of weight - thermochemical destruction of the sample during the synthesis, due to significant heat release reactions in the mixture.

CONCLUSION

After this series of experiments, the possibility of B_4C by the SHS as well as worked out the basic parameters influencing the process of synthesis was proved. It was also found out, that the structural materials, obtained by this method, have sufficient heat resistance and withstand large temperatures. And now it is need for further production testing of the samples. The samples should tested for the neutron-physical properties.

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INFLUENCE OF MODERN NUCLEAR TECHNOLOGIES ON THE DEVELOPMENT OF MEDICINE

E.A. Danchenko
Scientific advisor: Ph.D. A.V. Vukolov
Linguistic advisor: Senior teacher N.V. Demjanenko
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: katyushka_dnd@mail.ru

Annotation. This article describes the huge contribution of modern nuclear technologies in the development of medicine. The success which has made medicine due to these technologies. The article considers the main areas of application and the directions of development of nuclear medicine. Also this article directly describes the application of nuclear technology.

The purpose of this report is to show and appreciate the achievements of medicine that it received through the development of nuclear technology and to show what problems are encountered in the development of nuclear medicine. I think that the topic of the report is relevant in our society. Especially nowadays, when the nuclear industry and nuclear power have reached the highest level.

Our country has long laid a strong scientific tradition of peaceful nuclear technology. Enough to say that in 1954 the world's first nuclear power plant was built in Obninsk, and in 1958 Obninsk Medical Radiological center was created by a special decree of the Government. Here were laid most advanced of nuclear medical technology to diagnose and treat cancer patients for that time. So in our country rare by the technical complexity branch of medicine - nuclear medicine was identified, where the use of diagnostic and therapeutic procedures are increasing [7].

Nuclear medicine today - this is an area that includes the prevention, diagnosis and treatment of various diseases through the application of stable and radioactive isotopes both independently and in a variety of substances that contain them. The uniqueness of nuclear medicine lies in the fact that they can be used to diagnose and in some cases to predict and correct functional deviations of various human organs and systems in the very early (biochemical) stages of the disease and, therefore, provide more effective treatment. Other methods often do not make it possible [6].

The main areas of application of nuclear medicine include:

- oncology;
- endocrinology;
- cardiology;
- neurology;
- Evaluation of the functional state of organs and systems.

The development of nuclear medicine today is in the following areas:

- Radionuclide diagnosis;

- Radionuclide therapy;
- Electron beam therapy;
- Neutron and neutron capture therapy;
- Proton and proton-ion therapy [2].

So, how all this is done. In nuclear medicine, medical professionals inject a tiny amount of a radioisotope a chemical element that produces radiation into a patient's body. A specific organ picks up the radioisotope, enabling a special camera to take a detailed picture of how that organ is functioning. Radioactive drugs, known as radiopharmaceuticals, give off radiation, allowing special scanners to monitor tissue and organ functions. Abnormal areas show higher-than-expected or lower-than-expected concentrations of radioactivity. Physicians then interpret the images to help diagnose the patient's condition. For example, tumors can be seen in organs during a scan because of their concentration of the radioactive drugs. For example:

- Myocardial perfusion imaging maps the blood flow to the heart, allowing doctors to see whether a patient has heart disease and determine the most effective course of treatment.
- Bone scans can detect the spread of cancer six to 18 months earlier than X-rays.
- Kidney scans are much more sensitive than X-rays or ultrasounds in fully evaluating kidney function.
- Imaging with radioactive technetium-99 can help diagnose bone infections at the earliest possible stage.

These kinds of diagnostic procedures involve very small amounts of radioisotopes. In higher doses, radioisotopes also help treat disease. For example, radioactive iodine's widespread use in therapy for thyroid cancer results in a lower recurrence rate than drug therapy. It also avoids potentially fatal side effects, such as the destruction of bone marrow.

Sealed sources of radiation placed inside the body, or radiation directed from external sources, are effective in treating various cancers. Nearly half of all cancer patients in the United States receive radiation treatment at some point in their therapy.

Hospitals also use radiation to sterilize materials, thus helping to prevent the spread of diseases. Exposing these materials to radiation does not make them radioactive [3].

Fig.1. Nuclear medicine technologists work with computers and large pieces of technological equipment and must be comfortable operating them

A 2009 report from the National Council on Radiation Protection and Measurements (NCRP) found a dramatic increase in the use of nuclear medicine since the 1980s, especially computed tomography (CT) scans. These scans help guide treatment of car-accident injuries, cancer, blood clots in the lungs and many other conditions. Approximately 68 million CT scans were performed in the United States in 2006, according to the NCRP [8].

Now details about each direction and also about which devices and drugs are used here.

Start with the radionuclide diagnostics. Radionuclide diagnostics (radioisotope diagnosis) - beam study based on the use of compounds labeled with radionuclides. As such compounds approved for human administration for diagnostic and therapeutic purposes radiopharmaceuticals - chemical compounds whose molecules contain certain radionuclides are used.

The basic tools of modern nuclear medicine are gamma-camera and multi-detector gamma-ray tomograph for single photon emission computed tomography (SPECT). In Russia only 21 laboratories from the 300 nuclear medicine laboratories are properly equipped. Over 80% of workers gamma cameras operated by a decade or more, in need of modernization or radical, or complete replacement now.

Fig.2. Gamma camera

Positron emission tomography is a nuclear medicine technique for imaging using radiopharmaceuticals labeled with positron-emitting radionuclides, ultra-short. The main argument in favor of these nuclides was the fact that their use can reduce the time of the study and a radiation burden to the patient, as Most of the drug breaks down already in the study [1].

Fig.3. PET scanner

Next direction is beam therapy (radiation therapy).

Beam therapy is section of clinical medicine in which use methods based on the biological effects of ionizing radiation for the treatment of various diseases, especially cancer. Depending on the goals of treatment distinguish radical (achievement of complete resorption of the tumor and cure the patient) RT, palliative (inhibition of tumor growth, extending the patient's life) and symptomatic (removal of individual symptoms, such as pain, compression syndrome, etc.). Radiation therapy is used in combination with other methods of treatment of cancer - chemotherapy and surgical interventions.

The effectiveness of radiation therapy depends primarily on the location of the tumor, the stage of development and size. Also important things are the patient's age, and general condition.

In radiotherapy linear accelerators and high-tech device the so called knives are used now [1].

Fig.4. Linear accelerator

During treatment by linear accelerator, the patient is on a mobile couch, and the position of the body is evaluated using the laser system. The couch can be moved in different directions: up, down, left, right, forward and backward. Beam of rays out of a device called a gantry, which rotates around the couch. Moving patient table and gantry rotation around allow delivery of radiation to the tumor from many angles.

Fig.5. The stereotactic system Cyberknife

Besides I would like to pay attention to diagnostic and therapeutic radiopharmaceuticals.

Dagnostic radiopharmaceuticals can be used to examine blood flow to the brain, functioning of the liver, lungs, heart or kidneys, to assess bone growth, and to confirm other diagnostic procedures. Another important use is to predict the effects of surgery and assess changes since treatment [8].

The amount of the radiopharmaceutical given to a patient is just sufficient to obtain the required information before its decay. The radiation dose received is medically insignificant. The patient experiences no discomfort during the test and after a short time there is no trace that the test was ever done. The non-invasive nature of this technology, together with the ability to observe an organ functioning from outside the body, makes this technique a powerful diagnostic tool [4].

A radioisotope used for diagnosis must emit gamma rays of sufficient energy to escape from the body and it must have a half-life short enough for it to decay away soon after imaging is completed.

The radioisotope most widely used in medicine is technetium-99m, employed in some 80% of all nuclear medicine. It is an isotope of the artificially-produced element technetium and it has almost ideal characteristics for a nuclear medicine scan. These are:

- It has a half-life of six hours which is long enough to examine metabolic processes yet short enough to minimise the radiation dose to the patient.
- Technetium-99m decays by a process called "isomeric"; which emits gamma rays and low energy electrons. Since there is no high-energy beta emission the radiation dose to the patient is low.
- The low energy gamma rays it emits easily escape the human body and are accurately detected by a gamma camera. Once again the radiation dose to the patient is minimised.
- The chemistry of technetium is so versatile it can form tracers by being incorporated into a range of biologically-active substances to ensure that it concentrates in the tissue or organ of interest [5].

Its logistics also favour its use. Technetium generators, a lead pot enclosing a glass tube containing the radioisotope, are supplied to hospitals from the nuclear reactor where the isotopes are made. They contain molybdenum-99, with a half-life of 66 hours, which progressively decays to technetium-99. The Tc-99 is washed out of the lead pot by saline solution when it is required. After two weeks or less the generator is returned for recharging. A similar generator system is used to produce rubidium-82 for PET imaging from strontium-82 - which has a half-life of 25 days [9].

Myocardial Perfusion Imaging (MPI) uses thallium-201 chloride or technetium-99m and is important for detection and prognosis of coronary artery disease.

For PET imaging, the main radiopharmaceutical is Fluoro-deoxy glucose (FDG) incorporating F-18 - with a half-life of just under two hours, as a tracer. The FDG is readily incorporated into the cell without being broken down, and is a good indicator of cell metabolism.

Although radiotherapy is less common than diagnostic use of radioactive material in medicine, it is nevertheless widespread, important and growing. An ideal therapeutic radioisotope is a strong beta emitter with just enough gamma to enable imaging, eg lutetium-177. This is prepared from ytterbium-176 which is irradiated to become Yb-177 which decays rapidly to Lu-177. Yttrium-90 is used for treatment of cancer, particularly non-Hodgkin's lymphoma, and its more widespread use is envisaged, including for arthritis treatment. Lu-177 and Y-90 are becoming the main RNT agents [9].

Iodine-131 and phosphorus-32 are also used for therapy. Iodine-131 is used to treat the thyroid for cancers and other abnormal conditions such as hyperthyroidism (over-active thyroid). In a disease called Polycythemia vera, an excess of red blood cells is produced in the bone marrow. Phosphorus-32 is used to control this excess.

A new and still experimental procedure uses boron-10, which concentrates in the tumour. The patient is then irradiated with neutrons which are strongly absorbed by the boron, to produce high-energy alpha particles which kill the cancer.

Considerable medical research is being conducted worldwide into the use of radionuclides attached to highly specific biological chemicals such as immunoglobulin molecules (monoclonal antibodies). The eventual tagging of these cells with a therapeutic dose of radiation may lead to the regression - or even cure - of some diseases [5].

Nuclear medical procedures are safe, both for the patient and the technologist. Patients experience little or no discomfort and do not require anesthesia. Exposure to ionizing radiation is monitored closely, and kept well below safety limits [8].

Summing up I want to say that medicine indeed raised to the new stage of development due to nuclear physics. I hope it can be seen from the above. Therefore it can be concluded that nuclear physics plays an important role in the development of medicine. With its tremendous pace of development of nuclear physics is making an invaluable contribution to medical progress and its prospects gives hope to all humanity for a better future without the disease.

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NUCLEAR WEAPON

D. Dolmatov

Language advisor: Senior teacher N.V. Daneykina

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: dolmatovdo@tpu.ru

A nuclear weapon is an explosive device that derives its destructive force from nuclear reactions, either fission or a combination of fission and fusion. Questions of nonproliferation of nuclear weapons and disarmament are very important in modern world. In this case it is very important to know main principles of different types of nuclear weapons' design.

In this article current situation with nuclear weapon in the world is reviewed. Also different types of nuclear weapons' design are described. Author used open sources about nuclear weapon in his research.

Introduction

A nuclear weapon is an explosive device that derives its destructive force from nuclear reactions, either fission or a combination of fission and fusion.

Only United States of America used nuclear weapon in the course of warfare. On 6 August 1945, a uranium gun-type bomb "Little Boy" was detonated over the Japanese city of Hiroshima. Three days later, on 9 August, a plutonium fission bomb with code-name "Fat Man" was exploded over Nagasaki, Japan. These two explosions caused the deaths of approximately 200,000 people.

After this explosions nuclear weapons used only for testing purposes and demonstrations. There was about 2000 tests of nuclear bombs.

Countries with nuclear weapon

Only a few countries possess such weapons. List of countries with nuclear weapon and year of first test and amount of their warheads by these countries you can see on the Table 1. Israel is also widely believed to possess nuclear weapons, though it does not acknowledge having them. One state, South Africa, create nuclear weapons in the past but then nuclear arsenal in this country was disassembled.

Country	***Warheads active/total***	***Year of first test***
USA	2150/7700	1945
Russia	1740/8500	1949
Great Britain	160/225	1952
France	290/300	1960
China	n.a/240	1964
India	n.a/80-100	1974
Israel	n.a./80-200	Unknown (possibly 1979)
Pakistan	n.a/90-110	1998
North Korea	n.a./80-200	2006 (unsuccessful) 2009 (successful)

Table 1. Countries with nuclear weapon

Types of nuclear weapon

Nuclear weapon designs are physical, chemical, and engineering arrangements that make nuclear weapon detonate. There are three basic design types. In all the explosive energy of deployed devices is derived primarily from nuclear fission, not fusion.

Pure fission weapons were the first type of nuclear weapons' design. Also they have been the only type ever used in warfare. The active material is fissile uranium (uranium with a high percentage of U-235) or plutonium (Pu-239), assembled into a chain-reacting critical mass by one of two methods:

- Gun assembly: one piece of fissile material ("bullet") is fired at a fissile uranium target at the end of the weapon.
- Implosion: a fissile mass is surrounded by high chemical explosives that compress the mass and make it critical.

The implosion method can use either uranium or plutonium as fuel. The gun method only uses uranium. Plutonium is considered impractical for the gun method because of early triggering due to Pu-240 contamination and due to its time constant for critical fission being much shorter than that of U-235.

Boosted fission weapons improve on the implosion design. The high pressure and temperature environment at the center of an exploding fission weapon compresses and heats a mixture of tritium and deuterium gas. The isotopes of hydrogen fuse to form helium and free neutrons. The energy release from this fusion reaction is relatively negligible, but each neutron starts a new fission chain reaction, speeding up the fission. So, boosted fission weapons are more effective weapon of mass destruction then pure nuclear weapons.

Two-stage thermonuclear weapons work by using the energy of a fission bomb to compress and heat fusion fuel. When the fission bomb is detonated, gamma rays and X-rays emitted first compress the fusion fuel, then heat it to thermonuclear temperatures. The ensuing fusion reaction creates enormous numbers of high-speed neutrons, which can then cause fission in materials not normally prone to it, such as depleted uranium. Each of these components is known as a "stage", with the fission bomb as the "primary" and the fusion capsule as the "secondary"

Pure fission weapons

The first task of a pure fission weapon design is to rapidly assemble a supercritical mass of fissile uranium or plutonium. A supercritical mass is one in which the percentage of fission-produced neutrons captured by another fissile nucleus is large enough that each fission event, on average, causes more than one additional fission event.

Once the critical mass is assembled, at maximum density, a burst of neutrons is needed to start as many chain reactions as possible.

Early designs of nuclear weapons use an "urchin" inside the pit containing polonium-210 and beryllium separated by a thin barrier. After non-nuclear implosion the urchin was crushed, mixing the two metals, thereby allowing alpha particles from the polonium to react with nucleuses of beryllium. During this reaction free neutrons are produced.

In modern weapons, the neutron generator is a high-voltage vacuum tube containing a particle accelerator which bombards a deuterium/tritium-metal hydride target with deuterium and tritium ions. The resulting small-scale fusion produces neutrons at a protected location outside the physics package, from which they penetrate the pit. This method allows better control of the timing of chain reaction initiation.

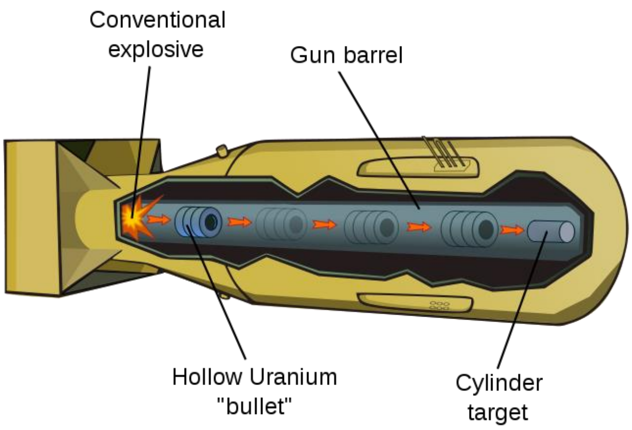
The critical mass of an uncompressed sphere of bare metal is 50 kg for uranium-235 and 16 kg for delta-phase plutonium-239. In practical applications, the amount of material required for criticality is modified by shape, purity, density, and the proximity to neutron-reflecting material, all of which affect the escape or capture of neutrons.

To avoid a chain reaction during handling, the fissile material in the weapon must be sub-critical before detonation. So, it must consist of one or more components containing less than one uncompressed critical mass.

Also temper is needed. A tamper is an optional layer of dense material surrounding the fissile material. Due to its inertia it delays the expansion of the reacting material, increasing the efficiency of the weapon. Often the same layer serves both as tamper and as neutron reflector.

Gun-type weapons

The gun method only uses uranium. Plutonium is considered impractical for the gun method because of early triggering due to Pu-240 contamination and due to its time constant for critical fission being much shorter than that of U-235. In this type of weapon before the detonation, the uranium-235 is formed into two sub-critical pieces, one of which was later fired down gun barrel by conventional explosive and join the other, starting the atomic explosion. The scheme of gun-type weapon is shown on picture 1

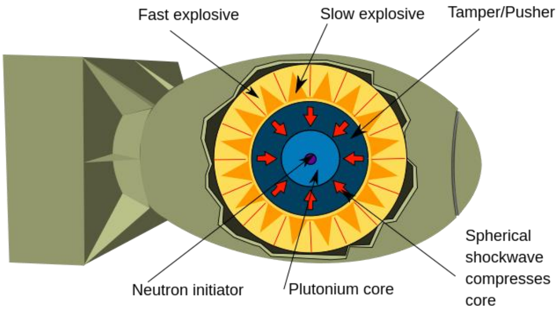


Picture 1. The scheme of gun-type nuclear bomb

Implosion-type weapon

In this type of nuclear weapon criticality was achieved by implosion. The plutonium pit was squeezed to increase its density by simultaneous detonation of the conventional explosives placed uniformly around the pit. Shockwave is provided by explosive lenses with slow and fast conventional explosives.

A pusher shell made out of low density metal—such as aluminium, beryllium, or an alloy of the two metals. The pusher is located between the explosive lens and the tamper. It works by reflecting some of the shock wave backwards, thereby having the effect of lengthening its duration. The scheme of implosion-type weapon is shown on picture 2.



Picture 2. The scheme of implosion-type weapon

Fusion-boosted fission weapon

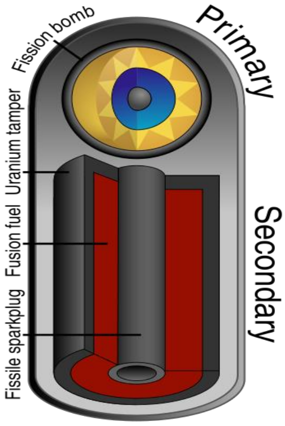
The pit of implosion-type weapon during fission provides ideal conditions for fusion which can be used for the boosting of fission. So, a 50–50 mixture of tritium and deuterium gas, can be pumped into the pit during arming. This mixture of gases will fuse into helium and release free neutrons soon after fission begins. The neutrons will start a large number of new chain reactions while the pit is still critical or nearly critical.Boosting allow to making nuclear weapons smaller, lighter, and with less fissile material for a given yield.

Thermonuclear weapon

Thermonuclear weapon uses energy from fission and fusion. And there is two types of design of this type of weapon.

In first type of design layers of fissile material was surrounded by mix of lithium deuteride and tritium. This design of nuclear weapon called “Sloika”. But increase of yield of nuclear weapon by using thus design was very small.

Another type of design is Teller-Ulam design. . In this type of design fission bomb and fusion fuel are situated (tritium, deuterium, or lithium deuteride) in a special, radiation-reflecting container. When the fission bomb is detonated, gamma rays and X-rays emitted first compress the fusion fuel, then heat it to thermonuclear temperatures. The ensuing fusion reaction creates enormous numbers of high-speed neutrons, which can then induce fission in materials not normally prone to it, such as depleted uranium. Each of these components is known as a "stage", with the fission bomb as the "primary" and the fusion capsule as the "secondary". All multi-megatons yield hydrogen bombs are constructed by Teller-Ulam design. The scheme of Teller-Ulam design is shown on picture 3.



Picture 3. Scheme of Teller-Ulam design

Virtually all thermonuclear weapons deployed today use the "two-stage" design described above, but it is possible to add additional fusion stages—each stage igniting a larger amount of fusion fuel in the next stage. This technique can result in thermonuclear weapons of arbitrarily large yield, in contrast to fission bombs, which are limited in their explosive force. The largest nuclear weapon ever detonated—the Tsar Bomba of the USSR, which released an energy equivalent of over 50 million tons (50 megatons) of TNT—was a three-stage weapon. Most thermonuclear weapons are considerably smaller than this, due to practical constraints from missile warhead space and weight requirements.

Fusion reactions do not create fission products, and thus contribute far less to the creation of nuclear fallout than fission reactions, but because all thermonuclear weapons contain at least one fission stage, and many high-yield thermonuclear devices have a final fission stage, thermonuclear weapons can generate at least as much nuclear fallout as fission-only weapons.

Conclusion

Main types of nuclear weapons' design were shown in this article. Yield of nuclear weapon depends on its construction. Nowadays it is possible to construct nuclear weapon which can release an energy equivalent of over 100 million tons and even more. This bomb can cause essential effect on our planet. That's why questions of nonproliferation and disarmament are very important in modern world.

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SAFE STORAGE AND WORK WITH NEUTRON SOURCES IN TPU

S.A. Edreev

Scientific advisor: Ph.D., As. Professor M.E. Silaev

E-mail: Edreev.stas@yandex.ru

Annotation: *Students of nuclear industry need to have practical skills of work with radioactive materials. According to principles of work with nuclear materials, people have to get as little radiation dose as it can be supported by radiation control department. There are different types of radiation protection can be used as far as they support the principles. Actual aim of this research work - provide safety in work with neutron sources in PTI of TPU.*

Key words: *Neutron sources, radiation protection, neutron flux.*

Research field: *dosimetry.*

Related science: *nuclear physics.*

Introduction

Nuclear security and physical protection study impossible without practical skills in measurements of nuclear and other radioactive materials. One should follow main principle while work with radioactive sources - hold radioactivity level as low as it possible take into account economic and social factors. Another important principle - provide radioactive material with physical protection.

The goal of this research - provide safety usage and storage of neutron sources in TPU. It means - to follow the rules of radiation security and physical protection.

To reach the goal it needs:

Analyze existing procedures with closed radioactive sources (CRS) and explore its disadvantages.

Suggest to change the procedures of work and storage of CRS.

Introduce changes in radiation protection of CRS

Conduct measurements and analyze results after changing of procedures.

It is necessary to change procedures of work and storage of CRS in laboratory 248 PTI because this laboratory changed the character of its use. It is used to be only laboratory for work with radioactive materials. After reconstruction it has lecture room and lecturer room besides the laboratory itself, CRS within.

Radiation protection service research shows that after reconstruction work and storage of CRS leads to unjustified radiation exposure of students and teachers not related with work of laboratory. It was decided to eliminate these disadvantages.

Research of existing procedures of w&s of CRS have to be conducted before any changes.

There are 2 neutron sources are use in the laboratory - californium and plutonium - beryllium. Plutonium - beryllium source is much more dangerous.

Laboratory is on the 2nd floor. Both sources is in the storage equipped with protection containers with paraffin.

To reach the goal w&s processes and construction of radiation protection should be changed. In order to do it, neutron dose, neutron flux and gamma - x rays dose should be measured.

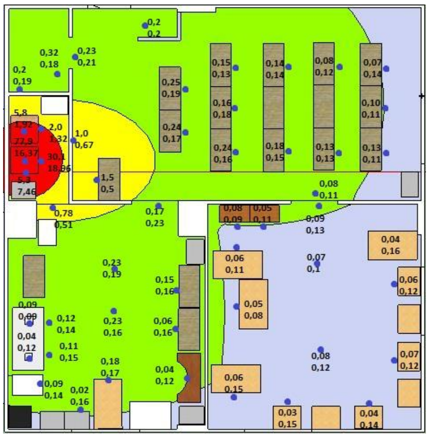
To conduct this kind of measurements, 51 detector positions in the laboratory was taken. This positions take in the place where students and lecturers sit through the classes. Detector height according to standards of radio ecological tests is 1 m from the floor. It is also close to height of chair in the lab.

To measure neutron flux dosimeter МКС - 01Р was taken. For gamma and x-ray dose measurements dosimeter ДБГ - 01 was taken.

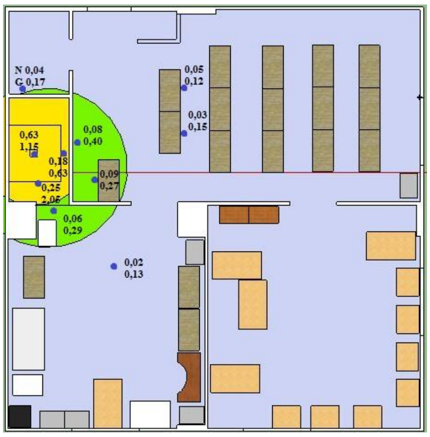
To integrate positive changes into neutron protection construction, different materials had been tested (polyethylene, boron polyethylene, container for transportation КТ - 1). According to this tests and change of character of laboratory, it was decided to create new storage construction. Required level of protection achieved by mixing protection capabilities of container for transportation and polyethylene blocks.

Control measurements show that radiation protection of neutron sources in storage are close to natural. Besides, some of the laboratory equipment had been reconstructed because research shows unsafe situations in the laboratory using this equipment.

Cartogram of measurements of neutron sources



Pic.1 Before reconstruction



Pic.2 After reconstruction

Conclusion

Results of research work are:

Safe conditions for storage of plutonium- beryllium and californium CRS sources have been created.

Safe conditions for students and lecturers in the 248 laboratory of PTI while work with CRS have been created.

Unjustified radiation exposure from neutron sources in the laboratory have been sufficiently redundant (natural radiation level achieved).

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A WAY FOR LOSSES CALCULATION FOR FREE-ELECTRON MASER

Y.L. Eyhorn, A.V. Galushkin

Scientific advisor: Senior teacher D.A. Verigin

Linguistic advisor: Senior teacher N.V. Demjanenko

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: aihornyurij@mail.ru

I. *Abstract*

In previous works [1-3] free electron maser based on Stimulated Coherent Diffraction Radiation (SCDR) generated in an open resonator was presented. Schottky Barrier Diode (SBD) detector was used to investigate the properties of the radiation in the range from 3 to 5 mm of wavelengths among broad frequencies stored in the cavity.

In this paper we represent calculations of resonator characteristics essential to obtain quality factor and stimulation factor. Main characteristic is losses of energy due to transmission through resonator mirrors, resistance loss, losses of openings in mirrors and losses on diaphragms. For this purpose we have used methods of losses calculations for free-electron lasers. Theoretical calculations have been performed for Novosibirsk free-electron laser and for SCDR setup.

Keywords: diffraction radiation, resonator, maser, coherent radiation, stimulated radiation, cavity optimization.

II. Introduction

Electromagnetic radiation, which was used in this research, has the frequency range from a 100 GHz to a few THz. It has intensively been used for research and development in physics, material science, chemistry, biology and medicine. The next requirements are necessary: excellent stability of the sources; full pulse shaping, sensitive non-cryogenic detectors and easy access to THz components [4]. It was decided to investigate the SCDR process to make THz source with necessary characteristics. Experimental setup of a pre-bunched beam pumped free electron maser based on SCDR was made for THz program launched at KEK: LUCX (Linac Undulator Compton X-ray source) facility. It was shown by first results that investigation and simulation for resonator cavity should be done.

In the paper a way of calculations of resonator characteristics essential to obtain quality factor and stimulation factor are done.

III. Experimental setup

A. Accelerator and detector

The experimental setup for investigating SCDR was designed and constructed at LUCX facility in KEK. The LUCX - laser undulator compact X-ray project is a multipurpose linear electron accelerator with 3.6 cell RF gun with a high mode separation and a high Q value is used to produce a multi-bunch high quality electron beam with up to 1000 bunches, a 0.5-nC bunch charge, and 10-MeV beam energy which is accelerated to 30 MeV by the normal conductivity 3-m S-band accelerating structure. Schottky Barrier Diode(SBD) detector was used to register SCDR. Its frequency range is from 60 to 90 GHz.

B. CDR resonator

The vacuum chamber consists of two 6-way crosses connected by an extension part. The distance between the centres of the crosses is exactly half a distance between successive bunches in the train, i.e. 420 mm. The resonator mirrors were mounted on two 4D vacuum manipulation systems (3 translation freedoms plus rotation). Moreover, another rotation freedom could be used offline manually with adjustment screws of the mirror holders. All four dimensions are motorized and remotely controlled. The first mirror is flat fused silica glass with 5 mm free opening for the beam. The surface of the mirror is partially aluminized, i.e. there is a 15 mm hole in aluminium layer to extract a small fraction of the radiation out of the resonator for observation and tuning purposes while keeping the rest inside. The second mirror has a spherical concave surface with radius of 840 mm (i.e. its focus is on the first mirror when resonator is aligned) and made of bulk aluminium with 5 mm free opening in its centre for a free passage of the electron beam.

IV. Theory

In the experiments [1-3] succesful generation of coherent diffraction radiation and working microwave resonator were shown. Next step of theoretical investigation is determination of resonator characteristics.

A. Accumulation and decay of resonator

In theory of radiation generation it is assumed that stimulation depends on acting radiation. In this case addition to electric field by stimulation (depends on electric field stored in cavity) is:

$$E_{SCDR} = a \cdot E_{Cav} \ .$$

where E_{DR} - electric field generated by single bunch, a - stimulation factor.

Then second bunch comes in cavity electric field in resonator would consist of electric field of diffraction radiation from second bunch, stimulation addition and stored DR from first bunch with losses accounting:

$$E_{tot,2} = d \cdot E_{DR} + E_{DR} + a \cdot d \cdot E_{DR} = E_{DR} \cdot (1 + d \cdot (1 + a)) = E_{DR} \cdot (1 + b) \ .$$

After calculating progression one can obtain formula for electric field in resonator after i-th bunch. Figure 1 shows dependence of radiation intensity on number of bunches passed through cavity.

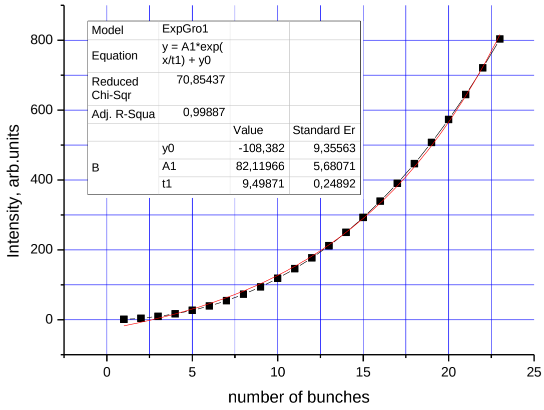

Fig. 1. Dependence of radiation intensity on number of bunches.

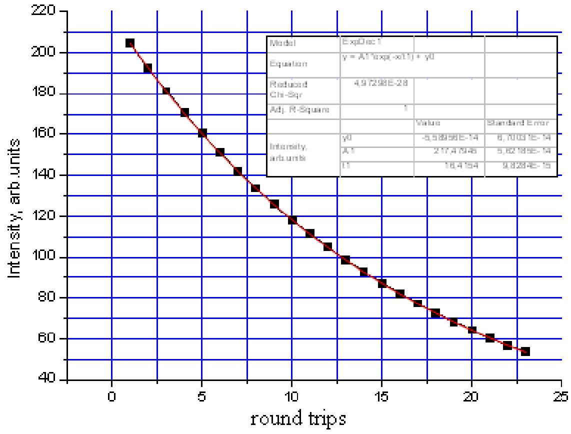

Fig. 2. Dependence of radiation intensity on round trips

After turning off beam of charged particles cavity should decay because of losses. With analogy of derived above one can obtain formula for losses of electric field in resonator:

$$E_{tot,i} = \frac{E_{DR} \cdot (1 - b^N)}{1 - b} \cdot d^{i-N}$$ – where N is number of bunches in train (i>N).

The result of simulation is shown on Figure 2.

In simulation we have shown that main characteristics of resonator cavity are generated DR, losses and stimulation factor. Using detecting system we can measure intensity of diffraction radiation and obtain its electric field. Therefore calculation of losses in resonator is important task to find stimulation factor.

A. **Diffraction losses.**

To calculate losses in resonator we have made investigation in common branches of science: free-electron lasers (FEL). In the work [7] scheme of losses calculation for Novosibirsk FEL was proposed. In these scheme losses can be divided in several groups: ohmic losses, losses on external aperture of mirrors, losses in holes of mirrors, losses on diaphragms.

Diffraction loss are calculated using the next formulas:

$$C_{dk,md} = e^{\frac{-\pi \cdot d_k^2 \cdot L_R}{2 \cdot \lambda \cdot (L_R^2 + z_{dk,md})}}$$

and

$$C_{mh} = \frac{\pi \cdot d_{mh}^2}{2 \cdot \lambda \cdot L_R \cdot \left(1 + \left(\frac{L_0}{2 \cdot L_R}\right)^2\right)} .$$

Where c_{md} - loss of external apertures mirrors; c_{dk} - loss at apertures; $k = 1,2,3$; L_0 - cavity length is given by the condition of synchronism between terahertz and electron beams ; d - diameter of element with losses.

V. Result

Optical cavity in Novosibirsk has structure shown in Figure 3. This optical cavity was used for a research.

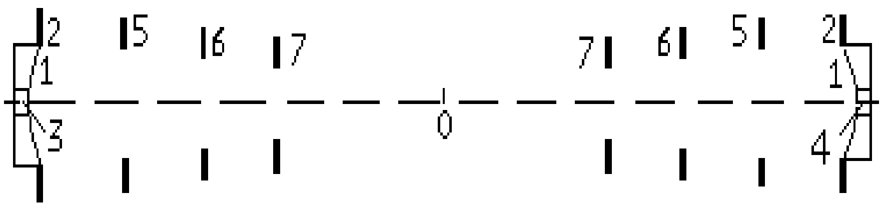

Fig. 3. Layout of Novosibirsk optical cavity

Here, 1- mirror; 2 - external aperture mirrors; 3,4 - holes in the mirrors; 5,7 - aperture.

And options of optical cavity adduce in Table 1.

Number of element	Diameter (mm)	Position on axis (mm)
2	190	±13294.5
3	9	±13294.5
4	3.5	-13294.5
5	105	±7500
6	101	±6300
7	78	±4500

Table 1. Diameter and position of elements on the line

Shows a graph of the calculation of internal loss NLSE for different Rayleigh's lengths obtained in programm Wolfram Mathematica. If this graph compare with graph from Kuboreva article[6], we can see that this result equal. It is mean that we can used formulas from Kuboreva article for calculation of loss in CDR.

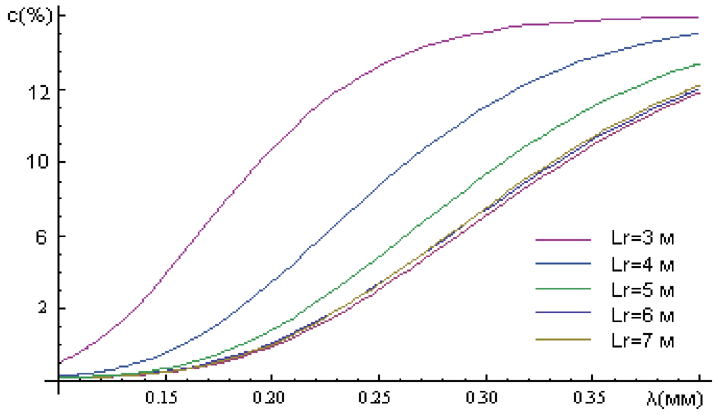

Fig. 4. Internal loss for round trip in an optical cavity

We introduce a scheme and the necessary information about CDR cavity.

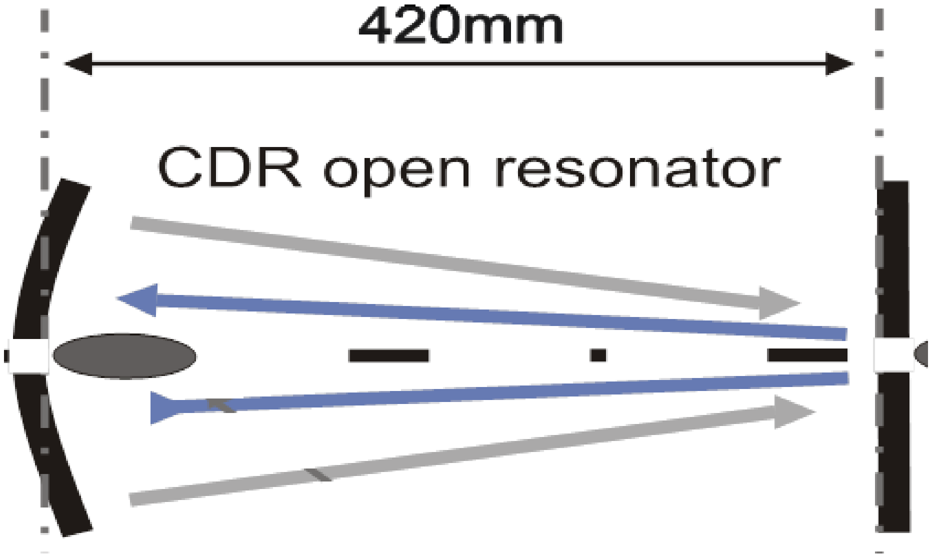

Fig. 5. Design scheme CDR cavity

	Diameter (mm)	Position on axis (mm)
Hole (left)	5	0
Hole (rught)	3	420
Diaphragm (left)	100	0
Diaphragm (right)	100	420

Table 2. Diameter and position of elements on the line for CDR cavity

Then, we construct a graph of external and internal loss using.

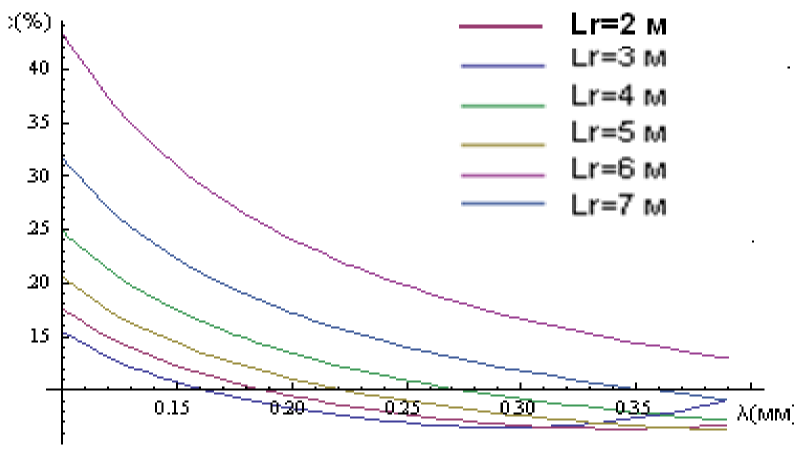

Fig. 5. External and internal loss for round trip in an CDR cavity

VI. Conclusion

Simulations show that losses in SCDR resonator in range of SCDR wavelength should be about %. Experiment shows great difference from this calculation. Therefore we can assume that theory developed for Novosibirsk FEL is more suitable for wavelength range from 100 to 300 mcm, while we investigate radiation in the wavelength range 2-8 mm. We should propose that the theory for Novosibirsk FEL will be used than we change SCDR source to THz region, and now we need to investigate microwave resonators to solve our problem.

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THE ORGANISATION OF THE NUCLEAR FUEL CYCLE OF THE NEW GENERATION BASED ON SERIAL THERMAL-NEUTRON NUCLEAR REACTORS

I.M. Gubaydulin, S.V. Bedenko

Scientific advisor: Dr., Professor I.V. Shamanin

Linguistic advisor: Teacher Y.V. Ermakova

Tomsk Polytechnic University, 30, Lenin Avenue, Tomsk, 634050, Russia

E-mail: commander_tom@mail.ru

Abstract

Calculations of neutron-physical parameters of (U,Th)O2 nuclear fuel irradiated in VVER-1000 reactor are performed. The research work contains calculations of actinides concentrations in perspective spent nuclear fuel, spectrum of spontaneous fission neutrons and irradiated neutrons resulting from (α,n) reactions. Dependences of concentrations of Cm242 and Cm244 isotopes on concentrations of Th232 isotope in fresh nuclear fuel are shown.

The State of Research

The scientific task of this researching work is absence of optimal operational conditions of perspective kinds of nuclear fuel composition ((Pu, Th)O2, (U, Th)O2, (U, Pu)O2, UC/(U, Pu)C, UN/(U, Pu)N), which are used in serial thermal-neutron nuclear reactors and as a result it is necessary to develop new distribution schemes and new approach to the nuclear waste management in fuel storage system and transportation.

Considering problem allows to pass to solution of the next scientific and technical tasks of modern nuclear industry, such as: 1) increasing of low efficiency of nuclear fuel productivity; 2) decreasing of radiation and chemical toxicity of nuclear fuel irradiated in thermal-neutron nuclear reactors; 3) solving the problem of raw materials base scarcity, which is connected with increasing of nuclear unit quantity. 4) starting work in thorium nuclear cycle field.

It is necessary to notice, that published document of Russian president №PR-899 about priority development ways of science, technologies and technicians, such as “Energy efficiency and energy supply”, “Nuclear energy”, “Nuclear technology” stimulated new wave of researches in field of nuclear cycle perfection and safety control (nuclear and radiation) in handling with nuclear waste.

This researching work “The organization of the nuclear fuel cycle of the new generation based on thermal-neutron nuclear reactor” belongs to such investigation.

Increasing of efficiency of nuclear industry is connected with solving of next primal problems. The first problem is connected with regeneration of spent nuclear fuel and returning it in nuclear cycle (closed nuclear cycle). The next problem is caused by increasing of measuring of burning fraction (or depth of burn-up?) (to 130 MWt⊙day/ton) both traditional nuclear fuel (UO2) and perspective ceramic fuel for serial reactors and reactors of new generation [2,3].

Increasing of burn up new kinds of ceramic nuclear fuel for serial reactors and reactor installation of new generation complicate the problem of waste management and reprocessing of uranium and plutonium. Also, it requires researching of new conceptual approach to the problem of this nuclear fuel and as a result it is needed to confirm safety of using cask and long term storage system.

Problems of nuclear and radiation safety of storage system and dry cask storage of spent nuclear fuel are connected with radiation safety and development of safety rules and manipulation procedures in view of dose characteristics (in particular spectral and integral characteristics of neutron radiation) of spent nuclear fuel [1, 2].

Today using methods and algorithms of calculation to define neutron component of dose characteristics of new kinds of fuel require confirmation of safety and, in some conditions, it is also needed in some additions and modernizations. Moreover, design features of new generation reactors and parameters of their operation cause changes of characteristics of radiation field from spent nuclear fuel, which influence level radiation near the storage system and transportation cask, but it is not considering in existing calculation methods for today [3].

The main problem of organization of new generation nuclear waste management is connected with calculation accuracy of concentrations of actinides, which form neutron radiation field. This problem can be solved by using of certain calculation modules of verifying programs (MCU5TPU, Scale 4.4.a and Scale 5.0). Simultaneously using of listed verifying calculation modules can secure correctness and accuracy of conducted calculations and also it allows to consider design features of new generation nuclear reactors and parameters of their operation.

It is need to note, that organization of new generation nuclear fuel cycle based on production of run light water reactor cause necessity of solving the same tasks, which were solved successfully to organization fuel cycle involving reprocessed uranium. In particular, problem of radiation safety is connected with accumulation of 228Th, which appears in result of 232Th and 232U disintegration [1].

Thus, scientific and technical solutions for reprocessed uranium nuclear fuel can be used to involving of new kinds of nuclear fuel in fuels for light water reactors. It requires proving and conducting of necessary calculation researches.

Algorithm of calculation

The calculation was performed using the software package SCALE 5.0. SCALE is an internationally recognized program which is based on the implementation of the Monte-Carlo method. This software package allows the calculation of neutron-physical parameters of the storage and transportation containers, with fresh and irradiated nuclear fuel, the calculation of the isotopic composition of spent nuclear fuel.

The decision to carry out computational studies fell on the analytical sequence CSAS25, which automatically handles the cross-section, and then it simulates physical weight of the technical system depending on the initial and boundary conditions expected.

This analytical sequence allows calculations of keff for the three-dimensional problems. For this purpose the values of isotopic composition of fuel or several fuels is given to software package SCALE 5.0, as well as compositions of other materials used in the following description of the model. Depending on the task, analytical sequence and library sections are selected. In the calculations the 27-group library of cross sections was used, which was obtained from the convolution of the 218-group library based on the library data ENDF / B-IV. The choice of the library is most optimal for the criticality of calculations.

Then the geometry was described. The package of applied programs SCALE 5.0 used cell modeling method, which greatly simplifies the calculation of the neutron-physical parameters for this problem. For this purpose the geometry of a single cell is described, and then, the field, which is an array of 22 × 11 cells is set. A more detailed computational model is described in the next section.

The module CSAS25 runs consistently functional modules BONAMI, NITAWL-II and KENO V.a. to handle the required cross sections and calculate the k_{eff} of «dry» storage system.

The Results of Calculations of Isotopic Composition of Uranium-thorium Spent Nuclear Fuel

Calculation is conducted with use of Scale 5.0 program. Characteristics of nuclear fuel with next characteristics of «fresh» fuel: (235U - 4 %, 238U - (96-76) %, 232Th - (0-20) %)O2.

Characteristics of irradiated fuel: burn up - 70000 MWt◌day/ton(U), confinement time - 5 years.

Graphs bellow show results of calculation of spectral distribution of irradiation from spent fuel of perspective kinds (see Figure 1 and 2) and results of calculation of nuclide composition of uranium-thorium fuel (U, Th)O2 in nuclear fuel cycle, based on light water thermal reactor (see Figure 3 and 4).

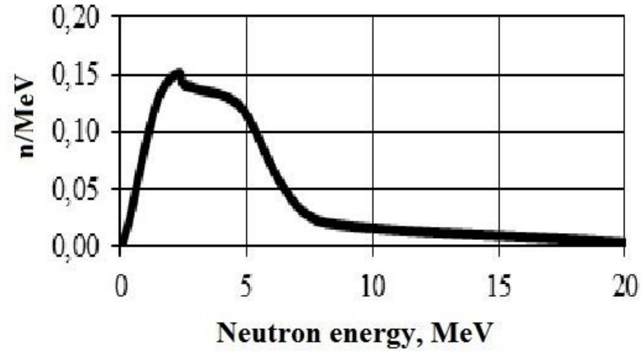

Fig.1. Spontaneous fission neutron spectrum

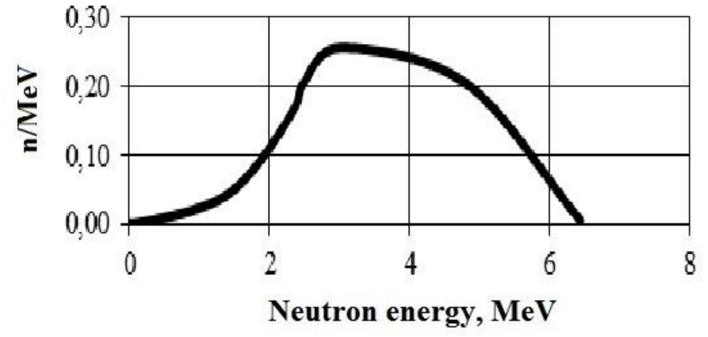

Fig.2. Neutron spectrum by (α,n) reaction

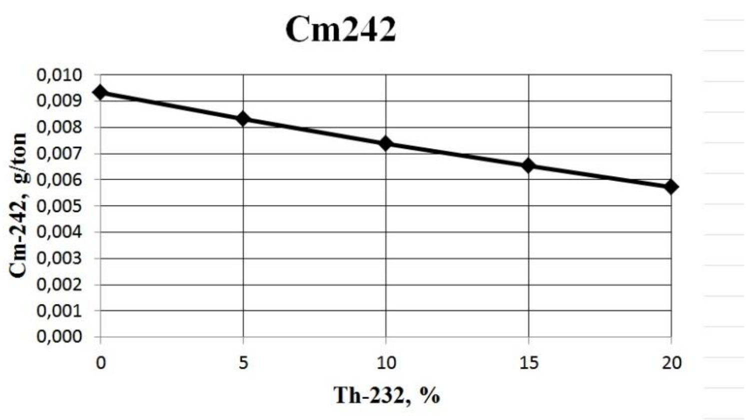

Fig.3. Dependence of 242Cm concentration in spent nuclear fuel on thorium concentration in «fresh» fuel

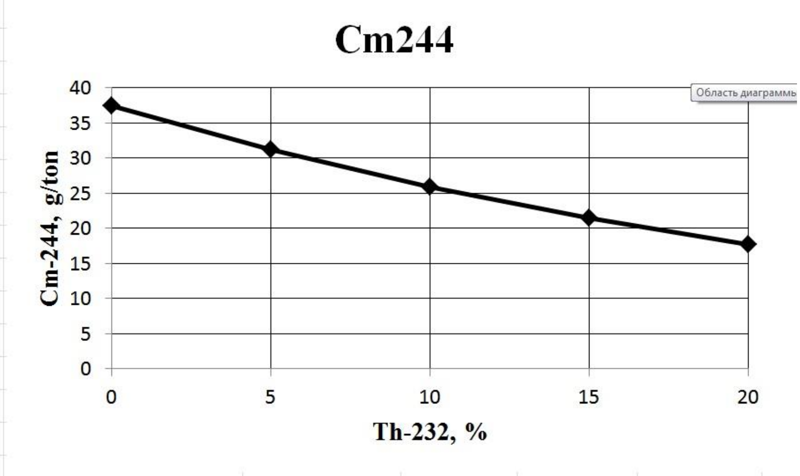

Fig.4. Dependence of 244Cm concentration in spent nuclear fuel on thorium concentration in «fresh» fuel

Conclusion

1. It was found, that part substitution of uranium on thorium bring to more intensively fission of 239Pu and 235U, as a fission cross section of thorium by thermal neutron approximately equals to zero, as a result thermal neutrons, which are captured by uranium nuclei in cause of traditional fuel and neutrons do not leak and participate in splitting of 235U and 239Pu.
2. Large values of radiation capture cross section in thermal range for 232Th result in 233U accretion, which has another neutron-physical feature.
3. Concentration of 244Cm and 242Cm (main source of neutrons) in spent thorium nuclear fuel less (more than in 2 times) than in standard uranium dioxide. Accordingly, thorium nuclear fuel has minimal neutron activity.

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CAUSES AND SOLUTIONS OF RADIATION POLLUTION PROBLEMS

V.V. Gafarova

Linguistic advisor: Senior teacher N.V. Demjanenko

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: gaveroni@mail.ru

ABSTRACT

The arnicle deals with «Causes and solutions of pollution from radiation», it tells about different sources of radiation pollution. It draws our attention to the properties of each source and their effects on people and environment.

The article consists of three logical parts. The first part tells about ionizing radiation. The paper gives a detailed analysis of this physical process. The second part is devoted to the explanation of different sources of radiation pollution. The third part of the article tells about environmental effects of radiation.

INTRODUCTION

The main purpose of this text is to provide information about different sources of radiation pollution. Text describes the main features of each source and their effects on people and environment.

All living organisms on earth are exposed to radiation by external and internal irradiation, by natural and man-made ionizing radiation. Radioactive pollution is the most dangerous form of physical pollution. Nowadays in developed countries the radioactive pollution of the environment is more dangerous because of the active development of nuclear power. In this article we want to characterize the major types of radiation sources and the effects of their influence on the human body.

This information will be useful for people studying nuclear physics and its applications. And for every man who wants to know “What are radiation sources?” and “What danger they represent for people and their health”.

IONIZING RADIATION

EMF (Electric and Magnetic field) radiation emissions come from human-made sources, like electricity coming from power outlets transmitted in wave forms, and in varying degrees of frequencies. The longer the wavelength means that there is a greater distance between the receiver and the energy source and therefore, the lower the strength or intensity of radiation received. In contrast, EMFs that have shorter wave lengths have a stronger impact.

Ionizing radiation becomes polluting if it fills a particular environment with high-levels of electromagnetically charged particles or ions. The effect of ionized particles in the human body depends on how far or near the human is to the EMF source. A person who accidentally touches the electric energy power of an open electrical wire receives a surge of electric current in his body called electric shock, because he touches the nearest source.

In a state of pollution, we receive these electromagnetic shocks in low frequency doses as they are released in the environment to make our mobile phones, television screens, radio transmitters, electronic appliances and the whole telecommunication system work. Hence, we are constantly receiving low frequency charged electromagnetic shocks in our body, and the multiple occurrences by which we receive those electric shocks can affect our body cells and its natural chemistry.

Non-ionizing radiation would be the opposite, which means the EMF energy transmitted is not enough to cause a particle to become electronically charged. However, based on the definition of radiation pollution, the energy transmitted, whether ionizing or non-ionizing, is harmful because it is capable of entering human bodies and affecting our systems in the same manner, as if we were receiving low doses of x-rays and gamma rays coming from multiple sources.

CAUSES OR RADIATION POLLUTION

Background radiation (which scientists call “ubiquitous background radiation”) is emitted from both natural and human-made radioactive chemicals (radionuclides).Some naturally occurring radionuclides are found in the earth beneath our feet, while others are produced in the atmosphere by radiation from space. Human-made radionuclides have entered the environment from activities such as medical procedures that use radionuclides to image the body and electricity generation that uses radioactive uranium as fuel.

Humans are continuously irradiated by sources outside and inside their bodies. Outside sources include space radiation and terrestrial radiation. Inside sources include the radionuclides that enter our bodies in the food and water people ingest and the air they breathe. Whatever its origin, radiation is everywhere (or “ubiquitous”) in the environment.

NATURAL SOURCES OF RADIATION

RADIATION FROM SPACE

Radiation that enters the Earth’s atmosphere from space can come from as close as the Earth’s radiation belts and the sun or as far away as beyond the boundaries of the solar system and even beyond the Milky Way galaxy. Radiation from beyond the solar system has enough energy to generate additional radiation as it passes through Earth’s atmosphere, creating either radionuclides in the air or secondary particles. Some secondary particles reach the Earth’s surface most readily near the magnetic poles where the Earth’s magnetic field is weakest and at high altitudes where the Earth’s atmosphere is thinnest. Radionuclides created by space radiation are called cosmogenic radionuclides. They include tritium (hydrogen-3), beryllium-7, carbon-14, and sodium-22.

TERRESTRIAL RADIATION

Radiation that originates on Earth is called terrestrial radiation. Primordial radionuclides (radioactive chemicals that were present when the Earth formed about 4.5 billion years ago) are found around the globe in igneous and sedimentary rock. From rocks, these radionuclides migrate into soil, water, and even air. Human activities such as uranium mining have also redistributed these radionuclides. Primordial radionuclides include the series of radionuclides produced when uranium and thorium decay, as well as potassium-40 and rubidium-87. In the past, one of the human activities that contributed to terrestrial radiation was production of nuclear weapons.

Today, an atmospheric weapon testing is not a significant contributor to background radiation because fallout has decayed since a weapon testing was stopped (in the United States, testing ended in 1963). The reactor accident at Chernobyl in 1986 is also not a significant source of background radiation in the United States.

MAN-MADE SOURCES OF RADIATION

There are other man-made sources of radiation that pervade the environment with more intense capabilities to penetrate the human body. It is simply because the sources of these radiation emissions were basically and intentionally designed to be powerful enough and capable of releasing energy in a single powerful blast.

1. Nuclear weapons testing sites and accidents

Nuclear energy released is called a nuclear explosion, and its effects can be both immediate and delayed but equally destructive. Its immediate effect is equivalent to multiple volumes of energy described as “nuclear fallout”, and is powerful enough to blast and burn anything within one kilometer (about 0.62 miles) of its range. Those who receive energy released by its explosion from farther distances of about 30 km (approximately 18.6 miles) radius, or become contaminated by the fallouts near the blasting site, will sustain the delayed effects, or the nuclear reactions, in their body. The volumes of charged particles received by the body continue to react and in the process, create chemically reactive compounds called *free radicals* inside the human anatomy.

2. Nuclear power generating plants

Other sources of radioactive pollutants in the environment are received through the so-called “controlled release of energy by nuclear-power generating plants”. These power plants do not release greenhouse gases but it appears that modern nuclear power plants release radioactive gases, like Carbon 14, tritium-carbon and krypton 85 in amounts that are traceable in the environment and form part of the atmospheric pollution.

3. Reprocessing plants and mines

Next in the list of pollution sources are the spent-fuel reprocessing plants and their by-products of mining operations**.** These by-products are not ordinary mine ores but radioactive ores like uranium and *plutonium*.

4. Experimental research laboratories

Lastly, experimental research laboratories are considered sources of ionizing radiation, polluting the environment. EMF from electrical generations are also considered as harmful but not in the same levels as those used by research laboratories during their extensive research activities. Thus, this particular source of pollution has been singled out.

The strength and intensity by which laboratories make use of electricity to power up lab equipment increases the amounts of radioactive pollutants released in the atmosphere. This increases the Radio Frequency (RF) received during transmittal of energy for telecommunication and EMFs for electronic appliance purposes.

Accordingly, radio frequencies are transmitted through the use of ionizing radiations in the form of

X-ray energy; hence, technicians are greatly exposed to high levels of RF‘s ionizing x-ray radiation, and they are, likewise, emitted by the research lab to the environment in greater magnitudes.

ENVIRONMENTAL EFFECTS OF RADIATION

1. Effects on life

Radiation can have devastating effects on living plants and animals. Radiation can damage living things at a cellular and genetic level. In some cases, damaged cells can repair themselves, but in other cases the damage is irreparable. One type of irreparable damage is genetic. Radiation can damage a cell's DNA, thus triggering cellular mutation that can sometimes result in cancer.

2. Effects on plants

Radiation can cause severe cellular damage in seeds which sometimes prevents them from sprouting and germinating, thus affecting the ability of plants to reproduce. In addition, radiation can cause genetic mutations in growing plants which can hurt their ability to survive.

3. Effects on animals

Radiation can trigger genetic changes in the cells of animals which result in the cells growing out of control. These out of control cell clusters are cancerous tumors. In addition, higher levels of radiation can cause damage to capillaries and small blood vessels, these higher levels can sometimes result in catastrophic heart failure or brain aneurysms. Because radiation is often accompanied by intense heat, which is simply a different type of radiation, exposure to intense radiation can often "cook" an animal. Some forms of radiation, such as microwave radiation, will cause animal life to "cook" from the inside out.

4. Longevity in the environment

Many forms of radiation do not stay long in the environment. For example, heat, a form of infrared radiation, dissipates quickly. All radioactive material decays over time. How long radioactive material will stay in the environment depends on the type of material. Strontium-90 is only radioactive for 53 days. Uranium-235 in the environment will remain radioactive for over 700 million years. Uranium-238 will remain radioactive for 4.5 billion years. Rubidium remains radioactive for 47 million years.

CONCLUSION

In this report we have provided information about different sources of radiation pollution. The article describes main properties of each source and their effects on people and environment.

There are two kind of ionizing radiation. It is natural radiation (radiation from space, terrestrial radiation) and man-made radiation (nuclear power plants, nuclear weapon, transportation, disposal of nuclear waste, uranium mining).

We consider that we should to reduce the use of different man-made sources of radiation or improve the safety of their use.

Mankind should think about the consequences of use of high technology in their lives. Since the damage we are doing to the environment in irreparable, and the impact on our lives and our planet.

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PARAMETERS OF PLUTONIUM-THORIUM FUEL CYCLE BASED ON SERIAL VVER-1000

P.V. Godovyh

Scientific advisor: Dr., Professor I.V. Shamanin

Linguistic advisor: Teacher Y.V. Ermakova

Tomsk Polytechnic University, 30, Lenin Avenue, Tomsk, 634050, Russia

E-mail: godovyh.pavel@mail.ru

Annotation

The work carried out systematic calculations of the integral parameters, charts download and transfer fuel in VVER-1000 that enhance internal stability by improving the operating conditions and modes of processing of nuclear fuel. As a way to achieve this goal have been chosen:

- *Optimization of partial loading and refueling;*
- *increasing the concentration of fissile nuclides in the oxide fuel;*
- *optimization of the concentration ratio of fissile nuclides in the fuel assembly thermal power plants of various types;*
- *Use thorium containing fuel compositions that provide greater value horsepower reactivity effect.*

The results can provide:

1. The use of (m% Th^{232}, n% U^{235}, k% Pu^{239}) O_2 fuel efficient in the transition from the campaign, formed by three cycles of burnout, a campaign consisting of 4 or 5 cycles. In this case, provided the high values of plutonium burning at relatively low reproduction rate for U^{233}.

2. The average value of burnout for TVS, which operated for five cycles of burnout, reaches 94.4 GW · d / t . For FAs with minimal Ru239 that are uploaded after the 1st cycle of burnout in the 1st campaign, it is 52.1 GW · d / t

3. Integral characteristics of the 1st campaign for VVER-1000, show that within 40 years can be recycled about 44 tons of weapons-grade plutonium condition.

In Russia, we consider two scenarios for nuclear energy in the XXI century - an innovative and evolutionary. The first of these involves the introduction of a closed cycle and fast reactors, the second - the preservation of reliance on thermal devices.

In the evolutionary scenario, the total demand for uranium will increase sharply, and about the middle of the century will be equal to the known uranium reserves in Russia. In reality, with a deficit of uranium, our country will face even earlier, as Russia is exporting uranium in the nuclear fuel.

Innovation scenario theoretically allows Russia not to depend on the import of uranium throughout the century. In practice, and there may be problems due to the need to sell nuclear fuel abroad.

To solve the problem of shortage of uranium in varying ways. One of them, looking very attractive -

a partial translation for the thorium cycle reactors.

Brief description of work

In Fig. 1 shows the movement of fuel during partial loads. Scheme in accordance with procedures of calculation are considering campaigns, including a different number of overloads (2, 3, 4).

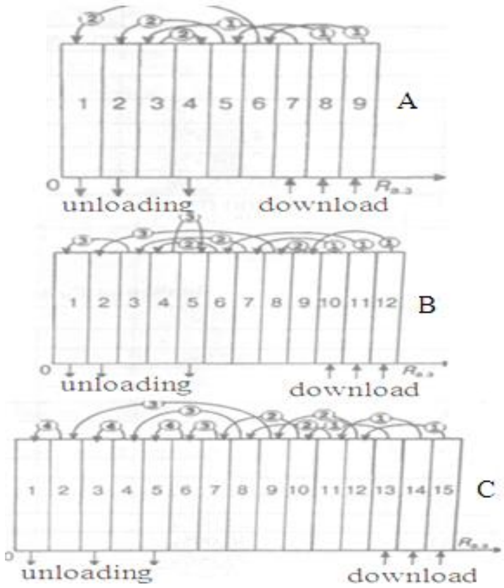

Fig. 1. Scheme of movement of fuel

As in the real case of the geometric characteristics of fuel assemblies are fixed, then in the course of settlement procedures should be borne in mind that the same radial sector are FAs with different nuclide composition. "Homogenized" concentration of nuclide n in the radial sector i is given by

$$C_n^i = \sum_{k=1}^{3} P_{ki} c_k^n,$$

where P_{ki} - fuel assembly content type k in the i-th radial sector; c_k^n – «homogenized» nuclide concentration n in the fuel assembly type k. The calculations take into account that "starting" core loading assemblies formed of three types: high enrichment - type 1, the mean - type 2, low - type 3.

In all these cases, the cross-section of the core is divided into two parts: the peripheral, which are placed in the start up 42 FAs type 1, and the center in which to start up located 109 FAs: 54 FAs type 2 and 54 FAs type 3 and 1 FAs (center) of type 1 (Fig. 1).

By moving the fuel scheme A in every part of the core reloading unloaded 51 FAs 50 FAs 51 FAs moved and loaded on the periphery. By moving the scheme B 38 FAs unloaded, 75FAs are moved and 38 FAs are loaded. In the case of the schema C to match amounts are - 30, 91 and 30.

In Fig. 2 shows the sequence of permutations in partial overload, appropriate traffic pattern fuel C. Partial overload is in 6 steps. In the first step of the core retrieved 30 FAs. Then, for 2-5 steps to reshuffle FAs «route» at the arrow-pointer: After step 2, "released" 30 channels, which move the next 30 FAs, "liberating" channels for rearrangements at the 3rd step and etc. on After a 5-step 30 are free of peripheral channels, which on the 6th (final) step is loaded "fresh" fuel assemblies of type 1 with the highest content of the fissile nuclide. Data traffic patterns and permutations of fuel assemblies during partial loads provide treatment "movement of fuel from the periphery to the center, while mixing in the radial and azimuthal directions."

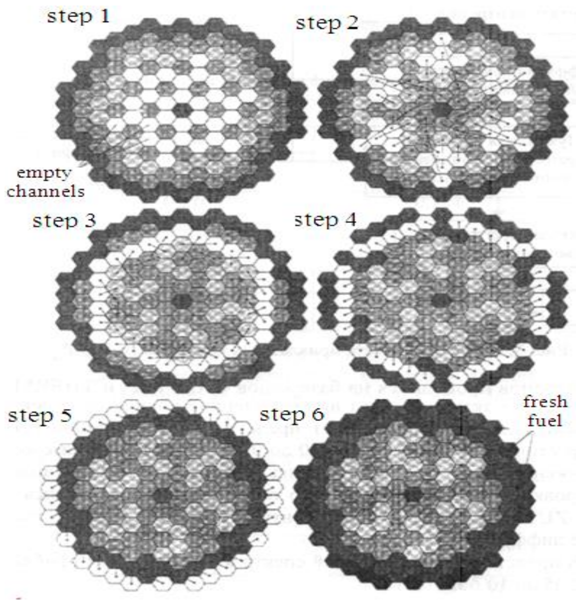

Fig. 2. FAs permutation. Scheme in partial overload

In the scheme A percentage of fissile nuclide oxide fuel is 10% for TVS type 1, 8% for FAs type 2 and 6% for FAs type 3. The ratio of the proportion of forms 1,67:1,33:1. In circuit B percentage and proportion are the same, but the campaign in this case includes four cycles of burnout and three respectively partial overloads. Scheme B (with the same values of the content and proportions) the campaign, formed by five cycles of burnout and four partial overloads.

The last cycle of burnout, from the start up, in all cases is equilibrium. The last cycle of burnout, from the start up, in all cases is equilibrium.

The sequence of calculations

Determination of the neutron spectrum and the spatial distribution of the neutron flux was carried out in 6-group approximation using a software package V.S.O.P (97) [1]. Block diagram of computer code is shown in Fig. 3.

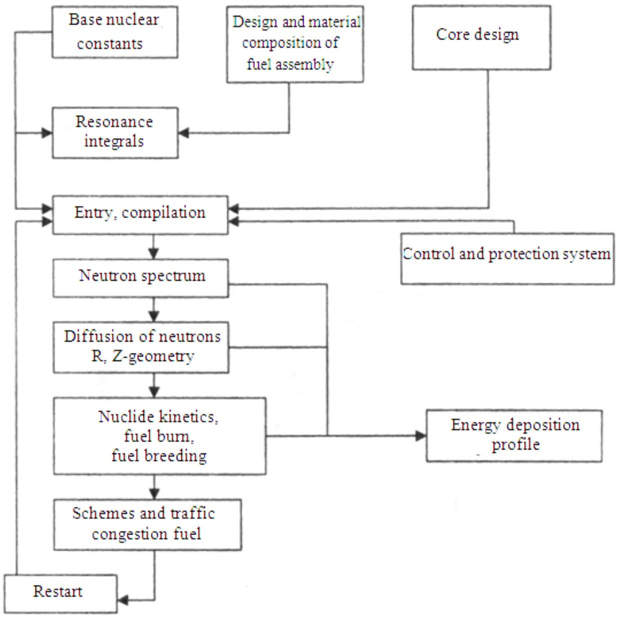

Fig. 3. The structure of the application package V.S.O.P.

The calculation of the neutron spectrum was carried out on the basis of codes GAM-1 [2] and THERMOS [3, 4]. Codes allow you to specify the extent of the core unlimited number of spectral bands with the corresponding types of spectra. Code GAM-1 is the neutron spectrum in the 68-group approximation in the energy range from 10 to 0.414 MeV. Group constants were prepared in P1-approximation. This takes into account the effects due to heterogeneity, and the factor of self-shielding. Resonance absorption cross sections were determined for Th-232, U-238 and Pu-242 is based on the code ZUT-DGL [5, 6]. The coefficients of the neutron leakage of spectral bands defined in the diffusion calculations.

THERMOS code is the neutron spectrum in the 30-group approximation in the energy range from 2.05 to 10^{-5} eV.

Immediately prior to neutron-physics calculations performed convolution 98 teams in six groups with energy boundaries: 10,5-2,5 MeV 2,5-0,8 MeV 800-46,5 keV 46,5-0,215 keV, 215 -0.414 eV, less than 0.414 eV - epithermal and thermal group.

Preliminary procedure "homogenization" involves consideration of all structural components and assemblies of the core, and the presence of H_3BO_3 in the water of the primary circuit. This allows close enough to the conditions of a real case to determine the material composition of all the elements of the design area.

The calculation results

The estimated maximum values of a prolonged campaign of relevant schemes considered are as follows:

Scheme A. Campaign - 2400 eff. d. I burnup cycle - 1100 eff. d, II burnup cycle - 600 eff. d, III - 700 eff. d.

Scheme B. Campaign - 2900 eff. d. I burnup cycle - 1300 eff. d, II burnup cycle - 450 eff. d, III - 550 eff. d, IV burnup cycle - 600 eff. d.

Scheme C. Campaign - 2950 eff. d. I burnup cycle - 1250 eff. d, II burnup cycle - day, III - 350 eff. d, IV burnup cycle - 450 eff. d, V burnup cycle - 450 eff. d.

In the case of oxide fuel compositions ThO_2-$U^{235}O_2$-PuO_2 at concentrations of fissile nuclides 7.7% (FAs type 1), 5.2% (FAs type 2) and 2.8% (FAs type 3) the duration of the campaign up to 1450 eff.d. for traffic schemes fuel A. This is - two partial overload and burnout cycle times are 500, 450 and 500 eff.d. respectively.

The ratio of fissile nuclides forms 2,75:1,86:1 proportion, and the shares of U^{235} and Pu^{239} in the fuel assembly of all three types are the same.

Findings

1. The use of (m% Th^{232}, n% U^{235}, k% Pu^{239}) O_2 fuel efficient in the transition from the campaign, formed by three cycles of burnout, a campaign consisting of 4 or 5 cycles. In this case, provided the high values of plutonium burning at relatively low reproduction rate for U^{233}.

2. The average value of burnout for TVS, which operated for five cycles of burnout, reaches 94.4 GW · d / t For FAs with minimal Ru239 that are uploaded after the 1st cycle of burnout in the 1st campaign, it is 52.1 GW · d / t

3. Integral characteristics of the 1st campaign for VVER-1000, in the organization of its fuel cycle based on the options listed in Table. 8 shows that for 40 years can be recycled about 44 tons of weapons-grade plutonium condition.

Indicators equilibrium cycle burnout with the following values:

- Download 232Th - 12,180 kg / GW (e)
- Download Pu (all nuclides) - 1390 kg / GW (e)
- Unloading Pu (all nuclides) - 357.2 kg / GW (e)
- Burning of Pu (all nuclides) - 1032.8 kg / GW (e)
- Burnout Pu (all nuclides) - 0.743
- Working hours 233U - 272,5 kg / GW (e)
- Average burnup - 94.4 MW · d / kg

8-year-old plutonium-thorium campaign for VVER-1000

##	download (feeding) 30 FAs	burnup cycle, GW·day / t	unloading, burnup, GW· day / t	Ingredients unloading	The further use of FAs
1.	79 t Th^{232} 6,86 t Pu^{239}	1-st 48	30 FAs 48	15,46 t Th^{232} 0,255 t U^{233} 0,19 t Pu^{239} 0,09 3t Pu^{241}	storage, processing
2.	15,42 t Th^{232} 1,75 t Pu^{239}	2-nd 14,5	30 FAs 62,5	15,40 t Th^{232} 0,288 t U^{233} 0,14 t Pu^{239} 0,089 t Pu^{241}	storage, processing

8-year-old plutonium-thorium campaign for VVER-1000 (continue)

##	download (feeding) 30 FAs	burnup cycle, GW·day / t	unloading, burnup, GW· day / t	Ingredients unloading	The further use of FAs
3.	15,42 t Th^{232} 1,75 t Pu^{239}	3-d 18	30 FAs 80,5	15,30 t Th^{232} 0,300 t U^{233} 0,096 t Pu^{239} 0,084 t Pu^{241}	storage, processing
4.	15,42 t Th^{232} 1,75 t Pu^{239}	4-th 17,5	30 FAs 98	15,25 t Th^{232} 0,334 t U^{233} 0,154 t Pu^{239} 0,108 t Pu^{241}	storage, processing
5.	15,42 t Th^{232} 1,75 t Pu^{239}	5-th (equilibrium) 18	31 FAs 116	14,64 t Th^{232} 0,345 t U^{233} 0,105 t U^{235} 0,180 t Pu^{239} 0,122 t Pu^{241}	storage, processing
			30FAs 68	not unloaded	permutation
			30 FAs 53,5	not unloaded	permutation
			30 FAs 35,5	not unloaded	permutation
			30 FAs 18	not unloaded	permutation

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FEATURES OF CONSTRUCTIONAL MATERIALS OF THE REACTOR BREST-300

S.A. Kloster, A.S. Nurkin

Scientific advisor: Ph.D., As. Professor Ju.B. Chertkov

Linguistic advisor: Teacher Y.V. Ermakova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: battchat@gmail.com

Annotation

The article shows the basic corrosion and mechanical properties required to structure materials used in the reactors with heavy liquid metal coolant. The article observes erosion and corrosion interaction of lead melt on different materials of nuclear reactor. The solution of this problem through the use of a special technology - lead coolant, which allows creating on the steel surface protective oxide film thickness and maintaining their optimum level. Key words: fast reactor, lead coolant, corrosion, heavy liquid metal coolant, reactor aggregate.

Introduction

BREST reactor is one of the perspective projected installations that uses heavy liquid metal as a coolant. The main feature of liquid coolant is high corrosion activity in relation to constructional materials.

In this connection main objective technologies of liquid plumbous coolant that occur during exploitation are:

- Provisions of corrosion resistance of constructional materials, which are used in connection with plumbous liquid coolant.
- Provisions of necessary purity of the coolant and inner surface of circuit gear (to pretend soiling isolated parts of gear).

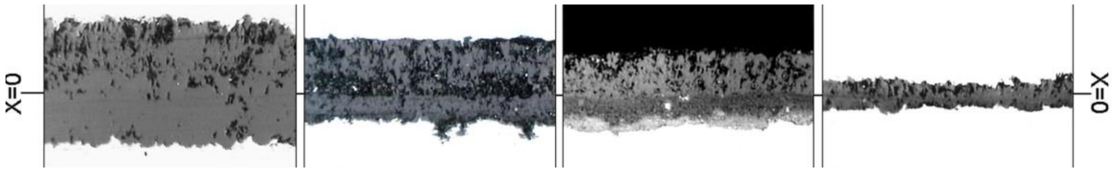
Main reason of high level of aggressivity of liquid lead in relation to constructional materials is dissolving of main components of steel (Ni, Cr, Fe), which boost in environment with gyration of coolant [3,4]. Passivation of steel with protective oxide tarnish such us Me_3O_4, which is created form inhibition liquid oxygen admixture, is considered as an effective method damping liquid metal corrosion [4]. In this article were considered features of formation oxide layer on steel surface 20Cr13, EP823 и Cr18Ni10Ti, and ARMCO-Fe in continuous contact with liquid lead saturated with oxygen. Chemical structure of steel is shown in table 1[5].

Table 1. Chemical structure of observable materials

Material	C	Si	Mn	Cr	Ni	Mo	Nb	V	Ti	W	N	Fe
ARMCO-Fe	0,02	–	–	–	–	–	–	–	–	–	–	bas.
20Cr13	0,20	0,50	–	13	–	–	–	–	–	–	–	bas.
EP823	0,17	2,04	0,74	13	0,28	1,60	0,20	0,20	–	0,19	0,94	bas.
Cr18Ni10Ti	0,08	0,60	0,61	18	10	–	–	–	0,70	–	–	bas.

Influence of the lead on construction materials

During soaking was observed metals liquid lead surface covered by charcoal-grey scale [5]. Thickness of scale increases with increasing of isothermal duration. Though this speed of corrosion determined by variation of sample's cross-section decreases when concentration of chrome increases [5]. During 1000 hours on the surface of all observing material scale is formatted, which consists of two layers growing in two opposite sides. Exterior, spongy part of scales with bar structure grows form boundary "solid metal/ liquid lead" to melt side, while exterior is more compact, growts to matrix side. Thickness of scale reduces in the row ARMCO-Fe→20Cr13→EP823→Cr18Ni10Ti [5].



Pic.1 Structure of scale on surface ARMCO-Fe and steel 20Cr13, EP823 и Cr18Ni10Ti after soaking in melt of oxygenic lead (CO[Pb]=$1,3\times10^{-3}$ mass.%) during 1000h with 550 °C X=0 - reference boundary «solid metal/ liquid lead»

Let us consider the features of scales of different steels. Scale, created on the surface of ARMCO-Fe, has two-ple structure. In exterior layer two areas are well discriminated: sponge with bar structure and compact one. Interior sponge layer is homogeneous relation to exterior, that is sponge in interior layer of scale grows eventually [5]. Main feature of austenite steel CR18NI10TI is that there is no lead in scale. As that exterior oxide layer is spite of being highly spongy doesn't contain lead. Lead areas are detected only in interior part of the scale, highly concentration of nickel is also detected [5]. Firstly on the steel surface EP823 two-ple scale is formed. But, it is striped when it reaches critical thickness (~ 18 mkm). Saturated with oxygen liquid lead falls on steel surface, and acescence is resumed [5]. After 2000h soaking on the sample apparent two scales, each of them consists of exterior and interior under layers. Obviously, that relation to other materials steel EP823 in that condition oxides cyclically. Second layer of scale have identical structure and containment to previous layer.

Conclusion. Basing on identified features of structure and containment of scale one can then conclude, that during a contact with oxygen-containing lead ARMCO-Fe and with steels 20Cr13, EP823, Cr18Ni10Ti at first steps the same mechanism of oxygenizing is implemented. On the surface of the samples the scale on the basis of magnetite is defined. Scale growth to melt side and matrix symmetrically relation to initial bonder "solid metal / liquid lead".

The speed of oxygenizing of the test materials decreases in the row ARMCO Fe→20Cr13→EP823→ Cr18Ni10i, so that chrome as for gas corrosion, plays the main role – slows down diffusion of cations from the layer of spinel material and reduce speed of growth of scale. It's important to note that lead didn't penetrate in scale, generated on the surface of the iron and chromium steels, bun can be found in the scale of Cr18Ni10Ti [5].The reason for this – nickel. Obliviously, during the growth of inner layer spinel material $Fe_{1+x}Cr_{2-x}O_4$ nickel an unreactive relation to oxygen hustles away to boundary "oxide/matrix" [5]. It is known that nickel has high solubility in lead and doesn't interact in formation of oxide layer, so that isobar-isothermal potential oxygenizing of the nickel is close to oxygenizing potential of the lead [3-6]. So that, during grow of inner layer of scale, there are non-oxygenizing parts enriched in nickel can be found. Similarly is formed scale on steel that contains nickel and melts in gas environment [7]. In case of continuous contact with lead melt enriched by nickel parts of layer spinel material may be selectively attacked by lead that is despite of high protection to oxygenizing scale thickness of steel’s Cr18Ni10Ti minimal comparably to other materials, inner layer of steel Cr18Ni10Ti doesn't have protective properties against to lead melt. The results obtained from the laboratory are in good agreement with theoretical data for steel oxygenizing in Pb melt and in Pb-Bi [2-6]. For example, during research of iron and steel in contact with eutectic Pb-Bi soaked at 500 °C during 500h assign that thickness double oxide film decrease with concentration of chrome in the steel [8]. It is also noted that, inner spinel material layer enriched in chrome, plays protective role and reduces steel oxygenizing speed [8].

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HIGGS BOSON. REVIEW ARTICLE

A.N. Mamedov

Scientific advisor: Ph.D., Prof. S.A. Reshetnyak

Language advisor: Teacher: A. Tsyrkal

National Technical University of Ukraine "Kyiv Polytechnic Institute",

Ukraine, Kyiv, Peremohy avenue, 37, 03056

E-mail: acy_m@yahoo.com

When you get on the scale in the morning, you may be hoping that it registers a smaller number than the day before - you may be hoping that you've lost weight. It's the quantity of mass in you, plus the force of gravity, that determines your weight. But what determines your mass?

That's one of the most-asked, most-hotly pursued questions in physics today. Many of the experiments circulating in the world's particle accelerators are looking into the mechanism that gives rise to mass. Scientists at CERN, as well as at Fermilab in Illinois, are hoping to find what they call the "Higgs boson". It is believed that Higgs is a particle or set of particles, that might give others mass.

In the beginning of the 1960s a number of exchange particles, also known as force carriers, had been discovered or proposed, along with theories suggesting how they relate to each other, some of which had already been reformulated as field theories in which the objects of study are not particles and forces, but quantum fields and their symmetries. However, attempts to unify known fundamental forces such as the electromagnetic force and the weak nuclear force were known to be incomplete. One known omission was that gauge invariant approaches, including non-abelian models such as Yang–Mills theory (1954), which held great promise for unified theories, also seemed to predict known massive particles as massless. Goldstone's theorem, relating to continuous symmetries within some theories, also appeared to rule out many obvious solutions, since it appeared to show that zero-mass particles would have to also exist that were "simply not seen". According to Gerald Guralnik, physicists had "no understanding" how these problems could be overcome.

The Higgs mechanism is a process by which vector bosons can get rest mass without explicitly breaking gauge invariance, as a byproduct of spontaneous symmetry breaking. The mathematical theory behind spontaneous symmetry breaking was initially conceived and published within particle physics by Yoichiro Nambu in 1960, the concept that such a mechanism could offer a possible solution for the "mass problem" was originally suggested in 1962 by Philip Anderson, and Abraham Klein and Benjamin Lee showed in March 1964 that Goldstone's theorem could be avoided this way in at least some non-relativistic cases and speculated it might be possible in truly relativistic cases.

These approaches were quickly developed into a full relativistic model, independently and almost simultaneously, in the second half of 1964, by three groups of physicists. Peter Higgs, who was in one of these groups, also wrote a short but important response published in September 1964 to an objection by Gilbert, which showed that if calculating within the radiation gauge, Goldstone's theorem and Gilbert's objection would become inapplicable. Properties of the model were further considered by other physicists. The original three 1964 papers showed that when a gauge theory is combined with an additional field that spontaneously breaks the symmetry, the gauge bosons can consistently acquire a finite mass. In 1967, Steven Weinberg and Abdus Salam independently showed how a Higgs mechanism could be used to break the electroweak symmetry of Sheldon Glashow's unified model for the weak and electromagnetic interactions, forming what became the Standard Model of particle physics. Weinberg was the first to observe that this would also provide mass terms for the fermions.

The resulting electroweak theory and Standard Model have correctly predicted (among other discoveries) weak neutral currents, three bosons, the top and charm quarks, and with great precision, the mass and other properties of some of these. Many of those involved eventually won Nobel Prizes or other renowned awards. A 1974 paper in Reviews of Modern Physics commented that "while no one doubted the mathematical correctness of these arguments, no one quite believed that nature was diabolically clever enough to take advantage of them". By 1986 and again in the 1990s it became possible to write that understanding and proving the Higgs sector of the Standard Model was "the central problem today in particle physics."

Theoretical need for the Higgs is very big because the Standard Model hypothesizes a field which is responsible for this effect, called the Higgs field (symbol:ϕ), which has the unusual property of a non-zero amplitude in its ground state; i.e. a non-zero vacuum expectation value. It can have this effect because of its unusual "Mexican hat" shaped potential whose lowest "point" is not at its "centre". Below a certain extremely high energy level the existence of this non-zero vacuum expectation spontaneously breaks electroweak gauge symmetry which in turn gives rise to the Higgs mechanism and triggers the acquisition of mass by those particles interacting with the field. This effect occurs because scalar field components of the Higgs field are "absorbed" by the massive bosons as degrees of freedom, and couple to the fermions via Yukawa coupling, thereby producing the expected mass terms. In effect when symmetry breaks under these conditions, the Goldstone bosons that arise interact with the Higgs field instead of becoming new massless particles, the intractable problems of both underlying theories "neutralize" each other, and the residual outcome is that elementary particles acquire a consistent mass based on how strongly they interact with the Higgs field. It is the simplest known process capable of giving mass to the gauge bosons while remaining compatible with gauge theories. Its quantum would be a scalar boson, known as the Higgs boson.

In the Standard Model, the Higgs field consists of four components, two neutral ones and two charged component fields. Both of the charged components and one of the neutral fields are Goldstone bosons, which act as the longitudinal third-polarization components of the massive W^+, W^-, and Z bosons. The quantum of the remaining neutral component corresponds to the massive Higgs boson. Since the Higgs field is a scalar field (meaning it does not transform under Lorentz transformations), the Higgs boson has no spin. The Higgs boson is also its own antiparticle and is CP-even, and has zero electric and colour charge.

The Minimal Standard Model does not predict the mass of the Higgs boson. If that mass is between $115\ and\ 180\ \frac{GeV}{c^2}$, then the Standard Model can be valid at energy scales all the way up to the Planck scale

($10^{19} GeV$). Many theorists expect new physics beyond the Standard Model to emerge at the TeV-scale, based on unsatisfactory properties of the Standard Model. The highest possible mass scale allowed for the Higgs boson is 1.4 TeV; beyond this point, the Standard Model becomes inconsistent without such a mechanism, because unitarity is violated in certain scattering processes.

It is also possible, although experimentally difficult, to estimate the mass of the Higgs boson indirectly. In the Standard Model, the Higgs boson has a number of indirect effects; most notably, Higgs loops result in tiny corrections to masses of W and Z bosons. Precision measurements of electroweak parameters, such as the Fermi constant and masses of W/Z bosons, can be used to calculate constraints on the mass of the Higgs. As of July 2011, the precision electroweak measurements tell us that the mass of the Higgs boson is likely to be less than about $161 \frac{GeV}{c^2}$ at 95% confidence level (this upper limit would increase to $185 \frac{GeV}{c^2}$ if the lower bound of $114.4 \frac{GeV}{c^2}$ from the LEP-2 direct search is allowed for). These indirect constraints rely on the assumption that the Standard Model is correct. It may still be possible to discover a Higgs boson above these masses if it is accompanied by other particles beyond those predicted by the Standard Model.

To produce Higgs bosons, two beams of particles are accelerated to very high energies and allowed to collide within a particle detector. Occasionally, although rarely, a Higgs boson will be created fleetingly as part of the collision byproducts. Because the Higgs boson decays very quickly, particle detectors cannot detect it directly. Instead the detectors register all the decay products and from the data the decay process is reconstructed. If the observed decay products match a possible decay process of a Higgs boson, this indicates that a Higgs boson may have been created. In practice, many processes may produce similar decay signatures. Fortunately, the Standard Model precisely predicts the likelihood of each of these, and each known process, occurring. So, if the detector detects more decay signatures consistently matching a Higgs boson than would otherwise be expected if Higgs bosons did not exist, then this would be strong evidence that the Higgs boson exists.

Because Higgs boson production in a particle collision is likely to be very rare (1 in 10 billion at the Large Hadron Collider), and many other possible collision events can have similar decay signatures, the data of hundreds of trillions of collisions needs to be analyzed and must "show the same picture" before a conclusion about the existence of the Higgs boson can be reached. To conclude that a new particle has been found, particle physicists require that the statistical analysis of two independent particle detectors each indicate that there is lesser than a one-in-a-million chance that the observed decay signatures are due to just background random Standard Model events – i.e. that the observed number of events is more than 5 standard deviations different from that expected if there was no new particle. More collision data allows better confirmation of the physical properties of any new particle observed, and allows physicists to decide whether it is indeed a Higgs boson as described by the Standard Model or some other hypothetical new particle.

On 22 June 2012 CERN announced an upcoming seminar covering tentative findings for 2012, and shortly afterwards rumours began to spread in the media that this would include a major announcement, but it was unclear whether this would be a stronger signal or a formal discovery. Speculation escalated to a "fevered" pitch when reports emerged that Peter Higgs, who proposed the particle, was to be attending the seminar. On 4 July 2012 both of the CERN experiments announced they had independently made the same discovery: CMS of a previously unknown boson with mass 125.3 ± 0.6 $\frac{GeV}{c^2}$ and ATLAS of a boson with mass 126.5 $\frac{GeV}{c^2}$. Using the combined analysis of two interaction types (known as 'channels'), both experiments reached a local significance of 5-sigma – or less than a 1 in one million chance of error. When additional channels were taken into account, the CMS significance was reduced to 4.9-sigma.

The two teams had been working 'blinded' from each other for some time, meaning they did not discuss their results with each other, providing additional certainty that any common finding was genuine validation of a particle. This level of evidence, confirmed independently by two separate teams and experiments, meets the formal level of proof required to announce a confirmed discovery.

On 31 July 2012, the ATLAS collaboration presented additional data analysis on the "observation of a new particle", including data from a third channel, which improved the significance to 5.9-sigma (1 in 588 million chance of being due to random background effects) and mass 126.0 ± 0.4 (stat) ± 0.4 (sys) $\frac{GeV}{c^2}$, and CMS improved the significance to 5-sigma and mass 125.3 ± 0.4 (stat) ± 0.5 (sys) $\frac{GeV}{c^2}$.

On 14 March 2013 CERN confirmed that:

"CMS and ATLAS have compared a number of options for the spin-parity of this particle, and these all prefer no spin and positive parity. This, coupled with the measured interactions of the new particle with other particles, strongly indicates that it is a Higgs boson."

This also makes the particle the first known scalar particle to be discovered in nature.

I hope that Higgs boson will help human beings to research universe origin and also to get better opportunities in future investigations.

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STUDY OF CHARACTERISTICS OF PROTON EXCHANGE MEMBRANE OF PVDF UNDER THE OXIDANT

J.V. Marachkovskaya, V.V. Sokhoreva
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

Main component of a polymeric electrolyte fuel cell (FC) is a polymeric proton exchange membrane (PEM). It has to provide proton transport from FC anode to cathode and barrier to event gases and liquids permeation while FC operates. It has to have rather high proton conductivity, chemical and long live steadiness in working temperature range and low cost. Commercially available membranes do not completely correspond to these demands and researches and development of the new membrane and methods of its manufacture is actual task.

Combined treatment of polymer films using ionizing radiation and chemical treatment was carried to create PEM. Radiation grafting of styrene to films of PVDF. Conducted preliminary irradiation of the polymer matrix by ultraviolet (UV) in the presence of styrene monomer. The exposure time was in the range of 15 - 30 minutes. After irradiation (UVR) polymer matrix was placed in a special holder (Fig. 1), the input window of the holder was made of a thin aluminum foil. Holder filled by styrene solution in toluene with the addition of isopropyl alcohol.

Figure 1. Holder of the polymer matrix.

Graft used a beam of alpha particles accelerated in the cyclotron R-7M to energy 27.5 MeV. The container was placed on a special holder perpendicular to the beam of α-particles. Uniform irradiation of polymers has been achieved by the rotation of the container holder. [1]

Was calculated dependence of the mean projected range of the ion energy on the program SRIM, which allows the calculation of ion ranges in solids. Mileage helium ions in the fluoropolymer PVDF than 0.6 mm (Fig. 2). This is enough to shoot alpha particles through the polymer even through the inlet aluminum window container.

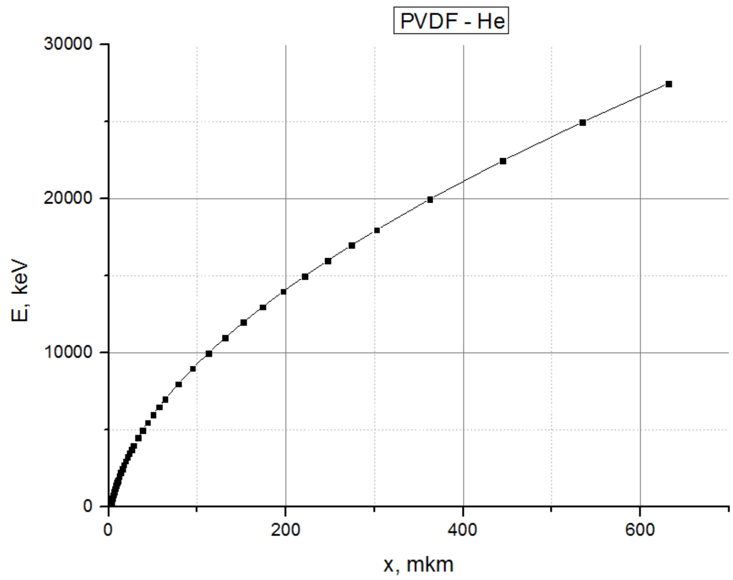

Figure 2. Dependence of the mean projected range of alpha particles in the polymer PVDF on energy.

The samples were irradiated with different doses, the maximum dose was 1.2 mGy. After irradiation the samples were containers surgery grafting styrene. The films are then extracted from the container, washed from styrene residues on the surface and placed in a quartz weighing bottles filled with sulfuric acid. Sulfonation occurred in an ultrasonic bath at a temperature of 70^0C.

Measured exchange capacity of sulfonated membranes is shown in Figure 3.

After inoculation, the samples were investigated sulfonation in sulfuric acid solution and the solution of sulfanilic acid with the addition of 3% H2 SO4 Sulfonation was carried out with a temperature of 90^0 C. With the help of automatic titrator was determined exchange capacity (OE) sulfonated polymer PVDF and polyimide. In Fig. 3. the dependence on time OE sulfonation and radiation dose. The distribution of elements in the sulfonated polymer membrane was determined by scanning electron microscopy and Rutherford backscattering.

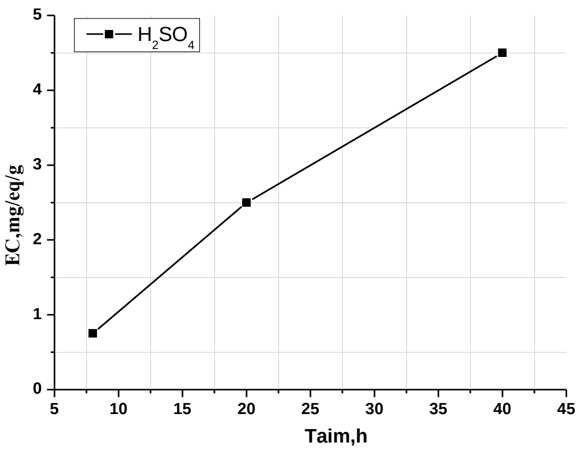

Figure 3. Dependence on the time OE membrane sulfonation.

Measured transverse proton conductivity of the membrane shown in Fig. 4.

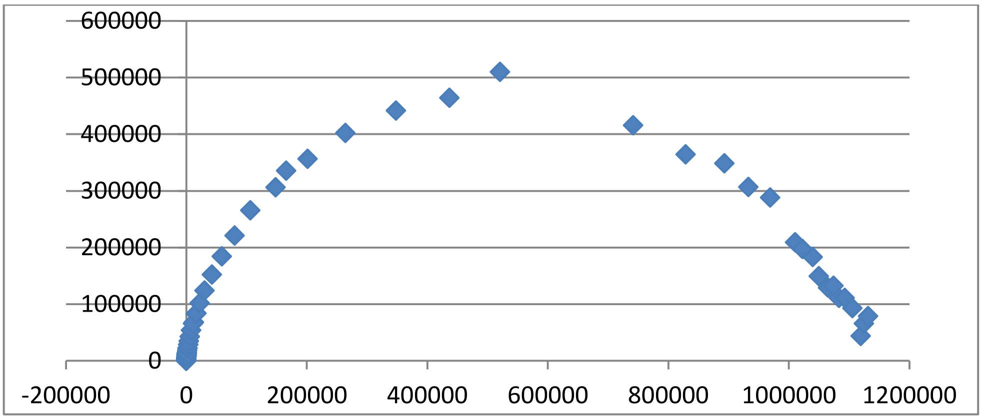

Figure 4. Transverse proton conductivity of the membrane.

As follows from the literature, in the process of POM can form hydrogen peroxide, which can destroy the connection grafted sulfo, therefore, investigated the variation of the exchange capacity of sulfonated membranes from time when placing it in the 6% solution of hydrogen peroxide (H2O2) [2].

The results showed that after 5 hours of exposure to H2O2 membrane exchange capacity of the membrane is not changed.

In conclusion, it should be noted that we have obtained and studied containing sulfonic PEM synthesized in the presence of radiation-initiated followed by thermal polymerization of styrene absorbed in the polymer PVDF, and then sulfonated acids containing the group SO_3. The degree of grafting, depending on the type of exposure and exchange capacity, it is shown that OE has the greatest value in the radiative effects on linear polymers ions ^{4}He.

Further research will be aimed at studying the effects of H_2O_2 on the operating parameters of the PEM.

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THE USING OF SEMICONDUCTOR DETECTOR IN MODERN EQUIPMENT

O.O. Matveeva

Scientific advisor: Dr. V.S. Yakovleva

Linguistic advisor: Senior teacher N.V. Demjanenko

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: matveeva_olesya91@mail.ru

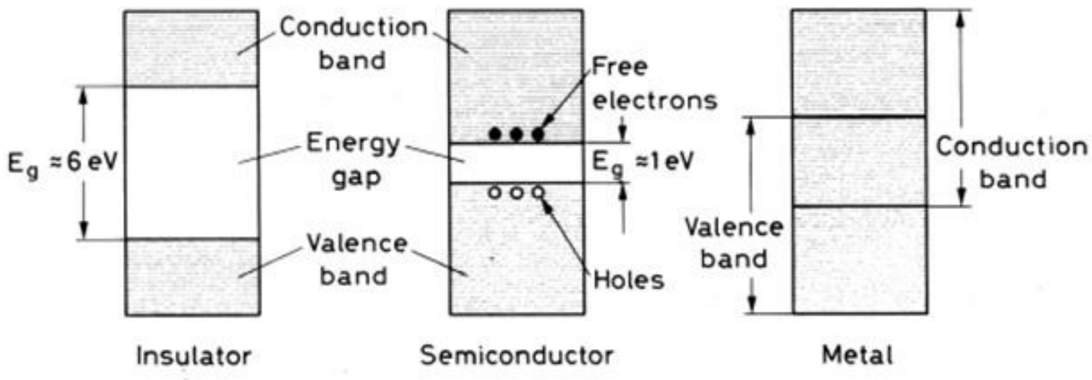
Annotation

The article describes using a semiconductor detectors in the world. A semiconductor detector is a device that uses a semiconductor (usually silicon or germanium) to detect traversing charged particles or the absorption of photons. In the field of particle physics, these detectors are usually known as silicon detectors. When their sensitive structures are based on a single diode, they are called semiconductor diode detectors. When they contain many diodes with different functions, the more general term semiconductor detector is used. Semiconductor detectors have found broad application during recent decades, in particular for gamma and X-ray spectrometry and as particle detectors.

Semiconductor detectors are most commonly used when best energy resolution is intended. Each type of radiation detector produces its inherent output product after interaction with radiation. In semiconductor detectors, the fundamental information carriers are electron-hole pairs, which are produced along the path taken by the charged particle (primary or secondary) through the detector. By collecting electron-hole pairs, the detection signal is formed. Of the available semiconductor materials, silicon is mainly used for charged particle detectors and soft X-ray detectors while germanium is widely used for gamma-ray spectroscopy. [1]

What Is a Semiconductor?

A semiconductor is a solid material that has electrical conductivity between a conductor and an insulator. Insulators have larger band gaps (energies that electrons must acquire to be free to move from atom to atom). When a semiconductor is at room temperature, very few electrons gain enough thermal energy to leap the band gap, which is necessary for electrons to be available for electric current conduction. The smaller bandgaps of semiconductors, however, allow for other means besides temperature to control their electrical properties. [2]



Pic.1. The principle of operation of semiconductor detectors.

Semiconductor radiation detector. In these detectors, radiation is measured by means of the number of charge carriers set free in the detector, which is arranged between two electrodes. Ionizing radiation produces free electrons and holes. The number of electron-hole pairs is proportional to the intensity of the radiation to the semiconductor. As a result, a number of electrons are transferred from the valence band to the conduction band, and an equal number of holes are created in the valence band. Under the influence of an electric field, electrons and holes travel to the electrodes, where they result in a pulse that can be measured in an outer circuit. The holes travel in the opposite direction and can also be measured. As the amount of energy required to create an electron-hole pair is known, and is independent of the energy of the incident radiation, measuring the number of electron-hole pairs allows the intensity of the incident radiation to be found.

Silicon detector. Most silicon particle detectors work, in principle, by doping narrow (usually around 100 micrometers wide) strips of silicon to make them into diodes, which are then reverse biased. As charged particles pass through these strips, they cause small ionization currents which can be detected and measured. Arranging thousands of these detectors around a collision point in a particle accelerator can give an accurate picture of what paths particles take. Silicon detectors have a much higher resolution in tracking charged particles than older technologies such as cloud chambers or wire chambers. The drawback is that silicon detectors are much more expensive than these older technologies and require sophisticated cooling to reduce leakage currents (noise source) as well as suffer degradation over time from radiation.

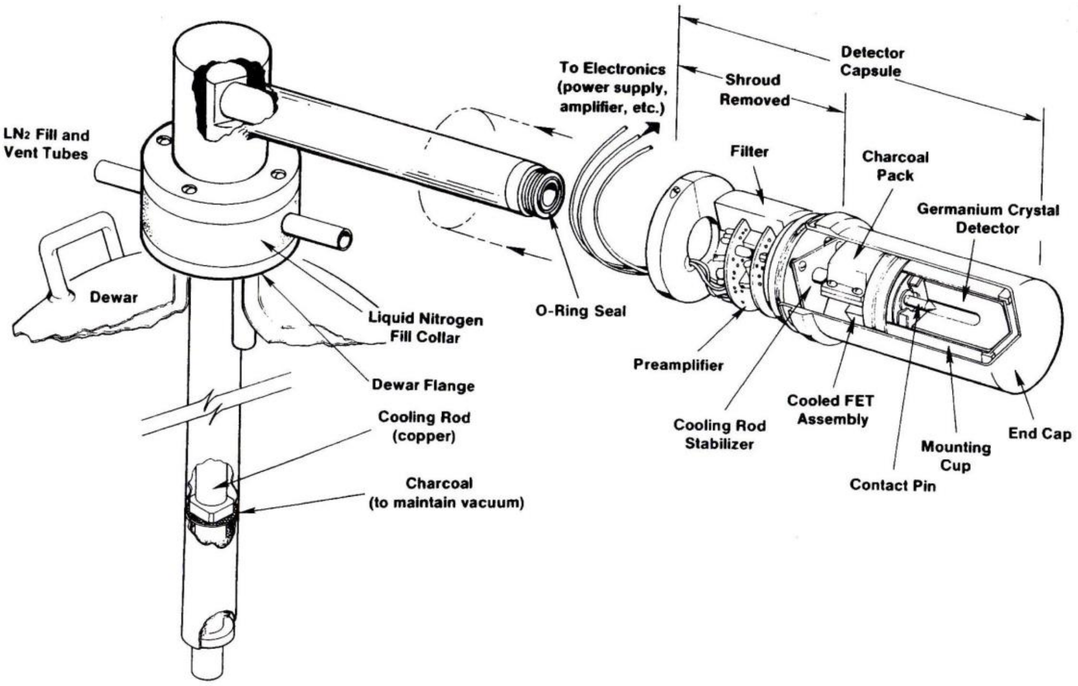
Diamond detector. Diamond detectors have many similarities with silicon detectors, but are expected to offer significant advantages, in particular a high radiation hardness and very low drift currents. At present they are much more expensive and more difficult to manufacture. [3-5]

Germanium detectors are mostly used for spectroscopy in nuclear physics. While silicon detectors cannot be thicker than a few millimeters, germanium can have a depleted, sensitive thickness of centimeters, and therefore can be used as a total absorption detector for gamma rays up to few MeV. These detectors are also called high-purity germanium detectors (HPGe) or hyper pure germanium detectors. Before current purification techniques were refined, germanium crystals could not be produced with purity sufficient to enable their use as spectroscopy detectors. Impurities in the crystals trap electrons and holes, ruining the performance of the detectors. Consequently germanium crystals were doped with lithium ions (Ge(Li)), in order to produce an intrinsic region in which the electrons and holes would be able to reach the contacts and produce a signal.

When germanium detectors were first developed, only very small crystals were available. Low efficiency was the result, and germanium detector efficiency is still often quoted in relative terms to a "standard" 3″ x 3″ NaI(Tl) scintillation detector. Crystal growth techniques since improved, allowing detectors to be manufactured that are as large as or larger than commonly available NaI crystals, although such detectors cost more than €100,000.

As of 2012 HPGe detectors commonly use lithium diffusion to make an n+ ohmic contact, and boron implantation to make a p+ contact. Coaxial detectors with a central n+ contact are referred to as n-type detectors, while p-type detectors have a p+ central contact. The thickness of these contacts represents a dead layer around the surface of the crystal within which energy depositions do not result in detector signals. It should be noted that the central contact in these detectors is opposite of the surface contact, making the dead layer in n-type detectors smaller than the dead layer in p-type detectors. Typical dead layer thickness are several hundred micrometers for an Li diffusion layer, and a few tenths of a micrometer for a B implantation layer.

The major drawback of germanium detectors is that they must be cooled to liquid nitrogen temperatures to produce spectroscopic data. At higher temperatures, the electrons can easily cross the band gap in the crystal and reach the conduction band, where they are free to respond to the electric field, producing too much electrical noise to be useful as a spectrometer. Cooling to liquid nitrogen temperature (77 K) reduces thermal excitations of valence electrons so that only a gamma ray interaction can give an electron the energy necessary to cross the band gap and reach the conduction band. Cooling with liquid nitrogen is inconvenient, as the detector requires hours to cool down to operating temperature before it can be used, and cannot be allowed to warm up during use. Ge(Li) crystals could never be allowed to warm up, as the lithium would drift out of the crystal, ruining the detector. HPGe detectors can be allowed to warm up to room temperature when not in use.[3]



Pic.2. High-purity germanium detector.

Two advantages of semiconductor as a detecting medium are much greater density than for a gas and reduced ionization energy (of the order of 1 eV to produce an electron-hole pair, compared with 5 eV to ionize a solid insulator and 30 eV to ionize a gas). As a result, a much greater density of free carriers is produced in a semiconductor. [6-7]

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THE DEPTH DISTRIBUTION OF THE ABSORBED DOSE OF THE ELECTRON BEAM IN THE TISSUE-EQUIVALENT MEDIUM

I.A. Miloichikova

Scientific advisor: Assistant Ye.S. Sukhikh

Language advisor: As. Professor R.I. Tolbanova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: ircha1988@mail.ru

Annotation

In the research the methodology of clinical dosimetry of electron beams using plane-parallel ionization chamber and radiochromic dosimetry films (the GafChromic EBT3 film) in non-water phantom is considered.

In the introduction the actuality of the research is discussed.

In the main part the main parameters of the plane-parallel ionization chamber, radiochromic dosimetry films and the non-water phantom are described. General principles of the methodology of the depth dose measurement are given. The results of the depth dose measurement of 2 MeV betatron electron beams are presented.

In conclusion the comparative analysis of the results is given.

Keywords: radiotherapy, clinical electron dosimetry, depth dose distribution, plane-parallel ionization chamber, radiochromic dosimetry film.

Research field: nuclear physics, material-radiation interaction, dosimetry.

Related sciences: medical physics.

Introduction

Radiotherapy is the medical use of ionizing radiation as a part of cancer treatment to control malignant cells.

A multi disciplinary team of specialists in cancer treatment and care includes medical physicists. Medical physicists determine the time of radiation from a particular radiotherapy machine to get the right dose. In diagnostics and radiation therapy special attention is given to the control of the parameters of ionizing radiation source, it includes carrying out clinical dosimetry. Therefore, today medical physicists focus on the creation of new methodologies, techniques and devices to control these parameters with the necessary accuracy.

Up-to-date modern advances in the commercial development of linear accelerators with suitable energy and retractable x-ray targets as well as the development of new radiotherapy methods allow extensive use of electrons for radiation therapy of surface and shallow-lying tumors (for example breast cancer).

The main advantages of the electron beams are: 1 - high degree of dose homogeneity in the target volume;

2 - high dose gradient at the boundaries between target and healthy tissue.

Thus, it is necessary to have a clear perception of scientific understanding and the methodology of clinical dosimetry of electron beams.

Research objective is to carry out clinical dosimetry of the electron beams.

The research tasks are to measure the depth dose distribution of the 2 MeV electron beams of the betatron using a plane-parallel ionization chamber and radiochromic dosimetry films (the GafChromic EBT3 film) in non-water phantom and to compare the results obtained.

Materials and methods

Source of emission

The irradiation was performed using the betatron prototype of a new generation. This device allows smooth changing of energy in a wide range of the dose depending on the clinical applications. The maximum kinetic energy of the electron is 3,5 MeV.

Dosimetry equipment

Plane-parallel ionization chambers are acceptable for relative dosimetry of electron beams. In the experiment the standard dosimeter AT5350/1 (date of gauging - 27.09.12) completed with a PTW-Freirburg Markus 23343 parallel-plate chamber (with the dose range 2 – 45 MeV; measuring volume - 0,055 cm^2; wall material was polyethylene) was used [1].

Radiochromic films are one of the most practical detectors used in non-water phantoms to obtain relative and absolute measurements for clinical electron fields [2]. In the experiment the GafChromic EBT3 radiochromic dosimetry film (the material is near the tissue-equivalent; the dose range was 1cGy to > 40 Gy) was used [3].

Measurement of the central-axis depth-dose curve can be done with a film placed between the plates of solid phantom parallel to the electron beam [2]. The fitted calibration curve allows calculating the value of the absorbed dose received from the given source of radiation in accordance with the value of the relative optical density of the film [4].

Nonwater phantom

In this work RW3 Slap Phantom T29672 was used. The material of the phantom is polystyrene (C_8H_8) containing 2 % (±0,4 %) of TiO_2 by mass. The density of the phantom is 1,045 g/cm^3.The electron density of the phantom is 1.012 times higher then the electron density of water [5].

Measurements of the depth dose distribution of the electron beams

Provided secondary electron equilibrium exists (normally within a few millimeters of the surface) and the energy spectra at each position are identical, the dose in water at a depth (d_{water}) and the dose in the solid at a corresponding depth (d_{med}) are related by

$$D_{water}(d_{water}) = D_{med}(d_{med})\left[\left(\bar{S}/\rho\right)_{coll}\right]_{med}^{water}\left[\varphi\right]_{med}^{water} \quad (1)$$

where $\left[\left(\bar{S}/\rho\right)_{coll}\right]_{med}^{water}$ is the ratio of the mean unrestricted mass collision stopping power in water to that in the solid. $[\varphi]_{med}^{water}$ is the fluence factor, that is, the ratio of the electron fluence in water to that in the solid phantom. In the first approximation the fluence factor could be equal to 1.

The depth in the nonwater phantom can be converted to water-equivalent. The water-equivalent depth can be approximated using a density determined from the ratio of the depth of 50 % ionization R_{50} penetrations by

$$d_{water} = d_{med} \times \rho_{eff} = d_{med}\left(R_{50}^{water}/R_{50}^{med}\right),$$

i.e., the effective density, ρ_{eff} given by the ratio of the R_{50} in water to that in the nonwater material. Recommended effective density of scaling depth from nonwater polystyrene phantoms to water phantoms for electron beams is 0.975.

In this case, considering the equation (1), the percent depth dose in water can be given by

$$\%D_{water}(d_{water}) = \left[\frac{D_{med}(d_{med})\left[\left(\bar{S}/\rho\right)_{coll}\right]_{med}^{water}\left[\varphi\right]_{med}^{water}}{\left[\ldots\right]_{\max}}\right] \times 100\,,$$

where the denominator equals the value of the numerator at the depth-of-maximum dose. [6]

Results and discussion

In figure 1 the results of the depth dose measurement of the 2 MeV electron beams of the betatron using the plane-parallel ionization chamber and the GafChromic EBT3 films in the phantom are shown.

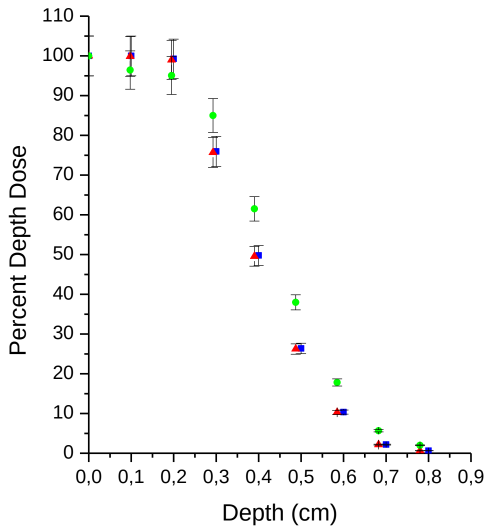

Fig. 1. Comparison of the film dosimetry results with the ionization chamber results (2 MeV electron beams of the betatron):

■ - *the depth dose distribution using plane-parallel ionization chamber in the non-water phantom;*

▲ - *the depth dose distribution using plane-parallel ionization chamber in water;*

◆ - *the depth dose distribution using the GafChromic EBT3 radiochromic dosimetry films in water.*

Conclusion

The measurements performed on the 2 MeV electron beams of the betatron show that the qualitative results obtained with the help of the GafChromic EBT3 films and the plane-parallel ionization chamber are in good agreement.

However, the values of the absorbed dose to the depth dose curves on the central axis quantitatively differ in the beginning of recession. This phenomenon can be explained by the fact that the betatron is being under development, consequently, the betatron did not work continuously and the measurements were carried out in different days.

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INNOVATIONAL NUCLEAR SYSTEMS OF 4TH GENERATION

T.I. Minin

Language advisor: Teacher Y.V. Ermakova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: elouseman@gmail.com

Annotation

The subject of this project is to give a brief overview of the technologies of the future. These nuclear technologies have already been developed and is currently being put into practice by the best minds of the world's leading countries. This paper consist of three main parts: a short historical overview of the development of each generation of nuclear systems, the name of the most famous and large-scale projects related to the fourth generation, determine the size of the contribution of the world's countries in the development of these technologies. Summary, this work is showing in colors a situation with developing of nuclear systems. Not all the information is new.

Introduction

In these latter days the nuclear reaction, as such, has successfully demonstrated the importance of its role as a source of energy. That is why the idea of using it evolves every year precipitously and countries develop new projects. However, there are necessary conditions on the method of energy that must be observed.

For example, the strategy of «Climate and Energy» developed in the EU affects all primary energy sources (thermal, nuclear, renewable) with an emphasis on energy conservation. Thus, it is assumed that due to the use of nuclear energy to reduce consumption of coal and other exhaustible energy sources. So people must make a version with nuclear technology more attractive to those already "bored" options. The most important criterion for the construction of new nuclear power plants has always been safety. A new wave of concerns about the operation of nuclear reactors put the brakes on the above forward-looking energy sector, but did not stop it.

One of the main reasons for turning large energy consumers in the direction of the development of nuclear power, experts say, is their reluctance to depend on quite unpredictable prices for traditional raw materials, the rapid depletion of old fields and unprofitable extract deeply buried material. The more became known not comforting outlook for economic market: by 2020, global oil production will peak and then decline. Goes out to the year 2030 to avoid a decline in production, humanity will have to find an alternative fuel good half of the current fields. One of the simplest solutions to the problem - increasing the production of natural gas. In this case, its reserves will be already depleted in 2050.

According to scientists, only nuclear power can satisfy the increasing growth of global energy consumption for hundreds of years.

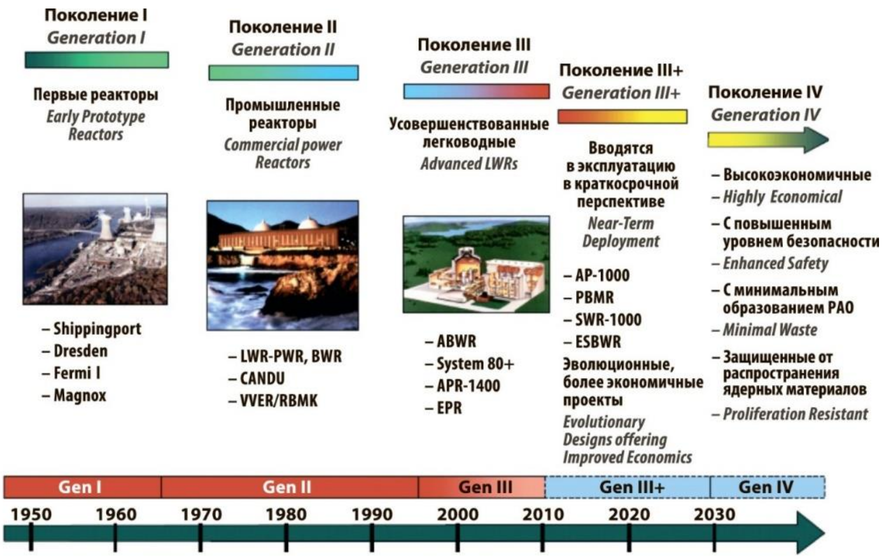
The following objectives:

1. Identify the most famous and large-scale projects of the fourth generation.

2. Consider separately the contribution of world countries in developing nuclear energy.

Main Body

With the advent of fourth generation nuclear technology, the term «reactor» is replaced by the correct term «system» that includes both direct the reactor and reprocessing (recycling) of nuclear fuel. These new systems must have high performance in the field of sustainable development, competitiveness, safety and reliability, as well as protection against the spread, justifying the use of the expression «technological breakthrough». Some of them will produce electricity, and others produce heat (temperature about 400-900 ° C) for use in various industrial applications - in the petrochemical industry, development of synthetic fuel, biomass gasification, hydrogen production from water, glass and cement. Lower temperatures (100-300 ° C) can be used for desalination of seawater and fertilizer. [1]



Pic.1 – development of reactor technolodge

Part of the fourth generation systems will work on fast neutron spectrum. Their ability to reproduce the fissile material in conjunction with the advanced technology division and transmutation has great potential. In addition, the nuclear fuel will be resistant to very high temperatures and ensure retention of actinides. As a result, the fuel cycle is completely closed. For this reason, the new systems provide a particularly effective sustainable development, due to the formation of minimal amounts of waste (burning all actinides).

The fourth generation nuclear systems require improvements in four areas: sustainable development, competitiveness on an industrial scale, security (reliability) and protection against unauthorized distribution. [2]

Results and discussion

The «innovative nuclear reactors and fuel cycles» (INPRO) has now brought together the best minds of the nuclear industry from thirty countries. One of the priorities is to develop an innovative multicomponent structure of a nuclear power system with enhanced reproduction of fuel, a closed fuel cycle and new types of reactors [3]. The creation of such systems will allow in the future to optimize the resources of enriched uranium and to minimize radioactive waste. In addition, scientists are actively working to improve the technology of other industries - economic performance of nuclear power plants in different countries, energy efficiency and infrastructure security stations, introduction of environmentally sound method of disposal of spent fuel, the development of guidelines to resolve the outstanding international legal issues and building a competent national strategies for the development of nuclear energy for its members. [4]

Conclusion

Innovative reactor technologies can help us make a big step in the development of the industry, as their goal – is to reduce all the costs. In this case, these technologies increase the availability of energy, which today is the most important and integral part of the economy.

Generation IV reactor concept provides a qualitative improvement of the fundamental characteristics of the reactor, as physical security: by incorporating passive safety systems and systems for the protection from the elements, reducing the significance of a nuclear non-proliferation, increase utilization rates of nuclear fuel and radioactive waste volume reduction, the economic attractiveness. Here are the countries that actively participate in the development of the fourth generation nuclear reactors: U.S., Russia, France, Japan, India and South Africa.

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THE DISCOVERY OF RADIOACTIVITY

R.A. Nurmukhametov

Linguistic advisor: Senior teacher N.V. Demjanenko

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

e-mail: nurruslan@yandex.ru

Annotation

This article explains what a long and difficult road to the discovery of radioactivity was done by scientists.

I. INTRODUCTION

Radioactivity is a natural phenomenon occurring when the spontaneous decay of atomic nuclei in which there is radiation. At the turn of the last century there was an event that changed the fate of humanity.

II. ANTOINE BECQUEREL

French physicist Antoine Becquerel pondering his experiment, choose from the collection double sulfate of uranium and potassium salt $K_2(UO_2)\ (SO_4)\ _2$, putting salt on a photographic plate, hidden from the light in black paper, and exposes the plate with the salt in the sun. Under the influence of sunlight salt has become a bright light, but this glow could not get on the photographic plate closed. After display of the photographic plate, clearly showed the image of salt cake. Becquerel checks itself again and again. February 26, 1896 came on cloudy days, and Becquerel regret hides prepared to experiment a photographic plate with salt at the table. Between the salt and the photographic plate he put copper cross, what to check, whether pass through it X Rays. But the weather was overcast and remained so until 1 mat. Morning of 1 March, it was sunny and the experiments can be resumed. However, Becquerel decided to display the plate, which lay a few days in a dark cupboard. On the displayed plate he has got a clear image of the cross and salt cake! It turned out that uranium salts by themselves without any influence emit invisible rays that illuminates the plate and pass through opaque layers. Thus was discovered the natural radioactivity of uranium compounds.

III. PIERRE AND MARIE CURIE

Observations Becquerel interested French scientists, a physicist and chemist Marie Sklodowska-Curie and her husband Pierre Curie physics. They have been looking for new radioactive chemical elements in minerals of uranium. With Marie Curie electrometer patiently checked radioactivity almost all known at the time the elements (80), and soon found that of these, only thorium also has this property - and even more so than uranium.

IV. RADIUM

Among the many chemicals and minerals it has attracted attention from pitchblende which at the time was mined uranium. Radioactivity of pitchblende was four times higher than uranium, which it contained. This was unexpected, because the chemical analysis showed that the thorium is missing in the pitchblende. Already by May 12, 1898, Pierre and Marie Curie were sure that they opened a new element, which was later named "radium". In July, they found in the waste ore is another radioactive element, which they called polonium. December 26, 1898, they reported their findings to the French Academy of Sciences. At the time, Marie and Pierre is able to demonstrate to listeners radium source, which was 900 times more active than the same quantities of uranium .It was a real revolution in chemistry, as previously considered indivisible atoms, and the chemical elements - the eternal and indestructible.

V. HARD WORK

By 1902, Marie Curie identified from tons of ore a few tenths of a gram of radium concentrated preparation, three years later, she had a 0.4 g of pure radium chloride, and only in 1910, 12 years after the start of work, fulfilled her dream: she finally saw a silvery-white metal drop of pure radium weighing 0.0085 g. But this drop is radiated at 3 million times stronger than the same drop of uranium.

VI. DEATH

Body of Maria Sklodowska-Curie, enclosed in a lead coffin, still emits radioactivity with intensity 360 Becquerel/m^3 at a rate of about 13 Becquerel/m^3. Scientific achievement of Pierre and Marie Curie was recognized all over the world have in their lifetime. In 1903, they together with Henri Becquerel received the Nobel Prize in physics. In 1911, after the death of Pierre Curie, the Swedish Academy of Sciences awarded Marie Curie's second Nobel Prize (in chemistry). Maria took the professorship in Paris and became the first woman - a professor. She was the first recipient of two Nobel Prizes. In honor of the Curies named artificially produced chemical element with atomic number 96 - curium Cm.

VII. CONCLUSION

The greatest discovery of the 20th century, once and forever changed the lives of all humanity. We received almost inexhaustible supply of energy that can replace oil, coal and gas. Disposal of nuclear waste is a major problem for today. It is the only natural barrier that stops us from the full transition to nuclear energy. The greatest strength is hidden from our eyes in the depths of the atoms of radioactive elements. It is only necessary to use it correctly.

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FLUORIDE SYSTEMS FOR MOLTEN SALT REACTOR

M.D. Parfenova

Scientific Advisor: V.I. Lutsyk, PhD, Full Prof.

Language Teacher: L.E. Bazanova, PhD.

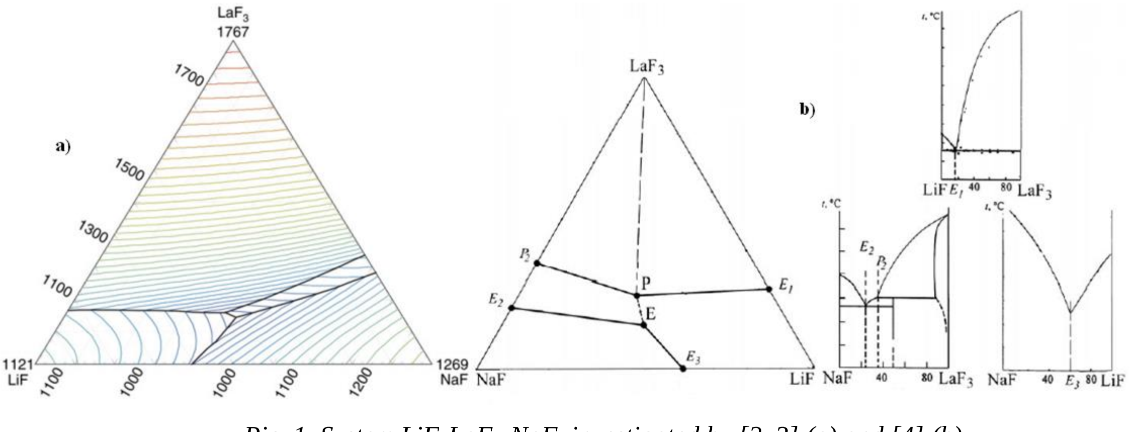
East-Siberian State Academy of Culture and Arts (ESSACA), Russia, Ulan-Ude, Tereshkova str., 1, 670047

E-mail: vilutsyk@pochta.ru

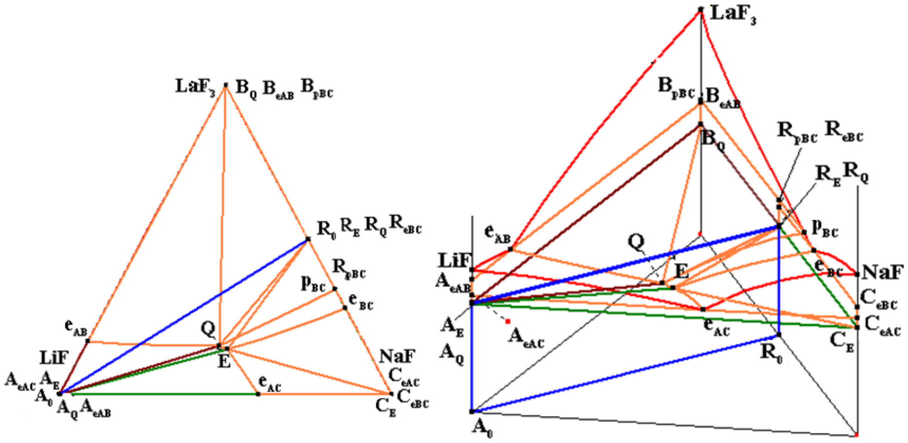
Abstract

The paper includes description of T-x-y diagram computer models for systems LiF-LaF_3-MF (M=Na, K) as the prototypes for molten salt reactor fuel.

1. **Introduction.** With regard to large amount of plutonium stockpile as resultant product from long period nuclear reactor's operation, with high-level nuclear waste as byproduct, the problem of Molten Salt Reactor (MSR) has been surely significant burden to be resolved to every country concerned [1]. The fissile material (^{233}U, ^{235}U and ^{239}Pu) will be dissolved in the molten fluoride matrix circulating in the primary circuit from the reactor core to the heat exchanger and back. Since the salt mixture is in liquid form, it can be extracted, and cleaned from the fission products in chemical reprocessing plant. For better solubility of these compounds the fluorides of alkali metals are foreseen to be a good candidate. Some ternary and quaternary systems have been investigated with this purpose [2-4]. As experimental data and the results of thermodynamic calculations do not guarantee the correctness of phase diagrams and their sections, their computer models are to be elaborated. As the first objectives of this aim the *T-x-y* diagrams for ternaries LiF-LaF_3-MF should be assembled and analyzed.



Pic. 1. System LiF-LaF_3-NaF, investigated by [2, 3] (a) and [4] (b)



Pic. 2. 3D computer model of LiF-LaF$_3$-NaF T-x-y diagram.

2. **T-x-y Diagrams assemblage**. Two types of original software [5, 6] were used for the phase diagrams assemblage from the surfaces and from the phase regions, with the different methods to approximate the surfaces. In the simplest case a contour of a surface is like the broken lines. The second approximation is based on the kinematical method. The form of binary curves (i.e. curve convex downwards or upwards) are taken into consideration in the process of the liquidus, solidus and solvus surfaces simulation.

When 3D model of phase diagram is assembled from the surfaces, only its vertical and horizontal sections may be analyzed. But when the same model was constructed from the phase regions, the new opportunities appear to produce the specific diagrams with the mass balances.

2.1. ***LiF-LaF$_3$-NaF System***. Besides the liquidus surfaces of the initial components, the 4th surface of the incongruently melting binary compound NaLaF$_4$ appears (Pic. 1, 2). After the thermodynamic calculation [2], the experimental investigation was fulfilled [4]. Computer model (Pic. 2) helped to correct the experimental isopleths and to analyze the microstructure formation in the process of the melt solidification.

2.2. ***LiF-LaF$_3$-KF System***. *T-x-y* diagram (Pic. 3) is sophisticated by the decomposed binary compound, which appears within the ternary liquidus as an inner field. Data for binary systems LiF-KF, LiF-LaF$_3$, KF-LaF$_3$, concerning the melt temperatures of initial components, points coordinates of binary eutectics e_{LiF-KF}, $e_{KF-LaF3}$, $e_{LiF-LaF3}$, peritectic $p_{KF-LaF3}$ and compounds R_1≡KF·LaF$_3$ and R_2≡3KF·LaF$_3$ are used as initial data at *T-x-y* diagram assemblage. The coordinates of ternary eutectic *E*, peritectic *P* and two quasi-peritectics Q_1, Q_2 also were given as initial data. As a result, the *T-x-y* diagram consists of 27 surfaces (Table 1) and 18 phase regions (Table 2).

Table 1. Surfaces of LiF-KF-LaF$_3$ T-x-y diagram

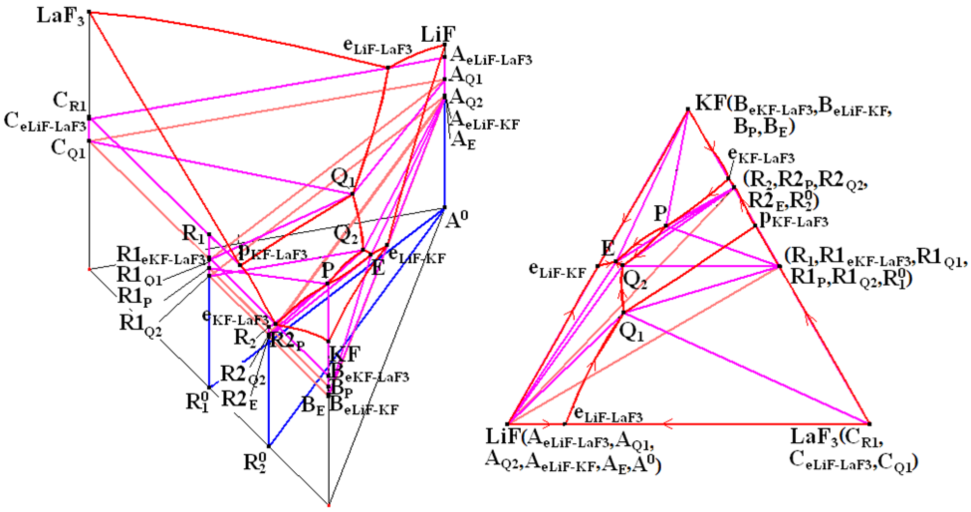
Symbol	Contour	Symbol	Contour	Symbol	Contour
q_{LiF}	$LiFe_{LiF-KF}EQ_2Q_1e_{LiF-LaF3}$	q^r_{CR1}	$p_{KF-LaF3}Q_1C_{Q1}C_{R1}$	q^r_{R2R1}	$PQ_2R2_{Q2}R2_P$
q_{KF}	$KFe_{LiF-KF}EPe_{KF-LaF3}$	q^r_{R1C}	$p_{KF-LaF3}Q_1R1_{Q1}R1$	q^r_{BR2}	PEB_EB_P
q_{LaF3}	$LaF_3e_{LiF-LaF3}Q_1p_{KF-LaF3}$	q^r_{R1B}	$e_{KF-LaF3}PR1_PR1_{eKF-LaF3}$	q^r_{R2B}	$PER2_ER2_P$
$q_{KF-LaF3}$	$e_{KF-LaF3}PQ_2Q_1p_{KF-LaF3}$	q^r_{BR1}	$e_{KF-LaF3}PB_PB_{eKF-LaF3}$	complex h_E	$A_EB_ER2_E(E)$

q_R	EPQ_2	q^r_{AR1}	$Q_1Q_2A_{Q2}A_{Q1}$	complex h_P	$B_PR2_PR1_PP$
q^r_{AC}	$e_{LiF-LaF3}Q_1A_{Q1}A_{eLiF-LaF3}$	q^r_{R1A}	$Q_1Q_2R1_{Q2}R1_{Q1}$	complex h_{Q1}	$A_{Q1}C_{Q1}R1_{Q1}Q_1$
q^r_{CA}	$e_{LiF-LaF3}Q_1C_{Q1}C_{eLiF-LaF3}$	q^r_{R2A}	$EQ_2R2_{Q2}R2_E$	complex h_{Q2}	$A_{Q2}R1_{Q2}R2_{Q2}Q_2$
q^r_{AB}	$e_{LiF-KF}EA_EA_{eLiF-KF}$	q^r_{AR2}	$EQ_2A_{Q2}A_E$	v_{R1}	$A_{Q1}A^0R1^0R1_{Q1}$
q^r_{BA}	$e_{LiF-KF}EB_EB_{eLiF-KF}$	q^r_{R1R2}	$PQ_2R1_{Q2}R1_P$	v_{R2}	$A_{Q2}A^0R2^0R2_{Q2}$

Table 2. Phase regions of LiF-KF-LaF$_3$ T-x-y diagram.

Symbol	Boundary surfaces	Symbol	Boundary surfaces	Symbol	Boundary surfaces
L+A	q_{LiF}, q^r_{AB}, q^r_{AC}, q^r_{AR1}, q^r_{AR2}	A+R2	v_{R2}	L+B+R2	q^r_{BR2}, q^r_{R2B}, h_E, h_P
L+B	q_{KF}, q^r_{BA}, q^r_{BR1}, q^r_{BR2}	L+A+B	q^r_{AB}, q^r_{BA}, h_E	L+C+R1	q^r_{CR1}, q^r_{R1C}, h_{Q1}
L+C	q_{LaF3}, q^r_{CA}, q^r_{CR1}	L+A+C	q^r_{AC}, q^r_{CA}, h_{Q1}	L+R1+R2	q^r_{R1R2}, q^r_{R2R1}, h_P, h_{Q2}
L+R1	$q_{KF-LaF3}$, q^r_{R1R2}, q^r_{R1A}, q^r_{R1B}, q^r_{R1C}	L+A+R2	q^r_{R2A}, q^r_{AR2}, h_{Q2}, v_{R2}	A+B+R2	h_E, V_{R2}
L+R2	q_R, q^r_{R2R1}, q^r_{R2A}, q^r_{R2B}	L+A+R1	q^r_{AR1}, q^r_{R1A}, h_{Q1}, h_{Q2}, v_{R1}	A+C+R1	h_{Q1}, V_{R1}
A+R1	v_{R1}	L+B+R1	q^r_{R1B}, q^r_{BR1}, h_P	A+R1+R2	h_{Q2}, V_{R1}, V_{R2}

3. **Research outcomes**. The arbitrary vertical and horizontal sections can be made for the obtained computer models of LiF-NaF-LaF$_3$ and LiF-KF-LaF$_3$ systems. Moreover, thanks to additional functions the software helps to decode the section of any surface, showing it position on the surfaces' contour. Vertical mass balances show a history of melt crystallization. They are used to decipher the heredity of the multicomponent heterogeneous material.



Pic. 3. 3D model of LiF-KF-LaF$_3$ T-x-y diagram.

4. **Conclusion**. Besides the real fluoride systems investigation, new geometrical models should be elaborated for the hypothetical ternary and quaternary phase diagrams [7]. New software is to be worked out with the possibility to simulate a surface of minimal area for the known information on its contour. New opportunities are to be added to decode the section of the phase regions. Rapid prototyping of the phase regions by the 3D printer will be very useful to understand the structure of phase diagram. Computer models

of multidimensional phase diagrams of the multicomponent salt systems will speed up the elaboration of the Molten Salt Reactor. Such idealistic new power generation system begins to draw attention from various countries in the world, in view of the nuclear proliferation and terrorism resistance, and safe and stable supply of low cost clean energy which the world significantly demands [1].

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APPLICATION OF NUCLEAR MAGNETIC RESONANCE IN MEDICINE

K.A. Pazukhina

Linguistic advisor: Senior teacher N.V. Demjanenko

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: lovely90@sibmail.com

Abstract

This report was written about Application of nuclear magnetic resonance in medicine. Nuclear magnetic resonance is the resonant absorption or emission of electromagnetic energy by matter. The report identified the main points: after the discovery of NMR in condensed media, it became clear that NMR will be the basis of a powerful method for investigating the structure of matter and its properties. The report allows the reader to know how important knowledge in the field of nuclear physics. It will be interesting to read a novice engineer who wants to connect his profession in this area.

Nuclear magnetic resonance (NMR) - the resonant absorption or emission of electromagnetic energy of the substance contained a nucleus with nonzero spin in an external magnetic field at a frequency ν, due to the reorientation of the magnetic moments of nuclei. The phenomenon of nuclear magnetic resonance was discovered in 1938 by Isaac Rabi in molecular beams, for which he was awarded the Nobel Prize in 1944. In 1946, Felix Bloch and Edward Mills Purcell received nuclear magnetic resonance in liquids and solids (Nobel Prize 1952).The same nucleus of atoms in different environments in the molecule show different NMR signals. The difference between this NMR signal from the signal of standard material to determine the so-called chemical shift, which is due to the chemical structure of the investigated substance. In NMR techniques have many opportunities to determine the chemical structure of substances, confirmation of the molecules, the effects of mutual influence, the intermolecular transformation.

Nuclear magnetic resonance introscopy

The phenomenon of nuclear magnetic resonance can be used not only in physics and chemistry, but also in medicine: the human body - a collection of the same organic and inorganic molecules. To observe this phenomenon, the object is placed in a constant magnetic field and exposed to radiofrequency and gradient magnetic fields. In the coil surrounding the object under study, there is a variable electromotive force, the amplitude-frequency spectrum of a transient and time characteristics carry information about the spatial density of resonant nuclei, as well as other parameters that are specific only for the nuclear magnetic resonance. Computer processing of this information forms a three-dimensional image, which characterizes the density of chemically equivalent nuclei, the relaxation times of nuclear magnetic resonance, the velocity distribution of fluid flow, diffusion of molecules and biochemical processes of metabolism in living tissues.Nuclear magnetic resonance introscopy, Nuclear magnetic resonance tomography, a world first invented in 1960 by V.A Ivanov. The application for the invention of an incompetent judge dismissed "... in view of the apparent futility of the proposed solutions", so it's certificate was issued only after more than 10 years. Thus, officially recognized as the author of MRI is not a group of Nobel Prize winners listed below, and a Russian scientist. Despite this legal fact, the Nobel Prize was awarded for a Nuclear-resonant tomography not V.A Ivanov.

NMR diagnosis in medicine

Work to develop a method of nuclear magnetic resonance in medicine developed on the basis of three methodological approaches: Changes relaxation time MRI and NMR spectroscopy of localized areas of the organism.Of particular importance for medicine is virtually harmless to the body MRI. This allows the study as often as necessary, until the continuous monitoring by the agency of vessels, joints, etc.Important opportunity of MRI and local NMR spectroscopy in obstetrics and gynecology: a combination of high spatial resolution, the physical "color" images and no harm has already been possible to obtain unique first experimentation in information data.

The global market of medical equipment for imaging, in 2002, was calculated 15 billion U.S. dollars. Despite the fact that since the discovery of X-rays has been more than 100 years, nearly half of this huge amount (46.5%) are in X-ray equipment.One of the revolutionary developments in the field related to the creation of fundamentally new technology for imaging - Magnetic resonance imaging (MRI). Fundamental discoveries of the seventies of the last century, which served as its foundation, in 2003, awarded the Nobel Prize in Physiology or Medicine. The essence of the effect of nuclear magnetic resonance is that the application of radio-frequency pulses to the object placed in a constant magnetic field of electromagnetic energy is absorbed and then releases it as response pulses, which can be recorded and analyzed.As we know, people in two-thirds of the water, the content of which in different tissues of the body is different. When placing the person in a strong constant magnetic field of the nucleus of the hydrogen atoms that make up water molecules are oriented in a particular direction, like microscopic compass arrows. Under the influence of radio wave pulse energy of the nuclei changes, and after the termination of the resonant wave radiation due to the nuclei of hydrogen atoms return to their original state. First medical Magnetic resonance imaging began in the early 80-ies of the last century. Currently there are more than 20,000 such devices. They help produce about 60 million in research annually.

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RADIATION THERAPY

I.V. Rasputin

Linguistic advisor: O.I. Shaikina

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: rasputin.ilia@yandex.ru

In our time, found a lot of different diseases, which are used to treat a variety of methods. These can be any folk remedies, but still, the most effective is modern medicine. Consider one such method is radiation therapy.

Radiation therapy, radiation oncology, or radiotherapy sometimes abbreviated to XRT or DXT, is the medical use of ionizing radiation, generally as part of cancer treatment to control or kill malignant cells. Radiation therapy may be curative in a number of types of cancer if they are localized to one area of the body. It may also be used as part of curative therapy, to prevent tumor recurrence after surgery to remove a primary malignant tumor.

Radiation therapy is commonly applied to the cancerous tumor because of its ability to control cell growth. Ionizing radiation works by damaging the DNA of exposed tissue leading to cellular death. To spare normal tissues (such as skin or organs which radiation must pass through to treat the tumor), shaped radiation beams are aimed from several angles of exposure to intersect at the tumor, providing a much larger absorbed dose there than in the surrounding, healthy tissue.

Radiation oncology is the medical specialty concerned with prescribing radiation, and is distinct from radiology, the use of radiation in medical imaging and diagnosis. Radiation may be prescribed by a radiation oncologist with intent to cure ("curative") or for adjuvant therapy. It may also be used as palliative treatment (where cure is not possible and the aim is for local disease control or symptomatic relief) or as therapeutic treatment (where the therapy has survival benefit and it can be curative). It is also common to combine radiation therapy with surgery, chemotherapy, hormone therapy, immunotherapy or some mixture of the four. Most common cancer types can be treated with radiation therapy in some way. The precise treatment intent (curative, adjuvant, neoadjuvant, therapeutic, or palliative) will depend on the tumor type, location, and stage, as well as the general health of the patient. Total body irradiation (TBI) is a radiation therapy technique used to prepare the body to receive a bone marrow transplant. Brachytherapy, in which a radiation source is placed inside or next to the area requiring treatment, is another form of radiation therapy that minimizes exposure to healthy tissue during procedures to treat cancers of the breast, prostate and other organs.

Mechanism of action

Radiation therapy works by damaging the DNA of cancerous cells. This DNA damage is caused by one of two types of energy, photon or charged particle. This damage is either direct or indirect ionization of the atoms which make up the DNA chain. Indirect ionization happens as a result of the ionization of water, forming free radicals, notably hydroxyl radicals, which then damage the DNA.

In photon therapy, most of the radiation effect is through free radicals. Because cells have mechanisms for repairing single-strand DNA damage, double-stranded DNA breaks prove to be the most significant technique to cause cell death. Cancer cells are generally less differentiated and more stem cell-like; they reproduce more than most healthy differentiated cells, and have a diminished ability to repair sub-lethal damage. Single-strand DNA damage is then passed on through cell division; damage to the cancer cells' DNA accumulates, causing them to die or reproduce more slowly.

One of the major limitations of photon radiation therapy is that the cells of solid tumors become deficient in oxygen. Solid tumors can outgrow their blood supply, causing a low-oxygen state known as hypoxia. Oxygen is a potent radiosensitizer, increasing the effectiveness of a given dose of radiation by forming DNA-damaging free radicals. Tumor cells in a hypoxic environment may be as much as 2 to 3 times more resistant to radiation damage than those in a normal oxygen environment.

Charged particles such as proton, boron, carbon, and neon ions can cause direct damage to cancer cell DNA through high-LET (linear energy transfer) and have an antitumor effect independent of tumor oxygen supply because these particles act mostly via direct energy transfer usually causing double-stranded DNA breaks. Due to their relatively large mass, protons and other charged particles have little lateral side scatter in the tissue the beam does not broaden much, stays focused on the tumor shape, and delivers small dose side-effects to surrounding tissue. They also more precisely target the tumor using the Bragg peak effect. This procedure reduces damage to healthy tissue between the charged particle radiation source and the tumor and sets a finite range for tissue damage after the tumor has been reached. In contrast, IMRT's use of uncharged particles causes its energy to damage healthy cells when it exits the body. This exiting damage is not therapeutic, can increase treatment side effects, and increases the probability of secondary cancer induction. This difference is very important in cases where the close proximity of other organs makes any stray ionization very damaging (example: head and neck cancers).

In conclusion we would say that when it comes to health, you should not think that the post-treatment may be even worse. But we need to trust modern medicine and experienced doctors who have treated.

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MODELING EMERGENCY SHUTDOWN OF THE MAIN PUMP OF WWER-1000 WITH THE SIMULATOR "W1000ST-TPU-MAN-TR-1"

V.V. Revkov, A.A. Shmatok, D.S. Dobrov
Scientific advisor: Ph.D., As. Professor Y.B. Chertkov
Linguistic advisor: Teacher Y.V. Ermakova
Tomsk Polytechnic University, Russia, Tomsk, 30, Lenin str., 634050
E-mail: tarazik@sibmail.com

The article is devoted to the acquaintance with the past research work in the field of the decision of various theoretical typical problems by means of a reactor training simulator WWER-1000.

The various solutions of the problems of the reactor installation's operator are probably at deep understanding of a principle of operating, design features of reactor types, and also knowledge of the basic physical processes which are necessary at operation.

During of work with a training simulator it was necessary to study the scheme of the first contour of a reactor WWER-1000, and also operation principles of includes equipment.

The research work consists of the three parts. The first part includes interface development of the training simulator. The second part includes the development of interrelation of the basic knots of the first contour. The third part includes working off of various scenarios of the reactor operation.

During the present research work the reactor training simulator WWER-1000 has been mastered, as well as skills of working reactor operator during operation time.

In conclusion it is necessary to note the importance of the performed work for knowledge of the future engineering personnel of the atomic power station as by means of the given software the mastered knowledge is applied in practice.

Article

Great software for simulation the different situations of exploitation of nuclear reactors is becoming more relevant in the modern world.

To implement the research was analyzed the processes taking place in the nuclear reactor WWER-1000 in case of emergency, particularly disconnection of the main circulation pump of the second loop of the primary circuit. To model this emergency the simulator«W1000ST-TPU-MAN-TR-1» was used. This simulator is a simulator of remote control reactor. It also covers a wide range of simulations of various situations, search for solutions, and control, visual examination of the physical processes on the relevant graphs, charts and tables.scheme of the first circuit of WWER-1000 is represented in *Fig. 1*.

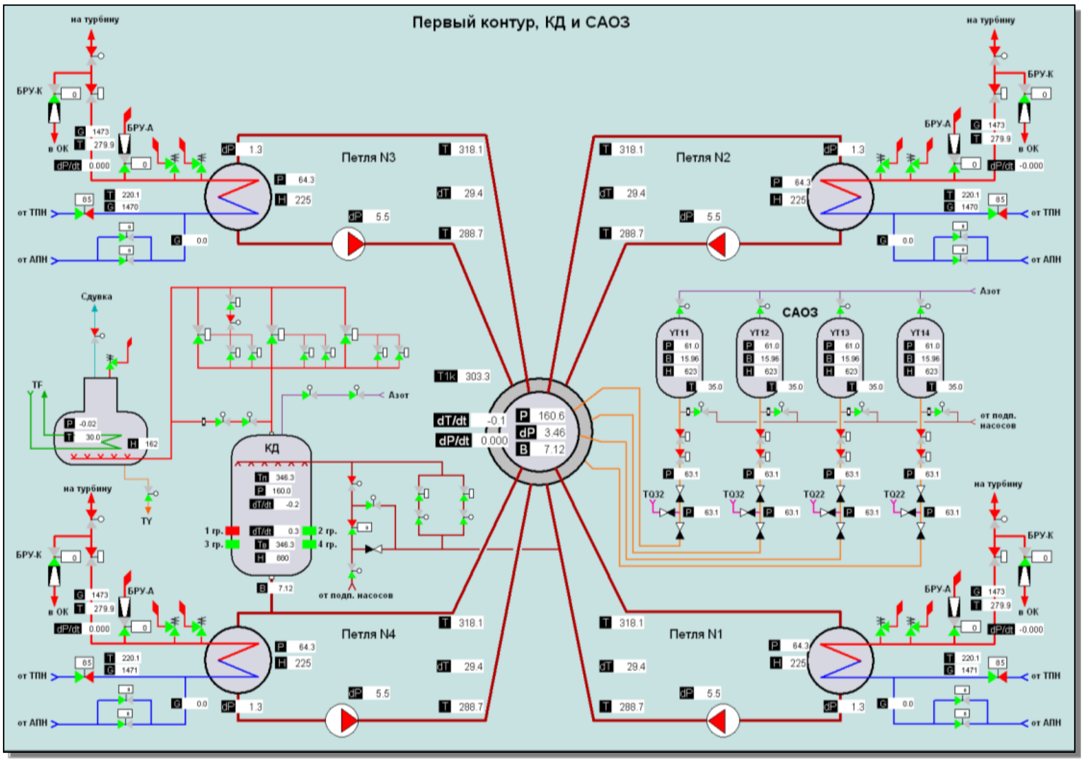

Fig. 1. The scheme of the first circuit of WWER-1000.

Circulation pump is equipment, pumping cooled water from the steam generator to the reactor, and is one of the major components of the primary circuit.In a sudden disconnection of the circulation pump operation of emergency protection takes place, it reduces the nominal power of the reactor and redistributes the remaining load to the rest of the working pumps. This situation was modeled in the experimental work.

In disconnection of one of the four working circulation pumps there was a reduction of coolant, so for borrowing the temperature characteristics of the core in the operating limits the following steps were taken. The reactor power was decreased. This situation is realized through immersion absorber rods (made of boron carbide). This in turn led to the nonuniformity of distribution of heat flux in terms of the core. Design of modern WWER-1000 allows to continue the operation of a nuclear installation in disconnection one of the four working circulation pumps at the level 67% of rated power. This process was implemented.

In disconnection of one circulation pump the operator receives all the data about the processes occurring in the core: changes in the relative power and water heating tapes in cassettes. These data are presented in tables and graphs of the analytic dependence in real time. The primary signaling device simulator is display «Emergency and warning system», represented in *Fig. 2.*

Fig. 2. Display «Emergency and warning system» of WWER-1000.

In the course of work was determined the mode of switching automation and principles of its operation, by which the regulation of the basic parameters of the primary circuit takes place.

Power control is the work of the «control power limitation» and «automatic power regulator». Change of power in turn triggers a change of control turbine pressure regulator of the primary circuit, and level control of pressure compensator and steam generator.

Work of the control power limitation» is according to the following principle: the value of the current installed capacity and the permitted capacity are compared. If the difference is 2%, the system generates a signal which is sent to the control unit of the control rod.

Conclusion

In the course of this work was simulated the situation of disconnection of one of the four working circulation pumps, investigated the processes occurring in the reactor and produced a power level control. Due to the automatic reduction in reactor power, steam flows to the turbine and feeds water in steam, steam turbine controls eliminate the imbalance of consumption by main highway turbine plant, connected with nonsynchronous decreasing steam flow and feed water. It was concluded that the operator should monitor the level of the deaerator and operation of automatically controlled condensate valve from the deaerator to drain. If necessary, drain valve can be additionally opened on the pressure of the condensate pumps.

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USING OF FOOD IRRADIATION IN OUR LIFE

Y.V. Rumyantseva

Linguistic advisor: Senior teacher N.V. Demjanenko

Tomsk Polytechnic University, Russia, Tomsk, 30, Lenin str., 634050

Abstract

In this memoir include important topics about food irradiation such as:<< are irradiated foods safe?>>, <<what foods are irradiated?>>,<< how will I know if meat and poultry products are irradiated?>>,<< how is food irradiated?>>,<< what are the sources of radiation used?>>.

Each topic contains information, which essential to understand technology food irradiation. For example, if we know what food became after irradiation we can decide how we this food will be influence on our organism.

Also we can know that rules is set by the Food and Drug Administration which necessary comply to irradiate food.

The memoir mentions different ways of food irradiation and also description of ionizing radiation sources.

This article destination for intensification our knowledge in field of nuclear physics.

Introduction

Food irradiation is a technology for controlling spoilage and eliminating food-borne pathogens, such as salmonella. The result is similar to conventional pasteurization and is often called "cold pasteurization" or "irradiation pasteurization." Like pasteurization, irradiation kills bacteria and other pathogens, that could otherwise result in spoilage or food poisoning. The fundamental difference between the two methods is the source of the energy they rely on to destroy the microbes. While conventional pasteurization relies on heat, irradiation relies on the energy of ionizing radiation. The FDA emphasizes that no preservation method is a substitute for safe food handling procedures.

Are irradiated foods safe?

Yes, irradiated foods are safe. Irradiation makes meat and poultry safer by reducing the numbers of harmful bacteria and parasites.

Food irradiation does not make foods radioactive. The radiant energy passes through the food. The food itself never contacts the source of the radiant energy. Irradiated foods are wholesome and nutritious. Nutrient losses caused by irradiation are less than or about the same as losses caused by cooking and freezing.

Public health agencies worldwide have evaluated the safety of food irradiation over the last fifty years and found it to be safe. In 37 countries more than 40 food products are irradiated. In some European countries, irradiation has been in use for decades.

In the United Stated, the Food and Drug Administration regulates food irradiation. In addition, food irradiation has received official endorsement from the American Medical Association, the World Health

Organization, and the International Atomic Energy Agency.

What foods are irradiated?

The FDA first approved the use of irradiation in 1963 to kill pests in wheat and flour. To date, the FDA and the USDA have approved food irradiation for use on fruits, vegetables, spices, raw poultry, and red meats.

How will i know if meat and poultry products are irradiated?

Consumers cannot recognize irradiated food by sight, smell, taste, or feel. Irradiated foods can be recognized by the presence of the international symbol for irradiation on the packaging along with the words "Treated with Radiation," or "Treated by Irradiation."

If irradiated meat is used in another product, such as pork sausage, then the ingredients statement must list irradiated pork, but the radura does not have to appear on the package.

Restaurants are not required to disclose the use of irradiated products to their customers; however, some restaurant svoluntarily provides irradiation information on menus.

How is food irradiated?

Bulk or packaged food passes through a radiation chamber on a conveyor belt. The food does not come into contact with radioactive materials, but instead passes through a radiation beam, like a large flash light. The type of food and the specific purpose of the irradiation determine the amount of radiation, or dose, necessary to process a particular product. The speed of the belt helps control the radiation dose delivered to the food by controlling the exposure time. The actual dose is measured by dosimeters within the food containers.

Cobalt-60 is the most commonly used radionuclide for food irradiation. However, there are also large cesium-137 irradiators and the Army has also used spent fuel rods for irradiation.

What are the sources of radiation used?

The food irradiation process uses three types of ionizing radiation sources:

- cobalt-60 gamma sources
- electron beam generators
- x-ray accelerators

Cobalt 60 Gamma Sources

Cobalt-60 emits ionizing radiation in the form of intense gamma rays. Gamma facilities" store it in stainless steel capsules (like "pencils" of cobalt), in underwater tanks. Cobalt-60 has several advantages :

- up to 95% of its emitted energy is available for use
- penetrates deeply
- yields substantial uniformity of the dose in the food product
- decays to non-radioactive nickel
- considered to pose low risk to the environment.

However, its 5.3-year half-life offers disadvantages:

- cobalt-60 "pencils" require frequent replenishment

- treatment of the food is relatively slow.

Cesium-137 is a gamma source that is also used for irradiation. Cesium-137 has a less penetrating gamma beam and a longer half-life, making it more suitable under certain circumstances.

Electron Beam Generators

Electron beam facilities generate e-beams with an electron beam linear accelerator. (It works on the same principle as a television tube.) The electrons are concentrated and accelerated to 99% of the speed of light and energies of up to 10 MeV.

Because e-beams are generated electrically, they offer certain advantages:

- they can be turned on only as needed
- they do not require replenishment of the source as does cobalt-60
- there is no radioactive waste

E-beam technology also has disadvantages:

- shallow depth of penetration
- e-beams must be converted to x-rays to penetrate large items such as carcasses
- high electric power consumption
- complexity, and potentially high maintenanc

X-ray accelerators

X-ray facilities use an electron beam accelerator to target electrons on a metal plate. Although some energy is absorbed, the rest is converted to X-rays. Like gamma rays, X-rays are penetrating, and can be used on food boxes 15 inches thick or more. This allows food to be processed in a shipping container-rays offer the advantage of high penetration, but share the other e-beam technology disadvantages.

Results

The FDA would have us believe that irradiation is perfectly safe. Yet research has revealed a wide range of problems in animals that ate irradiated food, including premature death, a rare form of cancer, reproductive dysfunction, chromosomal abnormalities, liver damage, and low weight gain and vitamin deficiencies.

Conclusion

As for food irradiation, it is very modern process, which allows saving product the long time. Also treating food with ionizing radiation can kill bacteria and parasites that would otherwise cause food borne disease; the food irradiation facilities themselves do not become radioactive, and do not create radioactive waste. And this process has different advantages, which we saw in the development.

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2. Unite States Department of Agriculture, Food Safety and Inspection Service http://www.fsis.usda.gov/home/index.asp
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Bespalov V.I. Interaction ionizing radiation with matter: Tutorial (Tomsk Polytechnic University

DEVELOPMENT OF TRAINING AUTOMATED ACCOUNTING AND CONTROL SYSTEM OF NUCLEAR MATERIALS

J.V. Sapunova, S.O. Korneychuk
Scientific advisor: Senior teacher A.V. Godovykh
Language advisor: Assistant J.V. Nedbaylo
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: nejulia_90@mail.ru

Annotation

This paper presents the design principles of development a training laboratory, which will provide trainings of student of specialty "Security and Non-proliferation of Nuclear Materials" with introduction the basic concepts of relational databases, programming tool through creation of computerized System of Accounting and Control of Nuclear Materials.

The Informational Technology holds an important place in the Accounting and Control of Nuclear Materials. Nuclear material data, which to be collected, processed, stored and used in accounting and control procedure, requires use of modern computer technology.

During education students of specialty "Security and Non-proliferation of Nuclear Materials" attend different courses that provide information on main issues in structure and ensure proper operation of Accounting and Control System of Nuclear Materials. In present time the main difficulty in the educational process is lack of possibility of providing internship of student for studying specificity problems, solved of Accounting and Control System of Nuclear Materials. Therefore there is a need for laboratory basis for practical studying of functioning elements of Accounting and Control System of Nuclear Materials and computerized systems of accounting and control of nuclear materials.

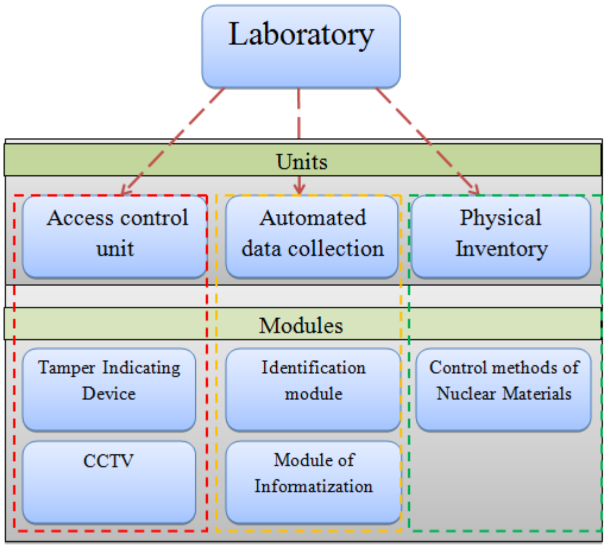
The main objective of the project is defining the basic principles of organization and structure of laboratories for studying of students and providing training courses and refreshment courses for nuclear facility staff in the field of Accounting and Control of Nuclear Materials.

This objective is achieved through design and development laboratories for Accounting and Control of Nuclear Materials and includes implementation following task. First of all, it is necessary to find a location for laboratory and modernize it. Secondly, computer hardware workstation should be developed. The next task is development of training hardware that includes selection of equipment, its installation, and configuration. Finally, it is necessary to make workbook or lab description for training courses.

Picture 1 shows the structure of the laboratory.

Development of a laboratory based on modular approach. It gives opportunity for practical study of all parts of Accounting and Control System, organization and functioning of Accounting and Control Systems (such as Accounting and Control System of Nuclear Materials, and the automated Accounting and Control System of Nuclear Materials).

Also modular approach of components and systems with the placement of devices on the workstation provides the consistent study of individual devices hardware systems under study. Based on obtained knowledge students can organize Accounting and Control System of Nuclear Materials of nuclear facility, provide control of related systems such as Physical Protection System.



Picture 1 - The structure of laboratory.

In addition, the laboratory is supposed to use of modern information technology, software, hardware for management and organization of Accounting and Control Systems, recording and displaying the obtained data.

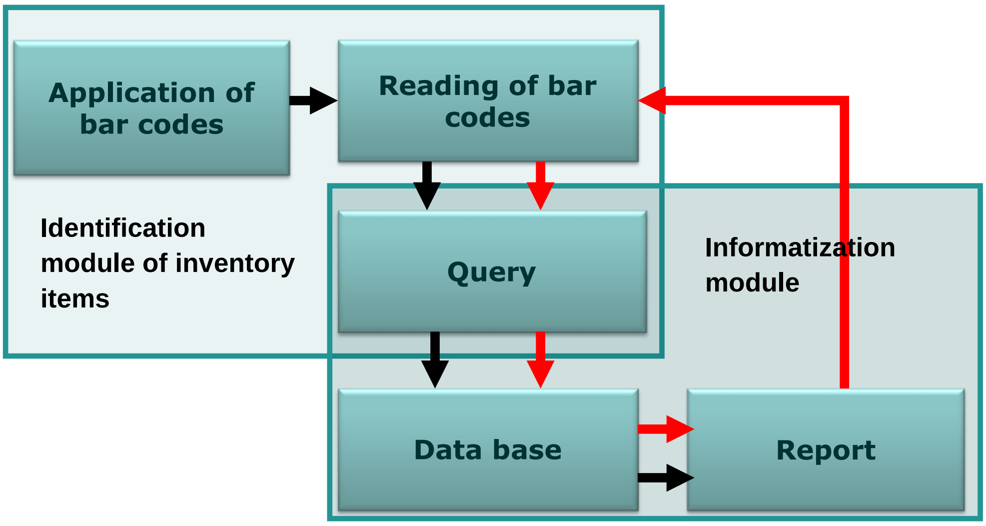
Study of the physical principles of automated Accounting and Control System of Nuclear Materials operation will be conducted by selecting specific technical devices in the making and modeling of Accounting and Control System.

The following questions will be studied during training laboratory:

- ➢ regulatory requirements for Accounting and Control Systems of Nuclear Materials and computerized Accounting and Control Systems of Nuclear Materials;
- ➢ development of the automated data collection of Accounting and Control Systems of Nuclear Materials;
- ➢ providing of information security;
- ➢ design and creation of relational databases for Accounting and Control of Nuclear Materials.

The first stage of training laboratory development was making of automated data collection system. It includes two modules, the Identification module [1] and the Informatization module [2]. The training database was worked out for this project. All information about the accounting items, their location, weight of item, material type, isotopic composition and the enrichment is entered into this date base with a bar coding[3]. The automated data collection provides the reliable object identification, the automatic reading and the input of the requirement data at the computer system on a real-time scale.

Picture 2 shows interaction of modules.



Picture 2 - Interaction of modules

This system has following advantages in comparison with hand input [4]:

- accuracy;
- timeliness;
- effectiveness;
- reliability;
- high error-rate performance;
- low probability of errors

Reporting and accounting data about nuclear materials keeps in the database of the material balance area. To accomplish the state control for nuclear materials, this information must be transferred in the superior controlling authorities on the enforced paths.

The following stage was to make the control access module [5]. The workstation was developed for "Tamper indication devices" (TID) module, showing such applied tamper indication devices, as the secure seals/stamps and also its installation methods, pull-off methods, continuity test, and the organizational management elements with TID.

TID is one of the components of the integrated nuclear materials safeguards and security system. This system is based on the strategy of "multiple layer protection". During many centuries the secure seals were used to confirm the wholeness of facilities and containers. At the nuclear industry the tamper-evident seals are using for the same purposes. Undamaged TID with the surveillance program enable responsible executives to be ensured in wholeness of the accounting item of nuclear materials with the confirmatory measurements.

The development of training course was being performed alongside the designing of these modules. The laboratory course includes two main directions, such as bar coding and databases that is used in computerized nuclear materials control and accounting system[6].

Thus, there are following results of the research work at the present time:

Two workstations have been developed: "Automated data collection at the nuclear materials control and accounting system” and “Tamper indication devices”.

Training system for automated data collection was made. This system gives the opportunity to demonstrate the functional operation of computerized control and accounting system on the hypothetical factory.

A few labs were created. They includes bar coding and the development of computerized nuclear materials control and accounting system.

The next stage of this research work is going to develop such module as “Physical inventory”, namely, to study the physical inventory procedures/methods, the nuclear materials control techniques, making a new workstations, and development of labs and workbooks

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SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS AS THE WAY OF SOLID RADIOACTIVE WASTE IMMOBILIZATION

S.N. Savanyuk., S.N. Savanyuk
Scientific advisor: Assistant A.O. Semenov
Linguistic advisor: Teacher Y.V. Ermakova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: savanuk@tpu.ru

Solid radioactive waste is one of the form of radioactive wastes that is directly subjected for storage and disposal after it is extracted from the reactor core. Problems that arise during solid waste management play crucial role in forming the future of nuclear energetics [1]. General purpose of the safe disposal of solid radioactive waste is to develop specific methods for its isolation from biocycle that will eliminate the negative environmental impacts on human health. Ultimately, the goal of the last stages of nuclear technology has always been reliable isolation of radioactive waste for the entire period of its radiotoxicity.

Nowadays, some sophisticated technologies of immobilization of radioactive waste are being developed, while research and amendment procedures of its safe disposal are carried out. The main criteria in the selection of wich method of disposal can be used for general use are implementation expenses minimization and secondary waste generation reduction. Universally recognized (including IAEA) solution for the final disposal of radioactive waste is its burial in the graves at a depth of not less than 300-500 in deep geological formations with a principle of multi-barrier protection and mandatory conversion of liquid radioactive wastes to a hardened state. Experience of underground nuclear testing has proved that for a certain choice of the geological structures there is no leakage of radionuclides from the underground space into the environment. Such method of radioactive waste management has made a strong demand for high perfomance moulds – matrices for a solid radioactive waste storage with a specificly defined properties [2]. Requirements to be met by the matrix material to bind fission radionuclides and small actinides can be summarized as follows:

- Ability to bind and retain in a solid state the greatest possible number of radionuclides and their decay products in the long-term (by geological standards) period of time.
- Stability in relation to the processes of physical and chemical weathering.
- Thermal stability at high levels of radionuclides containment.
- Availability of a set of physical and mechanical properties needed for the processes of transportation, disposal, etc.
- Mechanical strength.
- High thermal conductivity.
- Low coefficient of thermal expansion.
- Resistance to damage dut to radiation exposure.
- Simple production layout.

Feedstock and low-cost production.

Modern matrix materials are qlassified according to its phase state to vitreous (glassy) and crystalline. Glassy matrices are presented by borosilicate and aluminophosphate glasses, while crystalline matrices - by polymineral “synroc” and monomineralic zirconium phosphates, titanates, zirconates, aluminosilicates.

Generaly, glassy matrices that are made by borosilicate or aluminophosphate compositions have always been used for a long-term radioactive waste storage [2]. However, the latest research data on the interaction of such matrices with aqueous solutions sustain high uncertainty in its safe use as a reliable barrier from the migrating radionuclides.

An alternitave to glassy matrix is the crystalline matrix. First crystalline matrices were developed at the late 70’s and were presented as “synthetic rocks” or, simply, synroc – a titanium-ceramic substance that can incorporate nuclear waste in its crystals. Matrices that are made from synroc are much more resistant to leaching process than glassy matrices.

Requiements for matrices are so sophisticated that there is simply no “best suitable material”. Glassy and crystalline matrices are most appropriate to the physical, chemical and mechanical properties. However, the high cost of both productions and feedstock, as well as the relative complexity of the production layout, limit the application of such technologies in the fixation of radionuclides. In addition, the stability of the glassy matrices is not enough for its burial in the earth's crust without additional protective barriers.

Solid solutions of minerals are now considered as a potentionally new matireal for matrices that will prvent radioative waste leakage [3]. It is a well-known fact that isomorphic substitutions that take place in minerals are carried out by groups of the periodic table. The folowing is the exaple of some substitutions in minerals:

- In feldspars: $Na \rightarrow K \rightarrow Rb; Ca \rightarrow Sr \rightarrow Ba;\ \ Na \rightarrow Ca\ (Sr, Ba)$;
- In olivine: $Mn \rightarrow Fe \rightarrow Co$;
- In phosphate: $Y \rightarrow La \ldots Lu$.

The idea is to search for natural minerals with high isomorphic capacity that are capable to concentrate in itself specific element that are mentioned above.

The methods of production of solidified HLW forms include melting, cold crucible induction melting, solid-phase synthesis (which can be either hot pressing or cold pressing followed by sintering), hydrothermal synthesis and self-propagating high-temperature synthesis.

Melting (in the oven) is a simple, convenient and well established method by which nowadays is obtained a relatively fusible form - glass. Both melter walls and an electrical current passing through the melt may provide the heating [4]. Disadvantages of the method can be generally represented by higher aggressiveness of the melts (especially phosphate ones) against the majority of constructional materials.

Cold crucible induction melting is also considered quite promising. In addition to the glass it produces refractory mineral-like waste form. The method is as follows: charge of the oxides (or carbonates) of matrix-forming elements and waste in the required ratio is poured into the pot along with a "starter" material (generally given by shavings of titanium metal or graphite ring, which, after the "starting" heat is extracted). Then the molten material is poured into a mold [2]. The advantages of this method are relatively simple technology that requires neither high pressures nor very fine grinding of the charge for its complete homogenization. In addition, the melting can be conducted in the skull layer that eliminates the melt contact with the walls of the crucible.

Another method of high temperature consolidation of powders is so-called **solid-phase synthesis**. It may be of two varieties: hot pressing and cold pressing followed by sintering. Hot pressing allows you to get a material with very good mechanical properties (high density, low porosity, high mechanical strength).

In accordance with hot pressing method, the charge, mixed with a solution of HLW (high-level radioactive waste) simulation (simulator) is calcified at 750 ° C in a reducing atmosphere (a mixture of Ar-4% He) for 2 hours. The mixture is then loaded into a stainless steel bellows. After pumping air out and heating to 1200 ° C, a uniaxial load of 14-21 mega Pascal is applied.

However, hot pressing is a technically complex and expensive process. A simpler way to consolidate the powder is cold pressing followed by sintering. According to this method, a mixture of calcifications HLW with the charge matrix material is compressed into cylinders, which are then sintered. A common shortcoming of both methods, severely limiting their applicability for immobilization of HLW is a need to work with high-level dusting powders.

Hydrothermal synthesis allows for moderate temperatures (200 to 800 ° C) to carry out the reaction between substances with low reactivity. The main difficulty, which makes the method not very suitable for the production is the need to use high pressure (hundreds to thousands of atmospheres).

Self-propagating high-temperature synthesis (refered as SHS) is examined as one of the methods for matrices creation. During the process of SHS, spontaneous proliferation of solid-phase reaction in the compressed block of furnace occurs. Compressed block of furnace is represented by carefully selected mixture of oxidant and reductant. Metal oxides with a variable and highest valence, such as MoO_3, are used as oxidants [1]. Metallic titanium and aluminium are usually used as reductants. Propagation speed of the reaction zone depends on the composiotion and can vary from a fraction of a millimeter to tens of millimeters per second, while the temperature in the reaction zone can reach 1000 K [3, 4]. SHS is quite simple and easy-to-perform, nevertheless, exacting requirements are set up for a compressed block mixture. In addition, it is hard to obtain the mixture with an unifrom structure.

Of all the ways to obtain the matrices currently only two are widely used - melting and solid-phase synthesis. However, SHS still remains as one of the best alternatives to expensive methods in producing nuclide fixtating matrices.

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2. Teng Yuancheng 1 Lu Zhongyuan 2 Zhou Shiguang 3 Che Chunxia 1(1.Institute of Materials Science and Engineering,Southwest University of Science and Technology,Mianyang,621010; 2. Sichuan Province Key Laboratory of Advanced Building Materials,Southwest University of Science and Technology, Mianyang,621010;3. Institute of Environment Engineering, Southwest University of Science and Technology, Mianyang,621010);STUDY ON SYNTHESING HOLLANDITE SOLID SOLUTION[J];Radialization Protection;2005-02.

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ENVIRONMENTAL AND HEALTH EFFECTS OF RADIUM

E.A. Semendeeva
Language advisor: Teacher O.I. Shaikina
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: kate.semendeeva@mail.ru

The word "radium" comes from the Latin radius - «ray," so that the name of this element literally translates as "radiant." In my report I would like to clarify about environmental and health effects of radium. What is the radium? Whether it is safe for humans? And dose, that hitting us in the body can cause a variety of diseases?

Radium is a radioactive chemical element which has the symbol Ra and atomic number 88. Its appearance is almost pure white, but it readily oxidizes on exposure to air, turning black. Radium is an alkaline earth metal that is found in trace amounts in uranium ores. It is extremely radioactive. Its most stable isotope, SimpleNuclide|Radium|226, has a half-life of 1602 years and decays into radon gas.

Characteristics

The heaviest of the alkaline earth metals, radium is intensely radioactive and resembles barium in its chemical behavior. This metal is found in tiny quantities in the uranium ore pitchblende, and various other uranium minerals. Radium preparations are remarkable for maintaining themselves at a higher temperature than their surroundings, and for their radiations, which are of three kinds: alpha particles, beta particles, and gamma rays. Radium also produces neutrons when mixed with beryllium.

When freshly prepared, pure radium metal is brilliant white, but blackens when exposed to air (probably due to nitride formation). Radium is luminescent (giving a faint blue color), reacts violently with water and oil to form radium hydroxide and is slightly more volatile than barium. The normal phase of radium is a solid.

History

Radium (Latin "radius", ray) was discovered by Marie Skłodowskaia-Curie and her husband Pierre in 1898 in pitchblende from North Bohemia, in the Czech Republic (area around Jáchymov). While studying pitchblende the Curies removed uranium from it and found that the remaining material was still radioactive. They then separated out a radioactive mixture consisting mostly of barium which gave a brilliant green flame color and crimson carmine spectral lines which had never been documented before. The Curies announced their discovery to the French Academy of Sciences on 26 December 1898.

Health effects of radium

Radium was also put in some foods for taste and as a preservative, but also exposed many people to radiation. Radium was once an additive in products like toothpaste, hair creams, and even food items due to its supposed curative powers. Such products soon fell out of vogue and were prohibited by authorities in many countries, after it was discovered they could have serious adverse health effects.

Health effects of radium

Radium was also put in some foods for taste and as a preservative, but also exposed many people to radiation. Radium was once an additive in products like toothpaste, hair creams, and even food items due to its supposed curative powers. Such products soon fell out of vogue and were prohibited by authorities in many countries, after it was discovered they could have serious adverse health effects.

Radium is naturally present in the environment in very small amounts. Because of that we are always exposed to radium and to small amounts of radiation that it releases into the environment. Radium levels in the environment have greatly increased as a result of human activity. Humans release radium into the environment by burning coal and other fuels. Radium levels in drinking water may be high when it is extracted from deep wells that are located near radioactive waste disposal sites.

Currently there is no information available on the amounts of radium in air and soil.

There is no evidence that exposure to naturally present levels of radium has harmful effects on human health. However, exposure to higher levels of radium may result in health effects, such as teeth fracture, anaemia and cataract. When the exposure lasts for a long period of time radium may even cause cancer and the exposure can eventually lead to death. These effects may take years to develop. They are usually caused by gamma radiation of radium, which is able to travel fairly long distances through air. Therefore contact with radium is not necessary, for radium to cause health effects.

Radium (usually in the form of radium chloride) is used in medicine to produce radon gas which in turn is used as a cancer treatment.

Environmental effects of radium

It has been estimated that each square kilometer of the earth surface (to a depth of 40 cm) contains 1 gram of radium. Early in the twentieth century radium was extracted from uranium ores for use in luminous dials and medical treatment. The amount of radium in uranium ores varies between 150 and 350 mg/ton. The most in contained in the ores of Zaire and Canada.

Radium is constantly produced by the radioactive decay of uranium and thorium. Radium is present at very low levels in rocks and soil and strongly attaches to those materials. It is also found in air. High concentrations of radium exist in water on some locations. Uranium mining results in higher levels of radium in water near uranium mines. Plants absorb radium from the soil. Animals that eat these plants will accumulate radium. Finally, radium may concentrate in fish and other aquatic organisms and bio magnify up the food chain.

The study of radium has played a huge role in the development of scientific knowledge, because to successfully identify many others issues related to the phenomenon of radioactivity.

I'm glad you chose report of radium, because I'm really interested to write about it. And I answered the questions.

1. [http://www.webelements.com/webelements/elements/text/Ra/index.html WebElements.com - Radium]

2. [http://www.lateralscience.co.uk/radium/RaDisc.html Lateral Science - Radium Discovery]

3. [http://www.markwshead.com/stuffHappens/radium.html Photos of Radium Water Bath in Oklahoma]

4. [http://toxnet.nlm.nih.gov/cgi-bin/sis/search/r?dbs+hsdb:@term+@na+@rel+radium,+radioactive

5. http://www.lenntech.com/periodic/elements/ra.htm#ixzz2OZJ2An00NLM Hazardous Substances Databank – Radium, Radioactive]

RESEARCH AND OPTIMIZATION OF HIGH - FREQUENCY TORCH PLASMOTRON

E.E. Shlotgauer, O.D. Shahmatova
Scientific advisor: Ph.D., As. Professor, A.G. Karengin
Linguistic advisor: Teacher A.V. Tsepilova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: shlotyara@mail.ru

This paper focuses on the modes of radio-frequency torch plasmatron and shows the effect of the gas-dynamic aiHFlow quartz discharge chamber for thermal losses from high-frequency torch discharge in the case and the efficiency coefficient of the plasma torch.

It is known that the loss of thermal power in the case of a plasmatron radio-frequency torch discharge occurs by conduction, convection and radiation. [1] This paper focuses on the modes of high-frequency jet (radio-frequency torch plasmatron) plasma torch and the effect of the gas-dynamic aiHFlow quartz discharge chamber for thermal losses from radio-frequency torch discharge in the case and the efficiency of the plasma torch.

The experimental setup is based on radio-frequency torch plasmatron for generating an air flow of the plasma is shown in Figure 1.

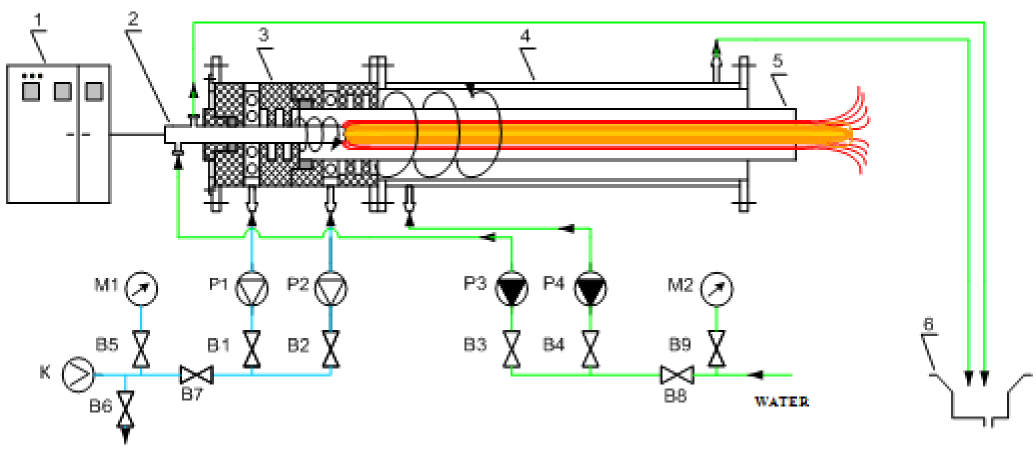

Fig. 1 Experimental set-based radio-frequency torch plasmatron

1 - High-frequency generator HFG8-60/13 2 - water-cooled copper electrode, 3 - input unit of the plasma (B1) and the cooling (B2) of gas, 4 - water-cooled casing of HF torch plasmatron;

5 - quartz discharge chamber 6 - discharge of cooling water, K - compressor, M1, M2 gauges, P1-P4- rotameters, B1-B9-valves.

High-frequency generator 1 is located in a shielded metal enclosure providing protection against *electromagnetic radiation and is designed to supply HF torch plasmatron.*

The main technical characteristics of the generator HFG8-60/13 are shown in Table 1.

Table 1 Main characteristics of the generator HFG8-60/13

Main	Unit	Value
Supply voltage	V	380
Mains frequency	Hz	50
Power consumption	кW	100
Vibrational Power	кW	60±6
Operating frequency	MHz	13,56±0,13
Efficiency factor	%	of at least 75
Anode voltage	кV	10,4÷10,5
Anode curren	A	7,6÷7,7
Current grid	A	1,8
Cooling water flow	m^3/h	at least 1,4

Due to gas dynamic aiHFlow chamber through a quartz discharge chamber losses of thermal power from HF torch discharge in the casing of HF torch plasmatron by conduction and convection can be significantly reduced, leaving only the losses due to radiation from HF torch discharge.

Figure 2 shows the effect of the gas-dynamic air flow (flow of cooling gas) quartz discharge chamber and the discharge capacity on the loss of thermal power from HF torch discharge in the casing of HF torch plasmatron.

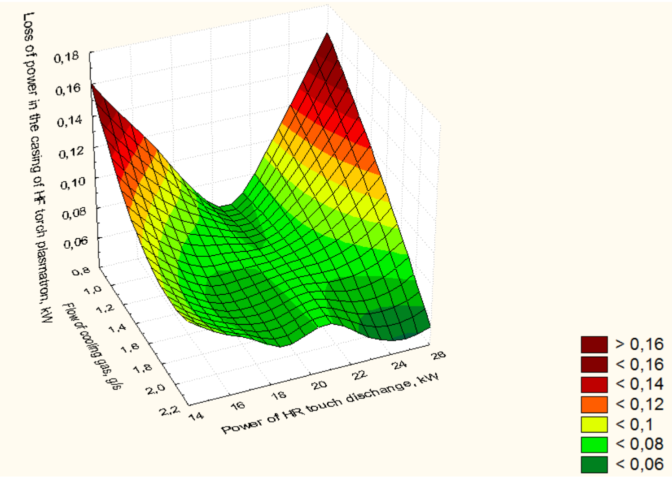

Fig. 2 Effect of the gas dynamic blowing quartz discharge chamber on thermal power loss of HF torch discharge in the case of HF torch plasmatron.

The analysis of the dependence obtained has shown that at the capacity of HF torch discharge under 18 kW and over 24 kW a low flow rate of cooling (less than 1.2 g/s) leads to a significant increase in the loss of thermal power from HF torch discharge in the case HF torch plasmatron. Minimum power losses in the casing of HF torch plasmatron are reached if the power of HF discharge is between 18 and 22 kW.

Increase in cooling gas flow rate reduces the loss of thermal power from HF torch discharge to HF torch plasmatron casing. When the flow rates exceed 1.5 g / s, they are stabilized. This suggests that the flow of cooling gas eliminates heat transfer from HF torch discharge to HF torch –plasmatron by conduction and convection, leaving only the transmission loss of power due to heat radiation.

Figure 3 shows the effect of the gas-dynamic air flow (flow of cooling gas) of quartz discharge chamber of HF torch plasmatron on the efficiency coefficient of HF torch plasmatron.

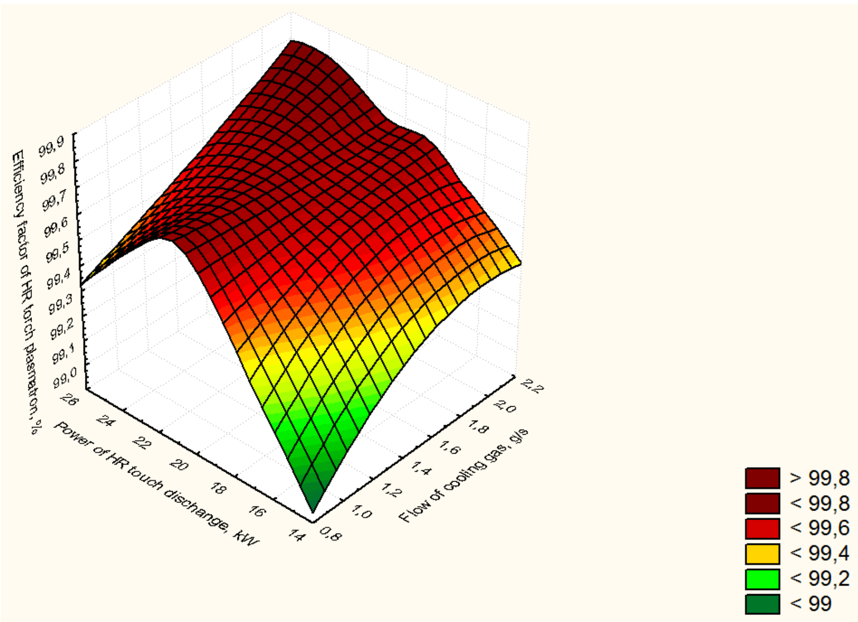

Fig. 3 Effect of the gas dynamic blowing quartz discharge chamber on efficiency coefficient of HF torch discharge the efficiency HF torch plasmatron.

It follows from the dependence that at low flow rates of cooling gas (below 1.2 g / s) HF torch plasmatron efficiency reaches 99.2% when the power of HF torch discharge is between 20 and 22 kW. When cooling gas flow rate is over 1.5 g / s, increase of HF torch plasmatron efficiency coefficient to a maximum of 99.7% also occurs along with increasing power of HF torch discharge.

Thus, the results of the research allowed to determine the optimum conditions to ensure high efficiency of HF torch plasmatron. The results of the research can be used to make industrial plants based HF torches designed for effective plasma processing and recycling of various materials.

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RADIOPHOBIA

A.A. Spirin

Language advisor: Senior teacher N.V. Demjanenko

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: andreysdrew@gmail.com

Annotation

The subject of this work is development of rational solution of negative attitude to radiation. In other words, the work is devoted to radiophobia. The purposes of it are offering the possible way to change situation with radiophobia and prediction consequences of the offered method. The sources of information are reliable, because information presented is correct and consistent with reality in different aspects.

There are few parts in this work. Introduction gives information about radiation and helps to understand what radiophobia is. Also why radiation is scared formulated there. The second part tells about main problems of society and their meaning about radiation. The next part is about the main reasons of radiophobia and about ways to refuse it. The last part includes conclusion. To summarize everything, this work is correctly reflects a situation with radiophobia in the world. Solutions developed in the project provides not new, but effective changing situation in a positive way. More than that qualification of the employees admits to speak about clean and correct results.

Introduction

Understanding Radiation

In order to understand radiophobia, it is important to have a basic understanding of radiation. Radiation can be classified into two types: ionizing and non-ionizing. Non-ionizing radiation is used in cell phones, radio broadcasts and microwave ovens. It is considered relatively safe, as it does not appear to cause health problems in reasonable doses. But it cannot be considered completely safe. Some experts are concerned about the effects of long-term, frequent cell phone use, particularly by children.

Ionizing radiation has both immediate and long-term effects on health by affecting the body at a cellular level. Depending on the level of exposure, acute radiation sickness can cause immediate effects, including nausea, headaches, fatigue and bleeding. Death can occur in hours or days if the exposure level is extremely high. Lower levels of exposure can cause long-term illness, particularly raising the risk of developing cancer. Yet ionizing radiation is successfully used in medical applications such as X-rays and cancer treatment, as well as protective services such as airport passenger and baggage screening. It is also used to generate power in nuclear reactors.

Why Is Radiation Scary?

Radiation is colorless, odorless and tasteless. It is impossible to tell whether you are being exposed and, if so, to how much, unless you have a Geiger counter or similar device. The knowledge that something you cannot experience with your senses could be causing you harm is at the heart of radiophobia.

"Unseen killer" is an extremely popular plot device in horror and science fiction films, and radiation neatly fits that bill. Meanwhile, the media is quick to jump on any possible radiation threat, reminding us endlessly of previous radiation-related events such as Chernobyl and the 1945 atomic bombings of Hiroshima and Nagaski, Japan.

Main idea

Radiophobia, or the fear of radiation, could be classified as a doomsday phobia. Radiation is all around us, from the sun's rays to X-rays. But too much radiation can be deadly. Events such as the 1986 Chernobyl disaster and the 2011 nuclear reactor concerns in Japan underscore the very real risks of radiation. At the same time, media hype and mass hysteria can make the risks seem higher than they are. Radiophobia occurs when you are not able to separate fact from fiction, causing panic and terror at the thought of radiation exposure.

Most radiation in the world is caused naturally through cosmic and terrestrial sources. Most of our exposure to natural radiation comes from radon in the rocks and soil and the largest man made source of radiation comes from coal-fire power plants. The radiation dose actually was much higher thousands of years ago than it is today and life is still flourishing.

The worldwide average background radiation dose is 2.4mSv per year and the average in the United States is 4.0mSv. A typical person is hit by 15,000 particles of radiation per second from natural sources (totalling 500 billion per year, or 40 trillion in a lifetime), and an average X-ray involves being hit by 100 billion. However, this is not dangerous because the probability for a particle of radiation to cause a cancer or a genetic disease is only one chance in 30 million billion (30 quintillion). Grand Central Station in New York City is made from granite, which contains uranium, and if you spent a whole year there you would get a dose of 6msv.

Natural radiation causes approximately 1% of all cancers and radiation from nuclear technology will increase the cancer risk by 0.002% which reduces our life expectancy by less than one hour. If you live within 75 kilometers from a nuclear reactor, you’d get an estimated trace exposure of 0.009 millirem a year, which is smaller dose than eating one banana, which contains the radioactive isotope potassium -40.

Ionizing and Non-ionizing Radiation

There's ionizing and non-ionizing radiation. Ionizing radiation is dangerous and has enough energy to damage cells, your DNA and cause cell mutation. Ionizing radiation is everywhere including minerals in the soil that emit alpha and beta particles as well as some gamma rays. Sunlight also has ionizing ultraviolet radiation. Non-ionizing radiation is mostly harmless.

Accidents

How much worse might the psychological consequences be if, in addition to explosive effects, radiation was also released? Radiation cannot be detected by the ordinary human senses, for it is odorless, colorless, and cannot be felt directly. Yet people generally know radiation can cause severe harm or even kill. Thus, when there is any known possibility of exposure, however remote, many people will imagine the worst until it is proven otherwise. Some even suffer from the morbid and persistent anxiety about radioactive materials, which has often been termed radiophobia.

For example, after the 1986 major accident at the Chernobyl nuclear power reactor in the Ukraine, people around the world were concerned when they learned that a radioactive fallout cloud might be headed their way. Even in areas where the actual exposure was just a little over the normal background radiation levels, some people refused to go outdoors unless it was absolutely necessary, they ate only canned food, and generally based their lives on avoiding what they perceived as a terrible threat. Some were so terrified of contracting a horrible and painful radiation-caused disease that they committed suicide rather than face that prospect.

Results

Treating Radiophobia

Only a trained mental health professional can make a definitive diagnosis of radiophobia and create a personalized treatment plan. Since unnecessary radiation exposure does carry some risks, your therapist will likely not guide you through actual exposure scenarios. Instead, treatment will probably focus on talking through your fears and helping you replace inaccurate thoughts and feelings about radiation with those that are more realistic.

Educating yourself about the actual risks and benefits of radiation can help calm your fears, but be careful which books and websites you choose. Look for authoritative sources such as government and university sites rather than those that may have an agenda. Force yourself to turn off the news during repetitive rebroadcasts of a possible nuclear disaster, and go for a walk or spend time with a friend.

Radiophobia is a difficult fear, since it is not easy to safely confront the object of your fear. But with patience and hard work, you can overcome your phobia and learn to treat radiation with healthy respect rather than fear.

Conclusion

To summarize the information presented, it’s obviously that radiophobia is really an important factor, slowing down the progress of nuclear energy. If people change attitudes to this problem, if people overcome their fears and prejudice, it will be the greatest step for progress of all humanity. Oil and gas are limited and will run out soon, but mankind can use nuclear energy as main source of energy for a long time. That’s why we should find methods to bring information about radiation and nuclear energy. Social advertisement on radio and TV, meetings, seminars, public radiation monitoring and full openness of nuclear sphere and some other ways have to go down radiophobia in history. If all fears are overcome the Humanity will go to the next level and cast off the chains of radiophobia.

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NUCLEAR TECHNOLOGIES IN ENGINEERING

E.A. Sviriduk

Linguistic advisor: Teacher O.I. Shaykina

Tomsk Polytechnic University, Russia, Tomsk, Lenin str, 30, 634050

E-mail: egor190894@mail.ru

Annotation

Advanced Nuclear Power Seminar Report

Nuclear power system is the most powerful energy system in the world. If the nuclear reactions are not used in the limited, they may become most one danger for the world. The misuse of nuclear power reactions can cause the converting the world into ash. Nuclear power is the most decent resource of energy that can be used to generate electricity and heat. There are only two nuclear power systems useful for human use.The first one is nuclear fission and second is radioactive decay.

INTRODUCTION

A major problem facing Planet Earth is provision of an adequate supply of clean energy. It has been that we face "...three simultaneous challenges -- population growth, resource consumption, and environmental degradation -- all converging particularly in the matter of sustainable energy supply." It is widely agreed that our current energy practices will not provide for all the world's peoples in an adequate way and still leave our Earth with a livable environment. Hence, a major task for the new century will be to develop sustainable and environmentally friendly sources of energy.Projections of future energy needs over this new century show an increase by a factor of at least two and one Half, perhaps by as much as a factor of five. All of the scenarios from reference 3 indicate continuing use of fossil sources, nuclear, and large hydro. However, the greatest increases come from "new renewables" and all scenarios show extensive use of these sources by 2050. Indeed, the projections indicate that the amount of energy derived from new renewables by 2050 will exceed that presently provided by oil and gas combined. This would imply a major change in the world's energy infrastructure. It will be a Herculean task to acquire this projected amount of energy. This author asserts that there are really only a few good options for meeting the additional energy needs of the new century in an environmentally acceptable way.One of the so-called new renewables on which major reliance is almost certain to be placed is solar power. Solar power captured on the Earth is familiar to all. However, an alternative approach to exploiting solar power is to capture it in space and convey it to the Earth by wireless means. As with terrestrial capture, Space Solar Power (SSP) provides a source that is virtually carbon-free and sustainable. As will be described later, the power-collecting platforms would most likely operate in geosynchronous orbit where they would be illuminated 24 hours a day (except for short eclipse periods around the equinoxes). Thus, unlike systems for the terrestrial capture of solar, a space-based system would not be limited by the vagaries of the day-night cycle. Furthermore, if the transmission frequency is properly chosen, delivery of power can be carried out essentially independent of weather conditions. Thus Space Solar Power could provide base load electricity.

TRANSMISSION

Solar power from the satellite is sent to Earth using a microwave transmitter. This transmission is transmitted to the relevant position via an antenna. The transmission is transmitted through space and atmosphere and received on earth by an antenna called the rectenna. Recent developments suggest using laser by using recently developed solid state lasers allow efficient transfer of power. A range of 10% to 20% efficiency within a few years can be attained, but further experimentation still required taking into consideration the possible hazards that it could cause to the eyes. In comparison to laser transmission microwave transmission is more developed, has high efficiency up to 85%, beams is far below the lethal levels of concentration even for a prolonged exposure. The microwave transmission designed has the power level well below the international safety standard (Frequency 2.45 GHz microwave beam). The electric current generated from the photovoltaic cells is passed through a magnetron which converts the electric current to electromagnetic waves. This electromagnetic wave is passed through a waveguide which shapes the characteristics of the electromagnetic wave.

Effectiveness of Wireless Power Transmission (WPT) depends on many parameters. Only a part of WPT system is discussed below, which includes radiating and receiving antennas and the environment between them. The wave beam is expanded proportionately to the propagation distance and a flow power density is increased inversely proportional to the square of this distance. However the WPT has some peculiarities, which will be mentioned here. WPT systems require transmitting almost whole power that is radiated by the transmitting side. So, the useful result is the power quantity at the receiving antenna, but not the value of field amplitude as it is usually required. Efficiency of WPT systems is the ratio of energy flow, which is intercepted by receiving antenna to the whole radiating energy.

Field distribution on the receiving antenna usually is uniform because its size is small comparatively to the width of the beam. For WPT systems this distribution isn't uniform. It has a taper form and it depends on the field distribution on the transmitting antenna.

For increasing of the energy concentration on the receiving antenna the phase distribution on the radiating antenna has usually a spherical form with the center in the point on crossing of the receiving plate and the

radiating axis. Radiating antenna of the WPT systems usually has a taper distribution of the field. This distribution allows to increase the efficiency and to decrease the field out of the receiving antenna.

The efficiency of energy transmission is expressed by the functional Λ^2. To increase Λ the field distribution on radiating aperture is made as a tapered distribution. High value of Λ is supposed to be in the majority of known projects of the WPT systems.

However, the effectiveness of the WPT system is defined not only by the value of Λ. It is also determined by the rectangularity of the field distribution on the radiating aperture, the rectangular distribution factor in the theory of antennas is usually called the surface utilization factor χ. The meaning of these two parameters Λ and χ is discrepant because to increase Λ^2 it is necessary to have the field falling down to edges, but to increase χ it is necessary to have a uniform field.

To increase the effectiveness of WPT system it is necessary to increase the product $\chi\ \Lambda^2$, though the requirements for each of both multipliers are opposite. This product is named a generalize criterion! It is possible to find the way out of this contradiction if the antenna is discontinuous (discrete) one. Let us produce the field distribution in the radiating discrete antenna falling to its edges not by means of creation of non-uniform distribution of the field but with the help of irregular situation of identical sub apertures, each of them having the uniform field distribution. It is supposed that the number of these apertures is sufficiently high in order to admit the approximation of the integral optimum monotonous Gauss distribution by means of step function. The places of sub aperture disposition can be found by the differentiation of this step function. Discrete distribution of sub apertures presents non-equadistant antenna array consisting of the similar elements. Such optimization is optimal in Chebyshev’s sense since the maximum error tends to zero while the number of sub apertures is tended to infinity. So the field in the place of observer’s disposition would be similar to step and the monotonous signal source. The falling to the edge field distribution is typical for the WPT problems. For the discrete-step distributions that means the concentration of sub apertures in the center and their gradual discharge on the edges. Thus all sub apertures are similar and have the uniform distribution of the field with the equal amplitude, which may reach the maximum admissible value.

The dismemberment of continuous apertures and slight moving of them apart in the space when all of apertures are equal and uniformly feed increases their effectiveness (the generalized criterion is increased). The generalized criterion determines the quality of the WPT Systems better than usual criterion. The optimal distribution form may be reached for the large radiating apertures where dismemberment at many parts is easily realized by disposition of sub aperture clots in places, which correspond to high field intensity (first of all it concerns the center of the radiator) and relieving sub aperture density at edges of antenna. This construction allows to approach to unit the value both of coefficients Λ^2 and χ. As a result the effectiveness of the WPT system will be essentially increased.

For receiving these transmitted waves rectennas are set up at the Earth. An antenna comprising a mesh of dipoles and diodes for absorbing microwave energy from a transmitter and converting it into electric power. Microwaves are received with about 85% efficiency and 95% of the beam will fall on the rectenna but the rectenna is around 5km across (3.1 miles). Currently there are two different design types being looked at- Wire mesh reflector and Magic carpet. Wire mesh reflector type rectennas are built on a rigid frame above the ground and are visually transparent so that it would not interfere with plant life whereas in the magic carpet type material pegged to the ground.

CHALLENGES

The development and implementation of any new energy source present major challenges. And it is acknowledged that bringing about the use of Space Solar Power on the Earth may be particularly daunting because it is so different. The major challenges are perceived to be:

(1) The mismatch between the time horizon for the implementation of SSP and that for the expansion of

conventional energy resources

(2) The fact that space power is intrinsically global, requiring enterprise models that give every player a suitable stake and adequate safeguards

(3) The potential for concerns over reliability, safety and environmental implications

(4) The need to obtain publicly-allocated resources outside the normal purview of the energy community

(5) Aeronautics and Space Administration (NASA) and in Japan by the Ministry of Economy, Trade and Industry (METI) indicate that demonstrations of space-to-ground transmission of power could come in the current decade and initial commercial power delivery in about 20 years. A significant contribution in terms of global energy would clearly take substantially longer. The challenge presented by this mismatch can be addressed in two ways:

First, governments will need to underwrite, to a major extent, the R&D needed to bring the enabling technologies to maturity. Governments have traditionally supported R&D efforts as a spur to new economic activity. Examples can be found in the development of rail and air transport systems, computers and, most recently, the internet.

Second, a near-term involvement by the users (the electric utilities and their suppliers) should be promoted. It is very important for these prospective users to keep abreast of progress as the technology matures.

The global scope of Space Solar Power will present another significant challenge in terms of appropriate enterprise models that give every player a suitable stake and adequate safeguards. International cooperation in the energy area is commonplace and indeed the infrastructure for energy is highly interdependent around the world. Energy acquisition, distribution, and utilization tend to involve multiple countries and far-flung networks along which various forms of energy flow. Similarly, international collaboration has been important in major space ventures of which Space Solar Power would certainly be an example.

Briefly, there are several reasons for international collaboration. The most compelling are:

• The need for increased energy supplies is a global need

• The impact on the environment of present energy practices is a matter of worldwide concern

• International coordination in energy provisioning is common today and the interdependence will only grow in the future

• The needed technology is widely distributed and no one country has all the capability

• The large scale of Space Solar Power will require international financing

• International regulations control critical resources, specifically slots in geosynchronous orbit and appropriate transmission frequencies

• Recognition of Space Solar Power as a viable and safe approach to energy will require an international consensus.

Space Solar Power is perceived as very different from all other power sources because of its wireless deliverymodest in view of the fact that the intensity of the transmitted beam.

Developing any substantial source of energy requires the dedication of significant amounts of capital, land, technical skills, etc. The exploitation of Space Solar Power will require all of these plus some that are unique. As noted before, SSP systems will likely operate in geosynchronous orbit. This orbit is at an altitude such that the platform appears to be stationary over a specific point on the surface of the Earth. As a result, this particular orbit is highly desirable for Earth-oriented activities, for example communications, hence international control is exercised over the assignment of positions or "slots" in this orbit.

The changes in dominant source over time were noted in an earlier figure and we see a continuing change. Considering the relative role of the various sources over just the last century, we have seen the prominence of wood vanish and that of coal diminish greatly. At the same time, the contributions of oil and gas rose from virtually nothing to dominance, and nuclear became a significant contributor in a matter of only 25 years.

Considering the changes washing over our world in almost all areas of life and the economy, can we expect anything less dramatic in the energy arena over the 21st century?

Today we the opportunity and the challenge to create a future that is energy-rich and sustainable, but we must be open to a departure from past and present practices and expect that the energy situation in 2100 will be very different from that of today.

The prudent response is a pro-active assessment of all reasonable options and pursuit of those that appear most viable, however futuristic they may seem at present.

ADVANTAGES

Unlimited energy resource. Energy delivered anywhere in the world, Zero fuel cost Zero CO_2 emission, Minimum long-range environmental impact, Solar radiation can be more efficiently collected in space

DISADVANTAGES.

Launch costs, Capital cost even given cheap launchers, Would require a network of hundreds of satellites, Possible health hazards, The size of the antennas and rectennas, Geosynchronous satellites would take up large sections of space, Interference with communication satellites

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PROTON EXCHANGE MEMBRANE

A.G. Umirzakov

Scientific advisor: Senior staff scientist V.V. Sokhoreva

Linguistic advisor: Ph.D., As. Professor T.G. Petrashova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: arman_umirzakov@mail.ru; armanumirzakov@tpu.ru

Annotation

The fuel cells are one of the most promising electrochemical power sources for remote locations and electric vehicle applications. The paper considers advantages of fuel cells and their applications. The focus is also put on how they operate and on the main component of the fuel cells proton exchange membrane.

Key words: proton exchange membrane; fuel cell; alternative source of energy

Introduction

First of all, it is necessary to say some words about the first working fuel cell. It was invented by William Grove in 1843 by reacting oxygen and hydrogen on separate platinum electrodes that were immersed in dilute sulfuric acid inside five cells of a gas voltaic battery and using the current produced to electrolyze water in another similar cell.

However, a more efficient design of the fuel cell was made in the 1960s for the Gemini and Apollo space missions. General Electric produced the fuel cell which generated electrical power for NASA's Gemini and Apollo space capsules also it supplied drinking water for the crew.

Reserve fossil fuels are limited and will be depleted in 70–150 years time. In addition, continued use of fossil fuels will generate greenhouse gases that will cause global warming and climate change [4].

Advantages and applications of fuel cells

Fuel cells have received widespread recognition as an alternative energy generation technology that is highly efficient and that operates in a renewable fuel economy. This electrochemically-based energy technology operates with high efficiency as it converts chemical energy directly to electricity. Unlike internal combustion engines, fuel cells bypass any thermal step during energy conversion, and therefore, they are not limited by the Carnot cycle, which only permits approximately 40 percent of the converted chemical energy to be used for work, depending on the temperatures employed.

Mechanically, fuel cells have no moving parts providing high durability, long lifetimes, and silent performance. Apart from being mechanically rigid systems, fuel cells are not consumed during operation like batteries. Instead, they continue to generate electricity as long as fuel is fed to them [2].

How a fuel cell operate

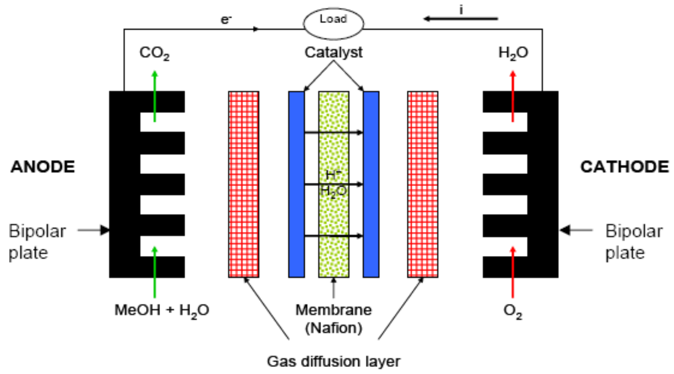

Figure 1: Schematic of Direct Methanol Fuel Cell

As it is shown in Figure 1, an electrical current generate by spatially separating a methanol oxidation reaction and an oxygen reduction reaction. Methanol is oxidized by water to form carbon dioxide, protons, and electrons at the anode. These protons and electrons subsequently react with oxygen to reproduce water at the cathode. Upon separation of the two redox half reactions, the electrons participating in the reaction can be extracted and directed through an external circuit, thus producing an electrical current. A potential load can be applied on the electrical current to produce usable work to power an electrical device. In order to complete the overall oxidation-reduction reaction, a medium is also required for proton transport. The direct methanol fuel cell utilizes a polymer electrolyte membrane (PEM) as its proton transport medium. The standard material in industry for PEMs is Nafion® because it is a superior proton conductor [3].

The proton exchange membrane (PEM) lies at the core of the cell. Since protons conduct through Nafion at a rate that is at least three orders of magnitude less than the rate at which electrons conduct through carbon cloth for a given potential drop, then the distance over which protons conduct must be minimized. Therefore, the thickness of PEMs is typically between 50 to 250 μm. Catalyst layers are directly adjacent to the PEM on each side. Catalysts are employed to speed up the kinetics of the anodic and cathodic reactions. Moving outwards, the catalyst is in contact with gas diffusion layers (GDLs). GDLs have two primarily roles. First, they provide routes by which fuel – aqueous methanol at the anode, and oxygen or air at the cathode – can reach reactive catalytic sites, and by which byproducts of reaction -namely carbon dioxide at the anode and water at the cathode- can diffuse back towards the bipolar plates and the outlet. To serve this function, GDLs are highly porous layers to facilitate fluid flow. Second, GDLs extract electrons from reaction as they are typically made of carbon cloth or carbon fibers, which conduct electricity at around 200 Scm^{-1}. The PEM, the catalyst layers, and the GDLs make up the heart of the fuel cell called the Membrane Electrode Assembly (MEA). The catalyst layers and GDLs taken together make up the electrodes. Bipolar plates are current collectors that provide a conduit for electrons to flow through an external circuit. The anodic plate harnesses the electrons received from the anodic reaction, and directs these electrons to the cathodic plate through a circuit. The cathodic plate receives electrons from the circuit, and conducts electrons through the GDL to the loci of oxygen reduction [3].

Nafion® membrane

The industry standard for PEMs is Nafion®, a supreme ion conductor developed and manufactured by Dupont®. Its perfluorinated backbone provides significant mechanical strength and hydrophobicity. Pendent to the tetrafluoroethylene (Teflon) backbone are perfluorovinyl ether chains that end with a sulfonic acid functional group. The sulfonic acid group is an exceptional ion-conducting moiety because its conjugate base is highly resonance stabilized. If R–SO3H loses a proton, H+, the negative charge is distributed over three oxygen atoms providing high stability. Figure 2 shows the molecular structure of Nafion.

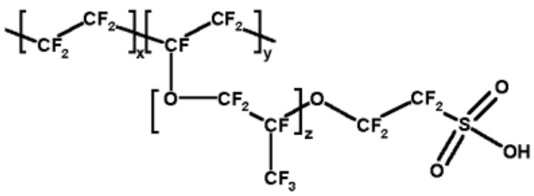

Figure 2: Molecular structure of Nafion

Since sulfonic acid sites in Nafion are highly acidic they contribute hydrophilicity to an otherwise hydrophobic organic macromolecule, thus, promoting the formation of ion clusters in Nafion. When coupled with sufficient water uptake, the proton-conducting ion clusters expand to become the dominant domain. In fact, hydration initiates the formation of continuous ionic channels that give protons direct access through the Nafion system. Unfortunately, in DMFCs, these ionic channels are the same channels through which methanol diffuses from the anode to the cathode causing unwanted methanol crossover and the concomitant loss of performance as well as fuel [3].

Radiation grafted membranes

Radiation grafting is a versatile method for the modification of polymers; even highly resistant fluoropolymers can be easily modified by the use of radiation. In the process of radiation grafting there are two main reactions: initiation of the polymeric backbone and growing of polymer chain from the polymeric backbone. There are two major types of grafting techniques: a simultaneous grafting and preirradiation grafting technique. In the simultaneous method the irradiation and growing of polymers are performed at the same time. Radiation continuously initiates a polymeric backbone, while polymer side chains grow from an initiated backbone. In preirradiation method, irradiation is followed by grafting reaction. In this method grafting and irradiation processes are separated in time. Therefore, the irradiated base film can be stored in a deep freezer (at -75°C) even a few months without any loss of its ability for initiation. After irradiation, the base film is immersed in a monomer solution and activated thermally to grow side chains. In principle any kind of high energy radiation can be used, X-ray, gamma, also an electron beam can be used for irradiation. Irradiation can be performed in vacuum, inert gas atmosphere (N2, Ar) or in the presence of air (peroxy/hydroperoxy method). In simultaneous grafting method, radiation induces, parallel, homopolymerization of the monomer and chain growth on the backbone polymer. In consequence, a higher amount of homopolymers than in the preirradiation technique is formed.

Conclusion

In conclusion, fuel cell performance is limited by three primary problems: slow anode oxidation due to carbon monoxide poisoning of the catalyst, high methanol permeation from the anode to the cathode, obstruction to fuel flow at the anode by carbon dioxide formation. We must modify PEM to get rid of such problems in future. At the same time, it is suggests to increase efficiency up to 80 percent nowadays it is 40 percent. The fuel cell will be the tec hnology of the hydrogen economy in the future when our fossil fuel runs out.

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THE CONDITIONS FOR A COMPUTERIZED SYSTEM CREATION FOR NUCLEAR MATERIALS ACCOUNTING AND CONTROL

Y.S. Vahrusheva

Scientific advisor: Senior teacher A.V. Godovukh

Linguistic advisor: Teacher A.V. Tsepilova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: julia_vach@mail.ru

Abstract

Students and professionals in the field of nuclear physics often face the problem of accounting and control of nuclear materials. This work is relevant for students who want to work in the future in the field of nuclear safety. The purpose of this work- is to introduce students to the principles, methods, and procedures of the practical implementation of accounting and control of nuclear materials at the enterprise level; acquaintance with existing problems and ways of solving them.

Introduction

Management of nuclear materials covers a wide range of scientific, technical, political, and economic issues related to the major problems of national security, environmental and radiation safety of the population, as well as non-proliferation of nuclear materials. All this activity is controlled and regulated by the state.

Nowadays in a widespread terrorist threats and displays of various unauthorized activities involving nuclear materials and nuclear facilities, it is important to create an effective system of accounting and control.

In order to create a system it is necessary to give a correct definition of accounting and control.

Control of nuclear materials – is administrative control over the availability and movement of nuclear materials to prevent their unauthorized use.

Accounting of nuclear materials – is definition of nuclear materials, preparation, registration of it in the reporting documents.

The conditions for a computerized system creation for nuclear materials accounting and control.

Nowadays the problem of theft prevention and unauthorized use of nuclear material remains important. Accounting - one of the measures for the control of nuclear materials, to ensure their safety and nonproliferation. As a consequence, it is necessary to create a computerized system for accounting and control of nuclear materials. The main task in the development of this system is a rational combination of technical means and measures to control and automate the measurements of nuclear materials.

This work highlights the main elements of a computerized system of accounting and control of nuclear materials:

-Software;

-Automated data collection and technology;

-Databases creation;

-Facilities and activities as part of accounting and control of nuclear materials.

The above mentioned components are considered in work.

It is well known that the software is the weakest point of the system. Anything that is operated by a standard PC is unreliable, prone to crash, hangs, errors. Therefore, in modern systems, all the basic functionality, that provides the system work, is moved to hardware devices. For example, in automated systems such devices are controllers. The next important concept that can be described is technology for the collection of data as an idea. In the accounting and control systems we could use such technologies as barcodes, RFID-tags with which the data are recorded on the accounting unit in the database. The database, as a part of the object, helps to ensure the automated data collection system of current and accurate information on developments of nuclear materials. The accounting and control system for barcode technology is based on the automated data collection system. This, in its turn, together with the establishment of databases of nuclear material, creates a computerized accounting and control system and provides reliable identification of objects, automatic reading of information and input into the database of information on nuclear materials: weight, isotopic composition, concentration, location.

Requirements for accounting and control of nuclear materials, formed on the basis of the conditions of the facilities operation and a number of regulations governing the systems of accounting and control of nuclear facilities.

All these components are designed to ensure consistent information of nuclear material at any time.

Conclusion

In the course of this work were identified the following provisions of accounting and control of nuclear materials:

- Organization of work in accounting and control of nuclear materials on the object and in the area of balance of nuclear materials, the structure and composition of workers employed accounting and control of nuclear materials.
- The regulatory and technical documents used in the organization for accounting and control of nuclear materials;
- Amount of nuclear material balance areas, boundaries and structure;
- Means of control access to nuclear materials;
- List and forms of accounting and reporting documents;
- Procedures for monitoring the state of accounting and control of nuclear material balance areas of nuclear materials;
- Procedure for the preparation and approval of personnel to work on the accounting and control of nuclear materials;

- Procedure for physical inventory.

For each material balance area should be developed and approved by the head of instruction for accounting and control of nuclear materials, in which must be defined: the procedures of accounting and control of nuclear materials used in the balance area of nuclear materials and procedures to assess the loss of nuclear materials.

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QUARKS AS BLOCKS OFNATURE

M.V. Yaschuk
Linguistic advisor: senior lecturer N.G. Novikova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: yaschukmv@gmail.com

Abstract

The main purpose of this work is to provide information about parts of elementary particles – quarks. The work describes the main properties of these particles and provides definition of the types of quarks such as up, down, strange, charm, top and bottom quarks. This information can be useful for people who try to understand the structure of the nature surrounding us as well as very helpful for understanding and making first steps in particle physics.

Introduction

Everybody knows that the matter is made up of small particles called atoms. These are tiny particles and cannot be seen with naked eyes. They are further divided into still smaller particles called electrons, protons and neutrons. The Protons, electrons and neutrons are known as subatomic or elementary particles.

But in 1964 two American Physicists Murray Gell Mann and George Zweig suggested that many elementary particles might also have a structure. They suggested that elementary particles are made up of extremely small particles called quarks. Quark is hypothetical particle that carries a fractional charge.

Development

Let us consider the properties of quarks which are the building blocks which build up matter, i.e., they are seen as the "elementary particles". In the present standard model, there are six "flavors" of quarks. They can successfully account for all known mesons and baryons (over 200). The most familiar baryons are the proton and neutron, which are each constructed from up and down quarks. Quarks are observed to occur only in combinations of two quarks (mesons), three quarks (baryons). There was a recent claim of observation of particles with five quarks (pentaquark), but further experimentation has not born it out.

Quark	Symbol	Spin	Charge	Baryon Number	Mass*
Up	U	1/2	+2/3	1/3	1.7-3.3 MeV
Down	D	1/2	-1/3	1/3	4.1-5.8 MeV
Charm	C	1/2	+2/3	1/3	1270 MeV
Strange	S	1/2	-1/3	1/3	101 MeV
Top	T	1/2	+2/3	1/3	172 GeV

Bottom	B	1/2	-1/3	1/3	4.19 GeV(MS) 4.67 GeV(1S)

*The masses should not be taken too seriously, because the confinement of quarks implies that we cannot isolate them to measure their masses in a direct way. The masses must be implied indirectly from scattering experiments. These masses represent a strong departure from earlier approaches which treated the masses for the U and D as about 1/3 the mass of a proton, since in the quark model the proton has three quarks. The masses quoted are model dependent, and the mass of the bottom quark is quoted for two different models. But in other combinations they contribute different masses. In the pion, an up and an anti-down quark yield a particle of only 139.6 MeV of mass energy, while in the rho vector meson the same combination of quarks has a mass of 770 MeV! The masses of C and S are from Serway, and the T and B masses are from descriptions of the experiments in which they were discovered.

Each of the six "flavors" of quarks can have three different "colors". The quark forces are attractive only in "colorless" combinations of three quarks (baryons), quark-antiquark pairs (mesons) and possibly larger combinations such as the pentaquark that could also meet the colorless condition. Quarks undergo transformations by the exchange of W bosons, and those transformations determine the rate and nature of the decay of hadrons by the weak interaction.

Confinement of Quarks

Speaking about confinement of quarks, it should be emphasized that there always has been a question about the confidence of the quark model when no one has ever seen an isolated quark. There are good reasons for the lack of direct observation.

Apparently the color force does not drop off with distance like the other observed forces. It is postutated that it may actually increase with distance at the rate of about 1 GeV per fermi. A free quark is not observed because by the time the separation is on an observable scale, the energy is far above the pair production energy for quark-antiquark pairs. For the U and D quarks the masses are 10s of MeV so pair production would occur for distances much less than a fermi. You would expect a lot of mesons (quark-antiquark pairs) in very high energy collision experiments and that is what is observed.

Basically, an isolated quark cannot be seen, because the color force does not let them go, and the energy required to separate them produces quark-antiquark pairs long before they are far enough apart to observe separately.

One kind of visualization of quark confinement is called the "bag model". One visualizes the quarks as contained in an elastic bag which allows the quarks to move freely around, as long as you don't try to pull them further apart. But if we try to pull a quark out, the bag stretches and resists.

Another way of looking at quark confinement is expressed by Rohlf. "When we try to pull a quark out of a proton, for example by striking the quark with another energetic particle, the quark experiences a potential energy barrier from the strong interaction that increases with distance." As the example of alpha decay demonstrates, having a barrier higher than the particle energy does not prevent the escape of the particle - quantum mechanical tunneling gives a finite probability for a 6 MeV alpha particle to get through a 30 MeV high energy barrier. But the energy barrier for the alpha particle is thin enough for tunneling to be effective. In the case of the barrier facing the quark, the energy barrier does not drop off with distance, but in fact it increases.

Result

This article gives a definition of such fundamental particles as quarks, describes properties of these particles and gives explanation why we can see an isolated quark.

Conclusion

In general, we can say that the hypothesis of quarks, and all that follows from it is the most conservative hypothesis about the structure of hadrons, which can explain the experimental data. Attempt to refuse from quarks results in difficulties with the description of the many experiments that are very naturally described in the quark model. But despite it there are some open questions:

- Why there are three colours and three generations of quarks. Does it have connection with our threedimentional space
- Are quarks truly elementary particles?

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PROCESSING Of ZR-1NB ALLOY BY HIGH CURRENT PULSED ELECTRON BEAM

A.S. Zalogina, A.N. Nikolayeva
Scientific advisor: Ph.D. N.S. Pushilina
Linguistic advisor: N.G. Novikova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: anast.zalogina@gmail.com

Abstract

Surface integrity changes of Zr1Nb including surface topography, microstructure and microhardness distribution along surface layer were investigated by different techniques of pulsed electron beam treatments (PEBTs). The surface observation and analysis of microhardness were performed to reveal the surface modification mechanism of Zr1Nb by PEBTs. The results show that the surface finish obtains good polishing quality and there is no phase transformation but the dislocations by PEBT. Furthermore, the microhardness in the surface modified layer is improved. The remelt and fine-grain microstructure of surface layer caused by LEHCPEBTs is the main polishing mechanism and the reason of modification of surface topography and the increment in microhardness is mainly due to the dislocations and fine grains in the modified layer induced by PEBT.

Key words: pulsed electron beam treatment (PEBT), zirconium alloy, hardness

Zirconium alloys have gained great advantage in the field of high technologies, manufacturing and production of usual consumer goods. For example, zirconium alloys are exploited as fuel assemblies in nuclear energy. There are extremely serious requirements to zirconium tubes due to the fact that they are used in hard operating conditions in the active zone of a reactor [1]. It was corrosion of fuel assemblies shells that caused a great number of accidents of nuclear reactors. It resulted in release of radioactivity and other undesirable effects. Nowadays there is application of covers treated by pulsed electron beam to increase the service life of zirconium products.

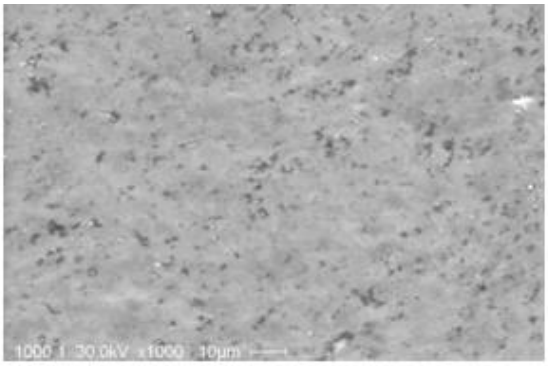

Fig. 1.The surface microstructure ofinitial zirconium alloy Zr-Nb

The interaction of intense-pulsed energetic beams with materials and its application has attracted much attention because of their hardware reliability, high degree of adjusting and the least cost of equipment. The high current pulsed electron beam irradiation produces transient heating and cooling near the surface and induces thermal stresses that can propagate into the bulk of the treated materials [2-4]. As a result, improved surface properties, often unattained with other surface treatment techniques, can be easily obtained in terms of corrosion and wear properties. The choice of beam characteristics plays an important role in pulsed electron beam irradiation: initial electron energy, density of energy, duration of pulse and quantity of pulses.

The goal of this work was to study the influence of energy density of the electron beam on the structure and properties of zirconium alloy.

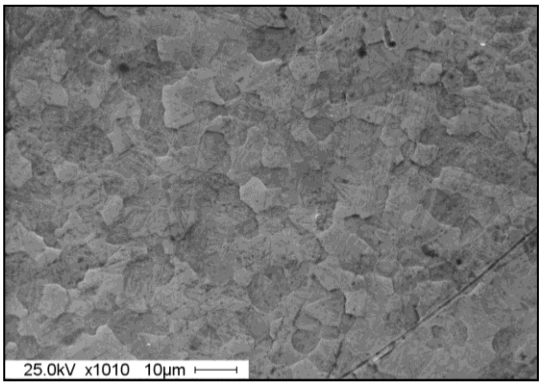

Fig. 2. The surface microstructure of zirconium alloy Zr-Nb treated by pulsed electron beam with E_s=18 J/cm^2 and N=1

Rectangular flat samples of 50 × 50 × 0,7 mm. for researching were made from zirconium alloy Zr1Nb. The samples were cut from a sheet of zirconium alloy Zr1Nb (brand E110) as they were delivered by the spark cutting. All surface defects (dents, scratches, rough risks) were removed by grinding and polishing operations. Grinding was carried out on the machine «Cone 2 M / V» with flint sandpaper.

The electron beam system «SOLO» used in this work was created in the Institute of High Current Electronics SB RAS. There was treatment of two sides of sample for 50 ms and with the initial energy E = 18 keV, the density of energy (E_s) changed from 5 to 25 J/cm^2. The microstructure of the treated samples was observed from the surface by using scanning electron microscopy (microscope Philips SEM 515). For scanning electron microscopy operated at 30 kV, the resolution was ~ 10 nm, depth of definition ~ 0,5. The surface Vickers hardness of the samples was measured at the top surface after the samples were used at different loads: 0.3, 0.5 and 1.5 N. The advantage of Vickers method is the possibility to experience materials with more higher hardness than other methods because of the diamond pyramid.

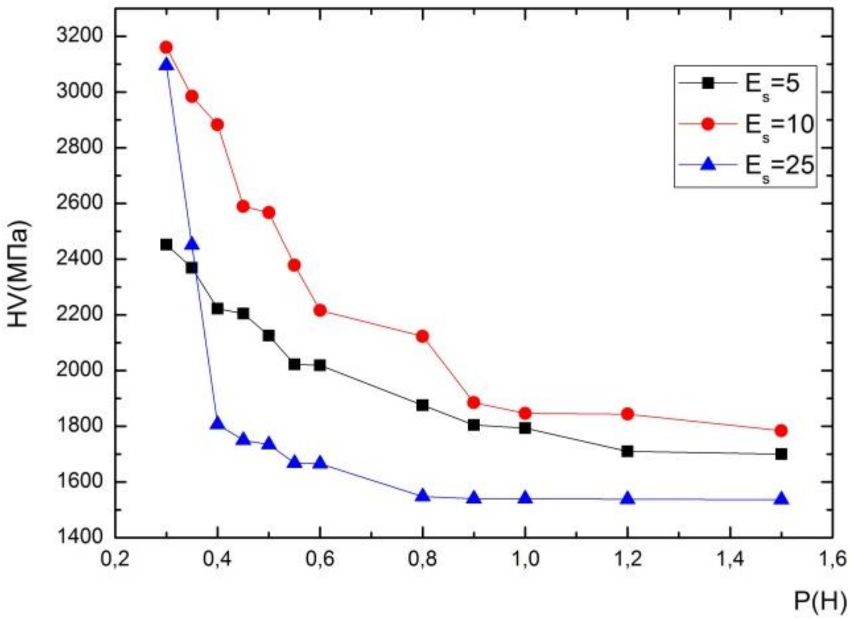

Fig. 3. The graph of hardness of the sample from the applied load with treatment different density of the beam

The studies of the structure of original zirconium alloy have shown that in the cross-section equiaxed grain structure with a grain size of (4 - 6) mm was formed (Figure 1). The grains are elongated along the rolling direction, their size in the longitudinal direction ~ 7 mm, coefficient of unequal axiality ~ 2.

During the study of irradiated samples significant change in their structure was observed. Thus, pulsed electron beam irradiation leads to the formation of structures with thin (needle) plates cutting the grains (Fig. 2). According to the diagram of the system Zr-Nb and literature, this structure is martensite. Feature of samples irradiated at Es = 25 J/cm2 is a high density of craters with a wide spread in size (1 to 5 microns).

The graph of alloy E110 change of hardness (HV) from applying loud (P) is performed in Figure 3. The hardness of initial material is characterized by steady distribution in width of analysis, it was equal to 1600 MPa. It follows from Figure 3 when E_s = 25 J/cm^2 the processing mode did not lead to any substantial increase of hardness more than by 5 mkm in spite of HV=3220 MPa on a subsurface layer. It should be noted that in case of research of hardness with loud 0,4 N there were detachments and splinters near the edges of indentations. As a result edges of indentations were bad and warped.

Also treatment with Es = 5 J/cm^2 does not lead to essential changes. Samples treated electron beam with E_s=10 J/cm^2 have the most high meanings of hardness on surface HV=3160 MPa and in width HV≈2613 MPa. According to literature [3] increase in zirconium alloy hardness after treatment is linked with formation of martensite as a consequence of very fast heating and a very fast cooling process. Finely divided martensite and stress of surface give the most contribution to hardening [3].

The results of study energy density of the electron beam influence in the range (5 ÷ 25) J/cm2 on the structure and properties of zirconium alloy are:

1) Radiation by IEP changes the structure-phase state of the surface layers - the appearance of martensite that improve mechanical properties of the material;

2) The maximum increase (more than 60% compared to the starting material) of hardness is observed by processing of E_s = 10 J/cm^2.

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СЕМИНАР
INTEGRITY OF TRADITIONS AND INNOVATIONS AS THE BASIS FOR THE DEVELOPMENT OF MODERN ENGINEERING SCIENCE

EFFICIENT SEARCH OF INFORMATION ON THE PORTAL OF NATIONAL ANTARCTIC DATA CENTER

N.S. Bubnov
Scientific advisor: PhD, Full Prof. L.S. Globa
Language advisor: A.S. Nypadymka
Institute of Telecommunication Systems, NTUU "KPI", Ukraine, Kiev, Industrialnyi alley, 2, 03056
E-mail: nsbubnov@gmail.com

Abstract: This article presents an approach to finding information on the Internet portal of knowledge of Antarctic research. As an information portal model used ontology. Special attention is paid to the lack of unified information space of Antarctic research, the creation of which can provide the conditions for significant economic changes in the country through the commercialization of unique Antarctic data.

Key words: Antarctic data portal, search for ontologies, knowledge representation, Antarctic research

The study of Antarctica has an important place in the research of scientists around the world. The contribution of Ukrainian scientists is becoming more notable in the study of the continent. During the work of Ukrainian scientists in Antarctica huge amount of research has been done in the field of the biological resources, organizing primary samples of maps. In this connection there is an actual problem associated with the collection, storage, retrieval and transmission of the data. To optimize and simplify the exchange of data, it was decided to establish Ukrainian Antarctic Data Portal. [1]

From the above the need for effective information retrieval technology in the portal of the National Antarctic Data Centre comes out. Ontologies were used as a model for knowledge representation on the portal subsequently let's consider the search for an ontology applicable in this case. [2]

Formal ontology can be defined as: O = {C, A, R, T, F, D}, where:

- C - a set of classes that describe the domain concepts;
- A - a set of attributes (attributes describe classes according to the specific characteristics. Each attribute has at least the name and value, and is used to store information that is specific to the object and is linked to it), describing the properties of the concepts and relationships;
- R - a set of relations defined on classes (relations establish links (describing dependence) between the elements of the ontology. Usually the ratio is an attribute which is valued as another object):
- T - the set of limitations of standard types of attribute values;
- F - set of restrictions on the values of attributes of concepts and relationships;
- D - multiple instances of the classes.

The ontology which is defined in such way can be used to represent concepts necessary for the understanding of knowledge in the field of Antarctic research, and for the executable in its framework data. [3]

Search of information is based on the ontology, so the user can specify a request, not only by keywords but also by words which are familiar to him in terms of the domain portal. The main elements of such search request are the basic concepts of ontology: its classes, attributes, and instances of classes, and the relationships that bind one concept with other concepts of the ontology. Formulated in this way a simple search query for the user's job, as well as comprehensive in terms of information found. [4] For example, the search query: "Find the results of studies carried out with the penguins that focus on the mean body weight, depending on the habitat, obtained by Nikolaychuk N.I. in 2008," will be formally as follows:

Class "Result of a study"
The relation "Is carried out":
Class "Object of study"
Attribute "Object of study" = "penguins"
The relation "Is aimed at":
Class "Purpose of research"
Attribute "Purpose of research" = "habitat"
The ratio of "received":
Class "Person".
Attribute "Name" = "Nikolaychuk N.I."
Class "Result of a study"
Attribute "year" = "2008" [5]

Let's see how the terms will appear in the search query concept ontology, we give them a formal description. Define the following variables:

C_1 = { Result of a study },

R_{AS_1} = { Is carried out },

C_2 = { Object of study },

A_{C_2} = { penguins },

R_{AS_2} = { Is aimed at },

C_3 = { Purpose of research },

A_{C_3} = { habitat },

R_{AS_3} = { received },

C_{4_1} = { Person },

$\mathrm{A}_{C_{41}}$ = { Nikolaychuk N.I. },

C_{4_2} = { Result of a study },

$A_{c_{41}}$ = {2008}. [6]

To implement a search query relevance of the following description of the classes: $C_2(\mathrm{A}_{C_2}, D_{C_2}, R_{C_2})$, $C_3(\mathrm{A}_{C_3}, D_{C_3}, R_{C_3})$, $C_4(\mathrm{A}_{C_4}, D_{C_4}, R_{C_4})$, $C_5(\mathrm{A}_{C_5}, D_{C_5}, R_{C_5})$, $C_6(\mathrm{A}_{C_6}, D_{C_6}, R_{C_6})$, $C_7(\mathrm{A}_{C_7}, D_{C_7}, R_{C_7})$. To implement a search query there are the following relations: the relation of the form class-data: $R_{IA_{56}} \leftarrow C_5 \subset C_6$, associative relationships: $R_{AS_1} = \{ C_1 \times C_2 \}$, $R_{AS_2} = \{ C_1 \times C_3 \}$, $R_{AS_3} = \{ C_1 \times C_4 \}$, $R_{AS_4} = \{ C_1 \times C_5 \}$, $R_{AS_5} = \{ C_5 \times C_7 \}$. [7]

The technology of the efficient search for ontologies on the website "National Antarctic Data Centre" is considered. Information base portal is ontology, which helps in the systematization and structuring of information, organize efficient search and navigation through the information on the portal of the National Antarctic Data Centre. The portal is under development. The resulting analysis of the information has helped to make site to became the most convenient for scientists and for ordinary users. The transmission of information resources increases the international fame development of Ukrainian scientists and beneficial to the country's image. The portal was created with the software Microsoft SharePoint Products and is scheduled for launch in the real environment in 2013.

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PROBLEMS AND SOLUTIONS IN ENGINEERING EDUCATION

E.V. Bulimenko, N.D. Turgunova
Scientific advisor: Ph.D., As. Professor R.V. Ostvald, TPU, Tomsk
Language advisor: Ph.D., As. Professor Yu.V. Falkovich
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
bulimenko.ev@gmail.com

Abstract: There is a good basis for the development of engineering education in Russia. First of all, Russia has a large number of engineering institutions with competent teaching staff and sufficient equipment, enabling future engineers in training to obtain the necessary knowledge. But to date, Russia has a number of problems in engineering education. This paper presents possible solutions to these problems.

The past twentieth century can rightly be called a "time engineering" and "the age of engineers." The progress of science and technology has led to the flourishing of the engineering profession, has mobilized unprecedented creative forces, and at the same time, the engineers laid much of the blame for the fate of human civilization. Before obtain a present value and scope, engineer, engineering itself was difficult, historically long path of development. The price of the efforts of many generations of humanity bit by bit acquire knowledge, accumulating technical skills, preparing the ground for the germs of engineering.

Without participation of engineering shots it is impossible to submit today the operational solution of any of the complex problems, put-forward new scientific and technical and economic reality. After all the science directly connects to equipment and is embodied in projects of the difficult units, the automated lines, powerful industrial complexes, first of all, thanks to creative efforts big and various on the structure of group of engineers. Engineering activity is today a key link in a known chain "science-equipment-production", and at the same time it turned into the most mass type of highly skilled brainwork. The new equipment demands, on the one hand, qualitatively other engineering thinking directed first of all on search of optimum decisions in the field of human-machine interactions, and with another - a moral maturity of the engineering worker, ability to solve complex technical problems "humanly".

Roots of engineering activity are lost in the depth of last millennia as it is known that the human civilization is based on transformation of the natural world by means of instruments of labor, and creation of various technical means, history of their creation and emergence - at the same time is also history of engineering activity.

Each engineer of an antiquity can be called safely the scientist, the philosopher, the writer; he was "obliged" to be a leader. Though it is necessary to notice that this occupation was frequent destiny of commoners, not prestigious occupation.

Having passed a long way of formation of engineering, it is possible to allocate in this process such period, as before engineering, which chronological framework is quite wide (from the I-II millennium BC, till XVII-XVIII century of new time) where handicraftsmen were the main founders of technical innovations still.

Rough science and equipment development (the second half of the XIX-XX centuries) leads to that engineering activity changes literally in the eyes. Relations of engineering work, the engineer with various elements of productive forces are strengthened, the structure of an engineering profession considerably becomes complicated, the scope of engineering methods extends. Appear new and functions traditional for the engineer are filled with new sense. Today the engineer is the representative of one of the most mass professions.

Now Russia has a large number of engineering educational institutions with competent teaching personnel and the sufficient equipment that gives the chance to future engineers to receive necessary knowledge in the course of training.

In Russia for development of engineering education there is a good reserve:

1. There is a successful experience of the elite defensive technical colleges working with the defensive enterprises to order and the subsequent presentation to production to the end user (to MAI, MFTI, MVTU of Bauman, etc., in total about 70 higher education institutions). In spite of the fact that they more were guided by linear model of the innovative cycle "from science to a product", the resource of transition to other options of an innovative cycle potentially at them is high and can be strengthened thanks to the traditions of development of new knowledge developed in these higher education institutions.

2. There is a various experience of many schools of sciences which have reached world level.

3. Traditions of engineering creativity, invention, substantially, not demanded by the country as a result of a separation of several generations of the Russian engineering case from the main supplier of engineering tasks - the market are very deep. In the early eighties the USSR made to a half of opening and world inventions, overwhelming number of which had no demand at the country industry. The sense of the Soviet equivalent of concept of an innovation popular in those years "introduction" tells for itself. On many factors of the USSR in the 80th years could become an independent, self-sufficient innovative pole of the world, but for this purpose there was no understanding of opportunities of innovative economy various elite groups of the country, first of all the imperious.

4. The number of the people having various experience of research works, in Russia is still great and exceeds number of research workers in the USA: at us 4.35 thousand people on 1 million inhabitants, in the USA - 3.73 thousand. At success of innovative economy in Russia they can play an important role in deployment of innovative programs, creation of the positive innovative environment.

5. And, at last, in Russia objectively there is a demand for new engineering shots. They are necessary already operating while in limited quantity to innovative sector of the Russian economy, they are necessary for staffing of federal programs of the innovative development for the first time approved by the government of the Russian Federation in 2002.

The academic and scientific activity has no in our country of that prestige that in Europe, and the best young talents usually don't choose for themselves scientific career. Probably, this situation can be corrected by development of the strengthened preparation on mathematics and natural sciences at high school and an intensification of fundamental preparation at universities. There is no doubt that the future of engineering becomes inevitable is connected with development of "pure" science more and more closely.

The Russian highest technical educational institutions pay much attention to design, and by means of implementation of the degree project they try to prepare the students for real practical work. The American highest technical educational institutions give to very few students in this area. In the field of designing of cars they understand very little. Many of them considered that the engineer has to prepare only sketches, and the draftsman who will choose the demanded sizes on the basis of last experience and by means of the directory has to design. The situation for the last 30 years considerably improved, but with our weak preparation at high school we won't be able to reach, apparently, that higher educational institutions in Russia have today.

The most important achievement of Russia in engineering education is the organization of preparation of engineers of new type whom we will call research engineers. This preparation is based on broad studying of such fundamental sciences, as mathematics, mechanics, and physics, for the purpose of gap elimination between "pure" and applied sciences.

The list of problems demanding solution is impressive. The first part of problems is connected with creation in Russia for the first time in its stories of the steady and successful innovative environment, overcoming within a short period of time three important psychological barriers in society and in scientific and educational communities.

1. In Russia there are no traditions to unite innovative creativity of scientists and engineers with market mechanisms, with commercial success. Still there is no effective mechanism of the personified encouragement of technical creativity, protection of intellectual property rights on results of engineering work. From all types of creative activity the engineering least status, engineers from all layers of the creative intellectuals are in the distress. The beginning of preparation of the innovative managers, new type of engineers occurs in a minimum of prestige of an engineering profession and a lot of work on a basic change of the relation of society to engineering work is required.

2. There are no traditions to work with various customers except the state which in Soviet period was guided, first of all, by political reasons. As result, in the country the whole directions of engineering creativity have no development; there are no systems of the feedback, allowing bringing corrections in created products according to requirements of end users (except for only military development). All education systems within decades worked in the conditions of 100% a state order. Transition to the market relations in preparation of the new engineering case demands development of unusual active space, will and ability. Actually higher education institutions, beginning the innovative way in education, have to change at the same time itself, i.e. will be compelled to apply art of updating, an innovation for the creative, organizational and financial development.

3. There are no traditions of lobbying of the interests in new conditions, carrying out in authorities of necessary bills, programs, decisions. First of all, there is no joint installation of scientific and educational engineering community on promotion of the idea of innovative economy, society and economy of

knowledge. All three main problems complicating innovative activity: absence of adequate legal base, the preferential taxation, effective system of the state support can be resolved in the conditions of democratic system of decision-making only through formation of the corresponding public opinion. And all interested participants have to find the place in this essentially important process of "innovative economy", including institutes of engineering education.

The second, the main, part of problems concerns actually changes in engineering education. The system of preparation of engineers as a whole in the country remained traditional, branch. Conservatism of an education system on the one hand played the positive stabilizing role last decade of reforms, having kept everything is positive that was saved up for many years, but on the other hand it didn't allow to develop internal incentives of modernization of education.

Communication with practice, with the industry and science remains weak. The remaining branch gap between education, science and production still doesn't allow using effectively the modern scientific equipment, both for researches, and for training. Long existence of engineering education under trying conditions a survival and considerable isolation brought, naturally, to inevitable processes of formation of the "education for the sake of education" installation, to emergence specific, adjusted on the internal purposes (maintenance of qualification system of reproduction and training, etc.) the high school science existing more in the information space.

Practicing of new engineering education can't be often realized because of insufficient informatization of higher education institutions, absence powerful the Internet of the centers, the electronic libraries, stable relations with foreign universities, an exchange of students, graduate students and teachers, work opportunities with the foreign innovative centers.

There are problems of teaching personnel: age, average age of teachers in higher education institutions often exceeds 50 years, and professional. The range of disciplines and training methodology in many cases should be defined still. Development of new courses and technologies of training demands new motivations, knowledge, skills of the teaching case.

The list of problems can be continued, but the most important from them, in our opinion, are: exit of higher education institutions to direct contact with the market, with production, with innovative activity, every possible development of scientific researches, and change of a paradigm of education. Entry of higher education institutions into various economic, educational, research and innovative network structures will allow solving these problems most successfully. The engineering educational community should realize usefulness of changes for the new future, to turn together with the state and different industries and business from military industrial complex and natural monopolies to banks and the small innovative enterprises a present crisis state of Russia into its innovative resource of development.

Uses of a known method of parallel planning and design, active exit in world information and innovative space can become mechanisms of achievement of the new purposes of engineering education of Russia, first of all, concentration of resources on the priority direction of preparation of innovative managers. Technical universities for achievement of the new purposes have to begin changes in two directions with the point of view of management. On the one hand they have to become the effective organizations, i.e. community of experts in the field of educated the look, united by the uniform purpose of transformation to higher education institutions of new type. On the other hand they inevitably have to become subjects of economic activity, control with which is exercised already as the business enterprises. Thus, in higher education institutions there is a need of creation of team of "changes" operating in common from "founders" of new educational space and the "organizers" providing economic efficiency of activity of higher education institution. The state in this scheme acts not only and not so much as one of customers of shots, but, first of all, in the form of the partner, the coordinator, the inspirer and the creator of the innovative environment.

Transformation of technical colleges into active, creating "organizations" sets for them new tasks of application in the practice of the basic principles of creation new, realization of policy of changes:

1. Planned systematic improvement of all of that becomes. Changes accumulated gradually turn after a while into new quality, in this case, engineering education.

2. Use of successes in the interests for new appendices and achievement of the new purposes.

This principle is especially important, in our opinion, in Russia as only visible successes in a condition to convince many of prospects of innovative economy in our country and need of changes for engineering education.

3. Initiation of changes as continuous process of training of creation of innovations and elaboration of installation that innovations can and have to be organized as systematic process.

Knowledge, production, business, education become interconnected. Universities become one of the main places of their meetings. What model of further development of Russia wouldn't be chosen: development of the national market, export of ready decisions and products on a foreign market, development of offshore programming and innovative activity, a core of any of them can be only coordinated actions of education, science, the industry and business for the sake of economic success.

For engineering education there came time of changes. The time of concentration of efforts of the state, business and society came to creation of effective prestigious engineering education. The time of address financial, moral and legal aid for education of future generations of engineering shots of arising innovative economy of Russia came. It will be that new "carpet" of competition on which Russia has chances to win victories. Creative victories, personal and command.

To turn knowledge into a source of successful development of the country becomes the main objective of new engineering education of Russia.

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EDUCATIONAL APPLICATION FOR STUDENTS OF NUCLEAR INDUSTRY AND NONPROLIFERATION

S.A. Edreev, A.E. Kolchev
Scientific advisor: Prof., Dr. V.V. Larionov
Language advisor: O.S. Glushakova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: Edreev.stas@yandex.ru

Annotation

The aim of this project is to make a contribution into nuclear industry by involving multimedia technology in educational process of students of nuclear sphere. One should be aware of the fact that it will make the process of learning much easier than it is and as consequence will improve quality of knowledge of students. Besides, this project is focused on the understanding of different basic nuclear physics processes with help of Microsoft flash animation.

The first part deals with the detailed description of visual aids during a lesson as well as with the problem of understanding of physics processes among the average student in the technical and non technical universities.

The second part covers the flash project which includes the example of multimedia in education.

After all the basic aspects being highlighted, the results of approbation and basic conclusion will be presented in detail.

Introduction

Key words: project, education, Microsoft flash, visual aids (animation)
Science: nuclear physics
Related science: computer science, methodology

Innovative approach in nuclear industry requires new approaches in the sphere of education of appropriate specialists. Science and technology developing allow introducing new methods of studying. It must be pointed that one of this methods is introducing educational multimedia animation programs. That is why the aim of this project is to create multimedia educational program (for nuclear physics).

The example of the program suggested in this work presents the project created on the basis of Microsoft flash to make the process of getting new skills in nuclear physics area more simple and feasible for every student owing to implementation of illustrative and animated theoretical material.

1. Modern application of visual aids during a lesson in relation to the problem of understanding the processes of nuclear physics

Today’s education requires a lot of innovational ideas to improve the process itself, to make educational process easier for students and for teachers and lecturers. Unfortunately, today only few students attend the library to take the books and learn “How it works”. Moreover, the high speed of the Development of the Internet and mass media leads to changes in people’s mind. Besides, al the high tech technologies contribute to the changes in the way of perception of new information.

The fact that should be taken into account is that there are some subjects in the university which are very hard even with using of books and lectures. For example, studying of physics as well as some of the physical processes isn’t very hard and they are intuitively clear for students such as low of uniform and direct motion. However there are a lot of processes in physics such as nuclear processes and thermodynamics processes which are extremely difficult for students even for students of technical specialties.

Thus, it leads to the idea that educational process must be improved anyway.

Multimedia technology is one of the easiest ways to solve the problem which was discussed above. The most of lecturers got used to apply the multimedia technology; in general it’s Microsoft PowerPoint presentations. It makes them free from writing and gives time to explain the slides and the process which is described. What is more a lot of teachers use the educational movies, and different cassettes with information (last point in general for teachers of different languages).

Without any doubt it makes make the process of perception of information a lot easier.

There is one very useful program which helps to create multimedia animation projects - Macromedia Flash.

2. The application in nuclear physics on the platform of MF

Firstly, concept of such application has to be developed.

The aim of this application is to give general information and postulates of nuclear physics processes required for students of nuclear industry and nonproliferation. Information should be given in the way of game to make students interested in the class.

It was decided to include in this application information about structure of matter, processes in nuclear physics, nuclear reactor and nuclear bomb processes, and information about thermonuclear reactor as the most prospective way of using nuclear energy.

It was decided to give information in axiomatic way to not follow evolution of science, which do teaching process slow. It makes perception of new information mush easier.

Great advantage of this application is animation of nuclear processes. Animation models reflect up-to-date knowledge of modern physics and also they help to understand the lecture.

This approach doesn’t give deep knowledge about the theme but this application is not supposed to provide it. For deep knowledge there are a lot of literatures students can use.

Educational course that was created for this application is quite short but full enough to structure basics in the students head.

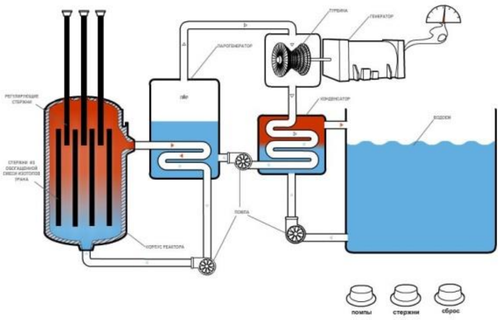
Information included in application:

- Matter structure - it is very first step in nuclear physics study to know what matter consist of.
- Isotopes and radioactivity - it is vital to know about isotopes for understanding of radioactivity.

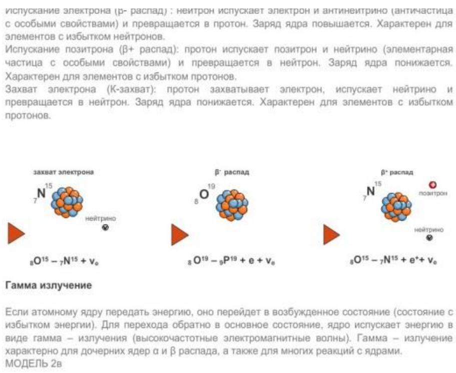
Animation model of radioactivity types is given

- Interaction of radioactivity with the substance
- Nuclear and thermonuclear reactors schemes
- Nuclear bomb work principle
- Interaction of radioactivity with living organisms

Application has been tested on TSU and TPU students. This test reveals convenience and efficiency of this application in education.



Pic.1. Nuclear reactor animation model



Pic.2. Beta - decay animation model

Pic.3. Nuclear bomb animation model

Results

The educational program was created with the intention to simplify the process of acquiring knowledge in the sphere of nuclear physics. The results were approbated on different faculties of National Research Tomsk Polytechnic University.

To make the situation clear it should be stated that the results of approbation met all requirements as long as the program:

- is very simple in use;
- does the nuclear processes very clear to all students of the group;
- enhances students' motivation in studying physics;
- contributes to the development of visual-image thinking;
- acts as means of increasing attention to the assimilation of the definite educational material;
- allows to specify the theoretical issues;
- makes the scope of practical application of material under study much broader;
- creates opportunities for modeling a number of processes;
- establishes lasting connections between the form of the theoretical material and its content;
- helps to enhance learning and cognitive activities of students.

Thus, resuming all the above aspects it must be noted that this project can be used by the students of non-technical faculties and even the students in high schools to simplify the process of studying.

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FILE SYSTEMS WITH DATA REPLICATION AND DATA HANDLING ON SERVER SIDE AND ON CLIENT SIDE

D.J. Izai

Scientific advisor: As. Professor N.A. Alekseev

Language advisor: A.S. Nypadymka

National Technical University of Ukraine "Kiev Polytechnic Institute",

Ukraine, Kiev, Pobedu avenue, 37, 03056

E-mail:dimmu4@mail.ru

Abstract: The main features of data handling in file systems with data replication of two types: file systems with data handling on server side and file systems with data handling on client side were considered in the present work, the advantages and disadvantages were determined, and the sphere of application of each file system was described.

Nowadays many big companies and corporations need to have their own storage of data and need to organize access to it. One of the ways of doing that is creation of servers and the usage of file systems. It is important for the company to store their information reliably, so file systems make data replication on their storages. File systems are different due to the data handling: some of them work with data mostly on server (for example Hadoop Distributed File System (HDFS)) or on client machine (for example Gluster File System(GlusterFS)).

HDFS is a block-structured file system: individual files are broken into blocks of a fixed size of 64 MB. These blocks are stored across a cluster of one or more machines with data storage capacity. Individual machines in the cluster are referred to as DataNodes. A file can be made of several blocks, and they are not necessarily stored on the same machine; the target machines which hold each block are chosen randomly on a block-by-block basis. Thus access to a file may require the cooperation of multiple machines, but supports file sizes far larger than a single-machine DFS; individual files can require more space than a single hard drive could hold.

If several machines must be involved in the serving of a file, then a file could be rendered unavailable by the loss of any one of those machines. HDFS combats this problem by replicating each block across a number of machines (3, by default).

Most block-structured file systems use a block size on the order of 4 or 8 KB. By contrast, the default block size in HDFS is 64MB - orders of magnitude larger. This allows HDFS to decrease the amount of metadata storage required per file (the list of blocks per file will be smaller as the size of individual blocks increases). Furthermore, it allows for fast streaming reads of data, by keeping large amounts of data sequentially laid out on the disk. The consequence of this decision is that HDFS expects to have very large files, and expects them to be read sequentially. Unlike a file system such as NTFS or EXT, which can see many very small files, HDFS expects to store a modest number of very large files: hundreds of megabytes, or gigabytes each. After all, a 100 MB file is not even two full blocks. Files on your computer may also frequently be accessed "randomly", with applications cherry-picking small amounts of information from several different locations in a file which are not sequentially laid out. By contrast, HDFS expects to read a block start-to-finish for a program. This makes it particularly useful to the MapReduce style of programming. That was said, attempting to use HDFS as a general-purpose distributed file system for a diverse set of applications will be suboptimal.

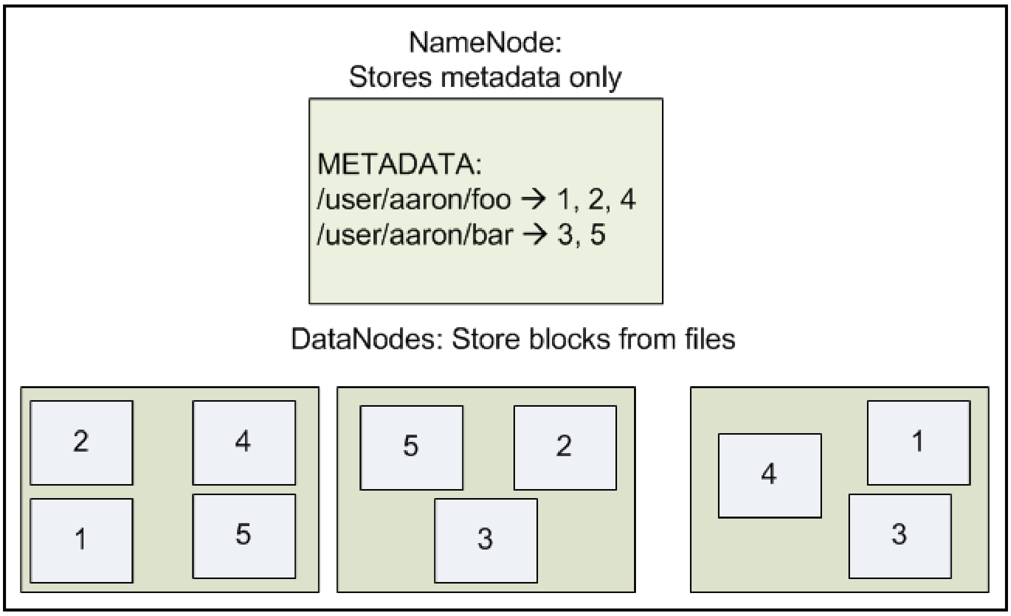

Figure1: DataNodes holding blocks of multiple files with a replication factor of 2. The NameNode maps the filenames onto the block ids.

It is important for this file system to store its metadata reliably. Furthermore, while the file data is accessed in a write once and read many model, the metadata structures (e.g., the names of files and directories) can be modified by a large number of clients concurrently. It is important that this information is never desynchronized. Therefore, it is all handled by a single machine, called the NameNode. The NameNode stores all the metadata for the file system. Because of the relatively low amount of metadata per file (it only tracks file names, permissions, and the locations of each block of each file), all of this information can be stored in the main memory of the NameNode machine, allowing fast access to the metadata.

To open a file, a client contacts the NameNode and retrieves a list of locations for the blocks that comprise the file. These locations identify the DataNodes which hold each block. Clients then read file data directly from the DataNode servers, possibly in parallel. The NameNode is not directly involved in this bulk data transfer, keeping its overhead to a minimum.

Of course, NameNode information must be preserved even if the NameNode machine fails; there are multiple redundant systems that allow the NameNode to preserve the file system's metadata even if the NameNode itself crashes irrecoverably. NameNode failure is more severe for the cluster than DataNode failure. While individual DataNodes may crash and the entire cluster will continue to operate, the loss of the NameNode will render the cluster inaccessible until it is manually restored. Fortunately, as the NameNode's involvement is relatively minimal, the odds of it failing are considerably lower than the odds of an arbitrary DataNode failing at any given point in time.

GlusterFS is a clustered file-system capable to scale to several peta-bytes. It aggregates various storage bricks over Infiniband RDMA or TCP/IP interconnected into one large parallel network file system.

GlusterFS has a client and server component and uses FUSE which allows to aggregate disparate storage devices, which GlusterFS refers to as "storage bricks", into a single storage pool or namespace. It is what is sometimes referred to as a "meta-file-system" which is a file system built on top of another file system. The storage in each brick is formatted using a local file system such as ext3 or ext4, and then GlusterFS uses those file systems for storing data (files and directories).

One of the main features that differs GlusterFS from another file systems is the concept of "translators" that provides specific functionality such as IO schedulers, clustering, striping, replication, different network protocols, etc. They can be "stacked" or linkned to create a file system that meets your specific needs. Using translators, GlusterFS can be used to create simple NFS storage, scalable cloud storage with replication, or even High-Performance Computing (HPC) storage.

GlusterFS begins with the concept of a storage brick. It is really a sever that is attached to a network with some sort of storage either directly attached (DAS) or has some storage via a SAN (Storage Area Network). On top of this storage creates a local file system using ext3, ext4, or another local Linux file system (ext3 is the most commonly used file system for GlusterFS). GlusterFS is a "meta-file-system" that collects these disparate file systems and uses them as the underlying storage. GlusterFS allows aggregating these bricks into a cohesive name space using the stacked translators.

The GlusterFS exports an existing directory as-is, leaving it up to client-side translators to structure the store. The clients themselves are stateless, do not communicate with each other, and are expected to have translator configurations consistent with each other. GlusterFS relies on an elastic hashing algorithm, rather than using either a centralized or distributed metadata model. With version 3.1 and later of GlusterFS, volumes can be added, deleted, or migrated dynamically, helping to avoid configuration coherency problems, and allowing GlusterFS to scale up to several petabytes on commodity hardware by avoiding bottlenecks that normally affect more tightly-coupled distributed file systems.

HDFS is used if there is a necessary to make a big storage and hold very large amounts of data (terabytes or even petabytes), and provide high-throughput access and there is a powerful machine that can be used as a server. If company needs to have simple data storage that can be changed easily and do not have a lot of computing resources, it using systems like GlusterFS.

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TRADITIONS AND INNOVATIONS IN ENGINEERING

D.A. Kolmakov, M.I. Krasnov
Language advisor: Teacher O.I. Shaykina
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: Krasnov-maks@mail.ru

Engineering business will be realized through application of both scientific knowledge and practical experience (engineering skills, abilities) with the purpose of creation (first of all planning) of useful technological and technical processes and objects that will realize these processes. Services in engineering can execute independent engineering companies. Such organizations offer the complex of commercial services in preparation and providing of process of production and realization of products, on service and of exploitation industrial, infrastructural and other objects, that plugs in itself engineer-consultative services of research, calculation-analytical character, on preparation of feasability studies, rule-making in area of organization of production and management.

The set of technical decisions and inventions created as a material resources for the subsequent progress, and shaped skills passed from generation to generation and skills which, collecting, became a basis for the subsequent theoretical judgement.

The especial role was played with progress of construction. Erection of cities, protective constructions, religious constructions always required the most advanced technical methods. Most likely in construction for the first time there is a concept of the project, when for realization of a plan it was required to separate idea from direct manufacture to have a possibility to operate process.

Process of engineering activity begins with formation of demand for the artificial mechanism or process. Having studied this demand, the engineer should generate a plan of the decision it is necessary for them to give the certain form - the project. The project is necessary, that a plan of the engineer (group of engineers), existing as idea, became clear to other people. The project is embodied in the further in a reality by means of building materials.

At the decision of a problem facing it the engineer can use already turned out decisions. In particular, the wide circulation since the earliest times has received typical design. However it is not enough for not trivial problems of standard decisions. In such cases it is possible to speak about engineering as about "engineering art" when applying special-purpose knowledge the engineer should create object, think up a way, what else earlier did not exist.

The professional thinking of engineer presents a difficult psychical process that, as well as any art, difficult yields to formalization. In the general approaching it is possible to distinguish the next stages at the decision of engineering task:

understanding of the technical requirements contained in an initial task;
creation of intention of decision;
confirmation or refutation of intention.

The given stages not necessarily pass consistently, more likely, process of formation of the answer to a task in view passes cyclically, and not always with clear comprehension. The guess can sometimes be as intuitive inspiration. Based on the saved up experience, it in the further is maybe explained and analysed, however in the first instant there is no possibility to tell as well as why it was born. Guesses are possible at an intuitive subtype of thinking as which it is possible to consider as the basic source of generation of ideas. It is closely connected and with other subtypes: synthetic and analytical, creative and routine, logical.

Probably, each of us observed of flight of a bird dreaming about that what as easily to soar having trusted in counter streams of air, but always there are those who dreams also those that that does.

The innovative project from a command of engineers from Germany under direction of Friza Ugnera - SkyFlash, is directed on that that dreams would become "volumetric". Ugner by means of jet satchel and a wing, capable to change the sizes depending on conditions, has aimed to make the sky more available.

Actually wing with adjustable geometry also is a basis of this innovative project. The given idea has been borrowed at the nature, Condor to change a trajectory and speed of flight or to go on decrease enough only slightly to taxi up a tail and to manipulate greater finger-shaped flywheel feathers on edge of each wing.

Having taken for a basis this principle, German engineers began to develop the innovative idea in a similar key to strengthen elevating force a wing is capable to increase, and then once again to accept the usual sizes for smooth flight. The given technology, as a matter of fact, is not new and in aircraft construction is applied widely enough, but in such compact type is presented for the first time.

As into the complete set of an arrangement enters two diesel micromotors established in a backpack "WingBody" which all operating stuffing, besides, is built in. The control panel is at "pilot" in a hand and by the form reminds the board for management of model aircrafts, in a role the chassis acts four permanently installed wheels which fasten in the field of a breast and knees. The gross weight of all equipment necessary for flight makes 25 kg.

Extreme looks not only the device but also a way of its management: what to change directions of flight or height, it is necessary to change a slope of a body and to place legs packed in fire-resistant boots specifically in a jet and if it is necessary to make sharply maneuver aside one of сопл is completely blocked by a leg. Developers have decided to make secure and have equipped "Skyflash" with a parachute which is maybe involved in case of an emergency situation. To a word the given lethal device passed only ground-based tests. From flying characteristics declared by developers it is known, that the maximal speed more than 320 km/hours, height of flight - about 8000 km, time of flight 1 hour.

Otherwise the engineering is a set of works of the applied character, including predesign technical and economic researches and backgrounds of the planned capital investments, necessary laboratory and experimental completion of technologies and prototypes, their industrial study, as well as the subsequent services and consultations.

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MODERN PRODUCTION OF SULFURIC ACID

D.A. Koshkina, K.A. Khoreva

Scientific advisor: Ph.D., As. Professor A.Yu. Vodyankin

Language advisor: Senior teacher Y.V. Rozanova, Senior teacher N.N. Zyablova

Tomsk Polytechnic University, Russia, Tomsk, Lenin Avenue 30, 634050

E-mail: koshkina_17@mail.ru

This article covers the major industrial methods of production of sulfuric acid. The paper presents the main stages of each method. Also it focuses on the advantages and disadvantages of the particular method. The types of materials used for production and the percentage of their use are considered in the paper. The application of sulfuric acid is described is well. Finally the information about the trends in the development of the production of sulfuric acid is presented. Article is of interest to students and students of chemistry and chemical technology.

Currently, sulfuric acid is one of the most important products of the chemical industry. The major use of sulfuric acid is in the production of fertilizers, e.g., superphosphate of lime and ammonium sulfate [1]. It is widely used in the manufacture of chemicals, in processing metals. It serves as the electrolyte in the lead-acid storage battery. The purpose of this paper is to describe the basic methods of sulfuric acid production, which are used in Russia. The objectives of this work are to conduct a literature review of existing methods of acid production; to determine the distinctive features of each method; to find out what methods are used now, and what their advantages are.

The raw material for the sulfuric acid production is pyrite (iron pyrite), elemental sulfur, hydrogen sulfide, and the exhaust gases. Nowadays, sulfuric acid is produced by two industrial methods: nitrous, there are over 200 years old, and contact utilized in industry in the late XIX and early XX century [2].

The first stage of the sulfuric acid production by any method is getting sulfur dioxide by burning sulfur feedstock. After cleaning sulfur dioxide, it is oxidized to sulfur trioxide, which combines with water to form sulfuric acid. Oxidation of SO_2 to SO_3 in normal conditions is slow. To accelerate the process catalysts are applied.

Nitrose (tower) method

In the first stage of the raw material sulfur dioxide is obtained [3]. In a special 3 oxidizing tower nitric oxide NO and NO_2 are mixed with air in a ratio to the mixture had equal amounts of NO and NO_2:

$$2NO + O_2 = 2NO_2.$$

This mixture is fed to the tower 4 and 5, irrigated 75% – sulfuric acid, a mixture of nitrogen oxides are absorbed to form nitrozillerny acid:

$$NO + NO_2 + 2H_2SO_4 = 2NO(HSO_4) + H_2O.$$

Solution of nitrozillerny acid in the sulfuric acid, irrigates towers 1 and 2 where a countercurrent SO_2 enters and water is added. As a result of hydrolysis of nitrozillerny acid hydrogen nitrate is formed:

$$NO(HSO_4) + H_2O = H_2SO_4 + HNO_2.$$

It oxidizes SO_2 by the equation:

$$SO_2 + 2HNO_2 = H_2SO_4 + 2NO.$$

75% sulfuric acid collects at the bottom of the towers 1 and 2 in a larger amount than it has been spent. Nitric oxide NO is returned back to the oxidation. As some of the NO is lost with the exhaust gases it must be added to the system HNO_3, which serves as a source of nitrogen oxides.

The lack of a tower of the method is that the resulting sulfuric acid has a concentration of only 75 % (with a greater concentration is bad nitrozillerny acid hydrolysis). It must be emphasized that concentrating the same sulfuric acid evaporation is more difficult.

The advantage of this method is that the impurities contained in SO_2 have no influence on the process, so that the original SO_2 is clean enough from admixtures. Besides, the sulfuric acid tower is not clean enough and it limits its application.

Contact method

Chemical scheme of the sulfuric acid product from pyrite comprises three successive stages [2]:

1. Oxidation of iron disulfide oxygen:

$$4FeS_2 + 11O_2 = 2Fe_2S_3 + 8SO_2.$$

2. Catalytic oxidation of sulfur dioxide (IV) with excess oxygen furnace gas:

$$2SO_2 + O_2 = 2SO_3.$$

Experimentally it has been found by chemical engineers that the optimal temperature for the reaction temperature is 400–500 °C. The best catalyst for this process is vanadium oxide V_2O_5.

3. Absorption of sulfur oxide (VI) to form sulfuric acid:

$$SO_3 + H_2O = H_2SO_4.$$

The technological process the sulfuric acid production from elemental sulfur differs from the process of production of pyrites. The most noticeable feature - no pretreatment stage furnace gas.

There is also a process for producing sulfuric acid from hydrogen sulfide, known as a "wet" catalysis [4]. In contrast to the sulfuric acid production methods from pyrite and sulfur, in the wet catalysis there is no special stage absorption of sulfur oxide (VI). The entire process includes only three successive stages: the burning of hydrogen sulfide, the oxidation of sulfur dioxide (IV) to sulfur oxide (VI), condensation steam and the formation of sulfuric acid.

Even more often as raw materials exhaust gases from industrial production, petroleum refining and from thermal stations are used. But when they are used, there are certain difficulties [5]. They contain different impurities dust, toxic substances and moisture excess.

According to the sulfuric acid world production in 2012 it was 230 millions of tones per year. And every year that number will grow, because the need for sulfuric acid is very high. World production of sulfuric acid from pyrite - 9 %, from the exhaust gas 30 %, of elemental sulfur, 61 % (2011 data) [6]. In Russia, as in the world, there is a tendency of growth of production of acid from elemental sulfur and non-ferrous metal waste gases. It can be inferred that the use of waste gases from other industries reduces emissions into the atmosphere and reducing the need for ore extraction.

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DETERMINATION OF KINETIC PROPERTIES OF CARBON FLUORINATION PROCESS

A.V. Rybakov

Scientific advisor: Ph.D., As. Professor R.V. Ostvald

Linguistic advisor: Senior teacher N.N. Zyablova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: rybakov91@tpu..ru

The possibility of amorphous carbon fluorination at moderate temperatures was determined. An analytical method of kinetic properties determination of fluorination process at 70-130 °C *was offered. The equation which describes the kinetics of the fluorination process and activation energy were determined.*

Key words: fluorination, amorphous carbon, kinetics, accumulators

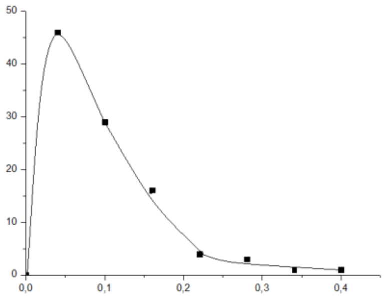
Nowadays, the world becomes more mobile. The accumulator's quality and capacity are fully determined by electrochemical system. The most perspective material for current production in such system is $Li/(CF_x)_n$, where "x" can change from 0,1 to 1,2. Fluorocarbon in this scheme becomes a cathode. System $Li/(CF_x)_n$ has many advantages: high voltage (2,7–3,6 V), specific energy (700 w*h/dm^3) [1], the lowest self-discharge (~1% per year), more safety and reliability during keeping and transportation .

The world's fluorocarbon market is far from saturation, because accumulators production gradually switches over to lithium electrochemical systems. Russian market size of fluorinated carbon was only 15 tonns in 2011. Therefore, it is being planned to work out and implement new resource-effective technology of fluorocarbon production. For creation of trial installation first of all it is necessary to study kinetics of the process.

There are various methods of carbon fluorination, for instance, by the mixture of fluorine and nitrogen gases at temperatures of 320-500 °C [1] or fluorination with catalyst at 100 °C [2]. There are works describing fullerene [3] and carbon nanotubes [4,5] fluorination. However, there is no research describing amorphous carbon fluorination. In present work the kinetics of heterogeneous reaction between fluorine and amorphous carbon at temperatures below 130 °C was determined.

Carbon was represented by ungeometrical particles which had bulk weight (0,79±0,05) g/cm^3 and real density 1,4 g/cm^3. Its classification is presented in figure 1, the amorphous carbon particles are shown in figure 2.

Particles share, %



d_{av}, mm

Figure 1. Carbon particles classification

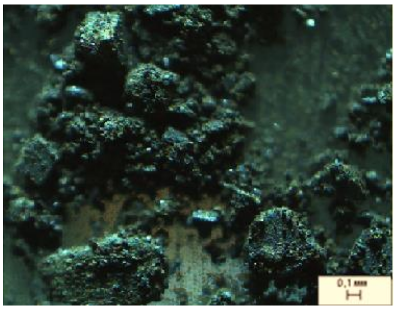


Figure 2. Carbon particles photo

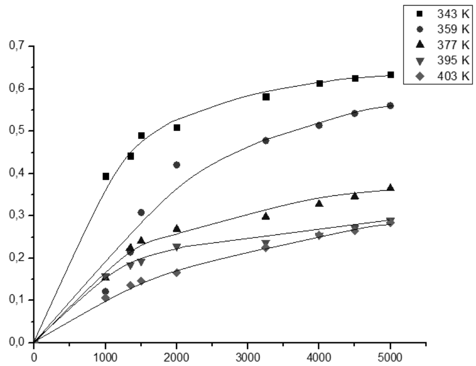
Before the research all the surfaces of experimental installation were passivated by the mixture of fluorine and argon gases. Then, the sample holder was hung up by the fiber to weigh sensor. One gram of the carbon was put into sample holder. Fluorination was carried out at temperature range from 343 K to 403 K during 1,5 hour. Fluorine volume flow rate was V_f = 4,2 l/h, argon volume flow rate was V_a=37,8 l/h.

Studying of carbon fluorination process was carried out in the nickel vertical reactor. The pilot installation was developed from corrosion-resistant materials in the fluor environment: nickel, stainless steel, copper. Fluoroplastic - 4 was applied as a sealing material.

Fluorine was received from the fluor electrolyzer. The fusion reaction occurred in the vertical reactor where carbon contacted with gaseous fluorine. Temperature monitoring in volume of reaction was carried out by chromel-kopel thermocouple. Temperature control was implemented with personal computer which showed the dependence of temperature on time. Weight measurement was implemented with inductive non-contact sensor which signal was brought to the monitor as dependence of sample weight on time.

The fractional conversion dependence on temperature and time was introduced in figure 3.

α, %



Time (τ), sec

Figure 3. The fractional conversion dependence on temperature and time

Figure 3 shows that the maximum fractional conversion value was achieved at 343 K, the minimum fractional conversion value was achieved at 403 K.

For further mathematical treatment of the received data for kinetics parameters determination three models were used:

Reducing sphere equation:

$$1-(1-\alpha)^{\frac{1}{3}}=k\tau$$

Yander equation:

$$1-((1-\alpha)^{\frac{1}{3}})^2=k\tau$$

Crank-Gistling-Brounstein equation:

$$1-\frac{2}{3\alpha}-(1-\alpha)^{\frac{2}{3}}=k\tau$$

For definition of the equation which can describe the experimental data more precisely, these equations were linearized and compared.

The kinetic lines were linearized into Crank-Gistling-Brounstein coordinates more precisely (fig.4).

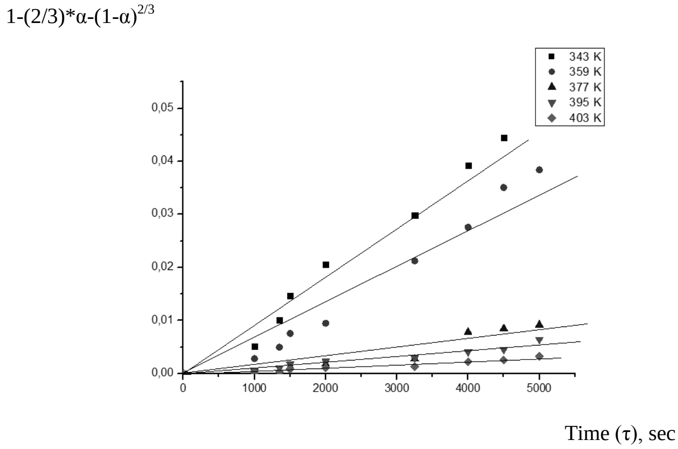


Figure 4. Kinetic lines linearization into Crank-Gistling-Brounstein equation coordinates

For activation energy determination the dependence of chemical rate on inverse temperature was constructed (fig.5). Activation energy was calculated from tangent and has value E_a=921,1 kJ/mole.

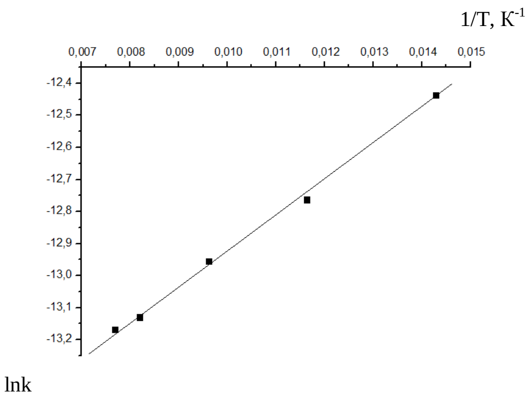


Figure 5. The dependence of chemical rate on inverse temperature

The gained data shows that amorphous carbon can be fluorinated from 70 °C, fluorination occurs into kinetic field as a result of the process limited by chemical reaction. The received Crank-Gistling-Brounstein equation for this reaction allow us to control the fluorocarbon fractional conversion value.

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GOLD EXTRACTION FROM BURROW AND VARIOUS PRODUCTION WASTES

R.R. Sharafutdinov, A.V. Mishustin

Scientific advisor: Ph.D., As. Professor R.I.Kraydenko

Scientific advisor: Senior lecturer Ya.V. Rozanova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: tpu_man@sibmail.com

This article covers the emerging problem concerning the search for alternative sources of gold. Modern methods were introduced to extract fine and ultra-fine gold. Benefits and drawbacks of each method were defined. Optimal conditions were identified for each of the considered method of gold extraction. Inferences about the appropriateness of using these methods to get gold were made. The article is of interest to specialists, engineers, students, academics, people interested in the topic.

To start with, it is important to mention that nothing is eternal in this world. In this case it applies to deposits of gold, which eventually became unfit for use. In recent years, therefore, there is a growing interest to alternative sources of gold. Particularly, they are the piles of old deposits and residues of various industries, where much of the gold is fine and ultra-fine sections with particle sizes less than tens of microns, tightly associated with mineral components of different nature. It is the imperfection of the early technologies of gold extraction has led to such new and unique techniques. Moreover, their effective development is impossible without the use of modern methods for assessment of stocks and gold extraction. At the moment to extract fine and ultra-fine gold one need to use ammonium thiosulfate and urea leaching.[1]

The most common to date method of cyanide leaching gold represents a great danger for the environment, so it is of inefficient use to extract gold from carbon and organic raw materials, it is very sensitive to the presence of copper, zinc, nickel, antimony and arsenic. [2]

Alternative method of cyanide leaching is ammonium thiosulfate leaching. Thiosulphates alkali metals are biodegradable and almost safe that allow people to apply them to the underground and heap leaching, they are cheaper cyanides and more efficient in the cyanide casecarbon and copper-bearing ore. However, technological optimization process is more difficult due to the large number of concurrent oxidation reactions and disproportion occurring with the participation of thiosulphates, strongly influenced by pH and redox potential (Eh) system at the resultant complexes.[3]

In the research the optimal concentration of thiosulphate - 0.1 M Na2S2O3 has been identified, deviation from which there has been a dramatic decrease in the efficiency of dissolving gold (fig. 1) has been found and fixed.[4]

Hence, decrease of concentration of copper (II) ions in leaching solution also reduces efficiency of dissolving gold (fig. 1). The presence of magnetite, significantly reduces the rate of dissolving of gold. With increasing concentrations of thiosulfate leaching solution in the presence of magnetite, the speed of dissolving gold insignificantly improves.[5]

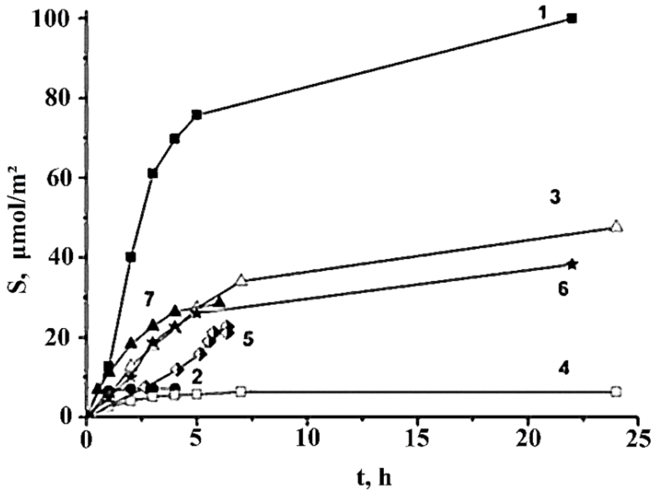

Fig. 1. Kinetics of dissolving(S) gold in leaching solutions of the following composition: 0.2 M NH3, 0.015 M CuSO4, 0.1 M Na2S2O3, pH = 10.4 (1); 0.2 M NH3, 0.015 M CuSO4, 0.2 M Na2S2O3, pH = 10.4 (2); 0.2 M NH3, 0.015 M CuSO4, 0.05 M Na2S2O3, pH = 10.4 (3);0.2 M NH3, 0.015 M CuSO4, 0.1 M Na2S2O3, pH = 9.4 (4); 0.2 M NH3, 0.01 M CuSO4, 0.1 M Na2S2O3, pH = 10.4 (5); 0.2 M NH3, 0.015 M CuSO4, 0.1 M Na2S2O3, pH = 10.4 in the presence of magnetite 0.5 mg/ml (6); 0.2 M NH3, 0.015 M CuSO4, 0.2 M Na2S2O3,pH = 10.4 in the presence of magnetite 0.5 mg/ml (7).

Other alternative methods consist in the use of acidic thioureasolutions. Advantages of this method compared with cyanide are: the higher (~ 10 times) process speed, the lower the dependence of efficiency from the presence of ions-impurity, lower consumption and corrosive reagents application of thiourea leaching at a concentration of about 3% urea TIO to extract up to 98% of the gold. [5]

However, there are disadvantages which are worth mentioning thiourea price of sodium cyanide at 25% is decomposed in oxidizing conditions, and extraction of gold from thiourea solutions with activated carbon is more problematic.

In the present research the optimal conditions for thioureaIeaching were identified: concentration of thiourea 30 g/l, sulfuric acid 10 g/l, the ratio of solid to liquid phase = 1: 3. Under these conditions the extraction of gold amounts to 93,5 %.[6]

This work has shown that at the moment we have several different methods of efficient and economically viable production of gold from alternative sources, such as old fields and waste dumps of various industries, without the use of toxic reagents. However, it is important to note that each method is effective only under certain conditions and for a specific composition of the substance.

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СЕМИНАР
GENERAL PROBLEMS AND PROSPECTS OF ENGINEERING DEVELOPMENT IN THE AGE OF GLOBALIZATION

DEVELOPMENT OF 60 GHZ SYSTEMS OF WIRELESS COMMUNICATIONS

O. Bespalova
National Technical University of Ukraine “Kiev Polytechnic Institute”
ave. Peremoga 37, Kiev, Ukraine, 03056,
E-mail: *nicson@list.ru*

Abstract. The paper presents requirements to support current and next generation 60 GHz wireless communication applications. This work includes information of usage 60 GHz frequency band, describes advances in wireless technology such as 3G and 4G. The work presented in this thesis is intended to support the design of low-cost 60-GHz transceivers for Gb/s transmission over short distances. Also this information comprises research into the characteristics of typical 60-GHz channels, the evaluation of the transmission quality as well as the development of suitable baseband algorithms.

Demand for very high-speed wireless communications is proportionally growing with respect to the increasing data rates reachable by optical fibers. The emerging research trend in computer networks is to cut more and more cables and to provide mobile and nomadic users with a data rate at least comparable with that one of wired Ethernet. GbE standard is now widespread and 10 GbE standard has been available since 2002.

The widespread availability and use of digital multimedia content has created a need for faster wireless connectivity that current commercial standards cannot support. This has driven demand for a single standard that can support advanced applications such as wireless display and docking, as well as more established usages such as network access.

While established and well-known fiber-optic data-transfer devices can provide multigigabit per second data rates, infrastructure costs and deployment time can be too expensive for some applications. Wireless links can be used to bridge the gaps in the fiber network and they can be deployed very rapidly, without the need for costly and complex trenching actions. Multigigabit wireless applications will include fiber segment replacement in future 3G and 4G backhauls, in distributed antenna systems, in enterprise connectivity, and in consumer-level applications, such as HDTV.

Future home and building environments are a domain where, in the coming decade, large quantitative and qualitative changes can be expected in services and applications, that ultimately will benefit from wireless multigigabit/s communication. Therefore, the need for such high data rates arises both in short-range scenarios and in medium-long range scenarios. The unlicensed 60 GHz frequency band has great potential for wireless applications. However, due to the unlicensed nature of the band, wireless networks operating in the 60 GHz band are likely to suffer from interference. Where a very huge bandwidth for multigigabit wireless communications can be made available as free spectrum without interference issues? The unique possibility is to look at EHF.

Recently, there has been a lot of interest in the development of 60 GHz systems for the indoor [1] and outdoor [2] applications, because this bandwidth has been allocated in many countries as free spectrum. The world-wide availability of the huge amount of license-free spectral space in the 60 GHz band provides wide room for gigabit-per-second (Gb/s) wireless applications. A commercial 60-GHz transceiver will, however, provide limited system performance due to the stringent link budget and the substantial RF imperfections. The particular motivation is the high attenuation (10-15 dB/km) caused by atmospheric oxygen for a band approximately 8 GHz wide around 60 GHz

However, because of higher propagation loss due to oxygen absorption at this band, it is not suitable for very long links. Further, the FCC has made available 13 GHz of spectrum in the 70-95 GHz (away from the oxygen absorption band, in order to facilitate longer range communication) for semi-unlicensed use for directional point-to-point “last mile” links. Above 60 GHz, both for long and short range, there is a lack of discussion on modulation, equalization, and algorithm design at physical layer. The possibility to use innovative and advanced radio interfaces based on IR UWB transmission technique, to realize multigigabit/s communications beyond 60 GHz [4], [5].

The 60Ghz band promises to provide a means of achieving very high data rate communications. With its 5-7GHz of bandwidth this band will allow communications in the range of gigabits per second. Of course, the band is not without its challenges. Path loss is more severe and implementing a highly integrated transceiver in CMOS will be challenging at the very least. CMOS has the advantage that it can support very large amounts of digital processing in a very small area and for very low power. The key to building advanced communications systems in CMOS, especially at a 60GHz carrier frequency, is to leverage the digital computational power of CMOS.

In addition high power sources are difficult to modulate at rates greater than several hundred Mbit/s so Gbit/s class systems, which require both high power and high speed are difficult to implement. Achieving sufficient power density with high modulation rates, whilst minimising overall power transmitted requires the use of multiple sources.

The data rates available using wireless communications typically lag those available using wired systems by approximately an order of magnitude for equivalent systems[1]. Gigabit Ethernet to the desktop is available using cable, but wireless networks that offer throughput of greater than 100Mb/s to the user, such as IEEE 802.11(n) are only just becoming available. The demand for wireless bandwidth will continue, with multi-techniques such as Multiple-InputMultiple-Output (MIMO) required to obtain capacity in crowded low-frequency regions of the spectrum. In particular, a MIMO configuration with space-time signal processing isused to establish a robust wireless link, even under NLOS conditions. [3]

There is also a move to higher regions of the spectrum, with 60GHz systems being developed IR UWB communication system is sensitive to typical H/W not idealities beyond 60 GHz (Phase Noise, Timing Jitter, LNA and HPA distortions) and compares its performance with the ones of a more classical continuous wave communications system based on FSK modulation. The exploitation of such higher frequencies represents the most suitable solution to develop a cooperative global information infrastructure in order to guarantee the so-called “Gigabit Connectivity” through aerospace links making such a radio segment a potential “backbone on the air” for global wireless connectivity. Therefore, the use of “beyond Q/V bands” will be the necessary condition to develop a multipurpose network, as integration of terrestrial and space systems, in order to support forthcoming high-data-rate services demands.

W band (75-110 GHz, respectively 4 -2.7 mm) could represent the answer to these needs due to the high bandwidth availability, short wavelength, reduced interference, small antenna size, allowing to propose many innovative services that need high-volume transfers. Currently, however, the performance behaviour of any solution for data transportation over W band frequencies across the Troposphere is still unknown, since no scientific and/or telecommunication mission has been realised, either on an experimental basis or in an operating mode. Therefore, missions in W band have to be studied in order to perform a first empirical evaluation of the Troposphere effects on the radio channel.

The focus of the analysis and performance evaluation of future missions for the exploitation of W band too for satellite communications aiming at designing a full line of P/Ls operating in such a frequency range. [6], [7] The design and performance analysis of missions to perform a first empirical evaluation of the Troposphere effects on the W band radio channel represent the preliminary useful step for realising a “System of Systems” which is able to meet the highquality data transmission requirements for a large number of end-users and data-oriented services.

CONCLUSION. There is increasing interest in developing 60 GHz multi-gigabit datarate wireless systems for short range wireless communication in homes, offices and small coverage areas. Interest in this application has been stimulated by the rapid advances in Silicon based technologies where single chip solutions appear possible operating at gigahertz frequencies.

Standards are still under development and major technical challenges still exist to reach the price points desired to allow broad deployment and thus the large volumes anticipated for target applications. [8]

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GENETIC ENGINEERING IN THE AGE OF GLOBALIZATION

O.O. Dolmatova

Linguistic advisor: O.I. Shaykina

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: wellwellwell@sibmail.com

Introduction

In the XX century. dynamic development of biological knowledge has led to the discovery of the molecular basis of life. Science itself closer to solving the greatest problems - the disclosure of the essence of life. Main goal - the solution of practical problems of agriculture, medicine and management of the evolution of life. The task is to create conditions for a sharp increase productivity of plants, animals and micro-organisms in learning ways to combat the health, longevity, long-term youth rights, to develop methods to control genetic processes underlying the evolution of species in the solution of problems associated with the widespread use of nuclear energy, chemicalization on national economy, with the flight of the spacecraft. Solved the greatest task of the organic world and the most important problem of biology - a phenomenon explained by heredity. Molecular biology efforts to decipher the genetic code, the synthesis of genes. Science is not only solves the problem that sets the date, but also prepares the future of technology, medicine, agriculture, interstellar flight, the conquest of nature. Genetic engineering, in turn, provides humankind altogether unexpected, surprising, and sometimes disturbing perspective: animal and human cloning, the creation of new forms of living genetically. This determines the increase of the responsibility of scientists - biologists for the future of our planet and its biosphere for the future of humanity.

What is genetic engineering?

Genetic engineering - a section of molecular biology, applied molecular genetics, whose task is purposeful design of new, not existing in nature combinations of genes by genetic and biochemical methods. It is based on the extraction of the cells of the body of a gene or group of genes, connecting them to specific nucleic acid molecules and the implementation of hybrid molecules into the cells of another organism.

Genetic engineering is a new, revolutionary technology, with which scientists can extract genes from one organism and introduce them to any other. Genes is a program of life - are biological structures that make up the DNK and which cause specific characteristics inherent in this or another living organism. Gene transfer makes it possible to overcome the species barrier, and send individual hereditary characteristics of one organism to others. Carriers of the material foundations of the genes are chromosomes, which contain DNA and proteins. But genes are not the chemical education, and functional. From a functional point of view, DNA is composed of a set of blocks that hold a certain amount of information - the genes. At the heart of the gene are its ability through the RNA to determine protein synthesis. In the molecule of DNA as it is written information identifying the chemical structure of protein molecules. Gene - section of DNA that contains information about the primary structure of a single protein (one gene - one protein). Since the organisms are present in tens of thousands of proteins, there are tens of thousands of genes. The collection of all the genes of the cell is its genome. All body cells contain the same genes, but each of them is implemented various parts of the stored information. So, for example, nerve cells, and the structural-functional and biological properties different from liver cells.

Restructuring genotypes for tasks of genetic engineering, is a qualitative change in the genes not associated with visible changes in the microscope the structure of chromosomes. Changes in genes, primarily due to the conversion of the chemical structure of DNA. Information about the structure of the protein, recorded as a sequence of nucleotides that is realized in the form of a sequence of amino acids in the protein molecule synthesized. Changing the sequence of nucleotides in the chromosomal DNA, loss of one and the inclusion of other nucleotide change the composition formed on the DNA, RNA molecules, and this, in turn, causes a new sequence of amino acids in the synthesis. As a result, the cell begins to synthesize a new protein, which leads to the appearance of an organism new properties. The essence of genetic engineering is that the genotype of an organism are integrated or exclude individual genes or groups of genes. As a result, embedded in a genotype previously missing gene can cause the cell to synthesize proteins, which it had previously not synthesized. The most common method of genetic engineering is a method of producing recombinant, ie containing a foreign gene plasmids. Plasmids are circular double-stranded DNA molecule consisting of several kilobases. This process consists of several stages.

1. Restriction - cutting the DNA, for example, a man into pieces.
2. Ligation - fragment with the desired gene include plasmids and sew them.
3. Transformation-introduction of recombinant plasmids into bacterial cells. Transformed bacteria with purchase certain properties. Each of the transformed bacteria multiplies and forms a colony of thousands of children - a clone.
4. Screening - the selection of clones transformed bacteria those plasmids carrying the gene of man.

This whole process is called cloning. With cloning, you can get more than a million copies of any fragment of human DNA or other organism. If the cloned fragment of a protein, it is possible to study experimentally the mechanism that regulates the transcription of the gene and the protein to accumulate in the right quantity. In addition, the cloned DNA fragment from one organism can be introduced into the cells of another organism. This can be achieved, for example, high and stable yields due to build gene provides resistance to multiple diseases. If you enter into the genotype of soil bacteria, the genes of other bacteria with the ability to fix atmospheric nitrogen, the soil bacteria will be able to translate the nitrogen bound nitrogen soil. By entering into the genotype of E. coli bacteria gene from human genotype, which controls the synthesis of insulin, scientists have found the insulin through such coli. With the further development of science will be possible to introduce a human embryo missing genes, thus avoiding genetic diseases.

The possibilities of genetic engineering

Significant progress was achieved in the practical development of new products for the medical industry and the treatment of human diseases. At present, the pharmaceutical industry has gained a leading position in the world, which is reflected not only in the volume of industrial production, but also the funding invested in this industry (economists estimate that it has entered into a leading group in terms of the purchase and sale of shares in equity securities). An important innovation was the fact that pharmaceutical companies included in their scope of new varieties of crops and animals, and spend the tens of millions of dollars a year, they also mobilized release chemicals for life. Addition to the production of the construction industry and so on. It is not tens of thousands, perhaps hundreds of thousands of highly skilled professionals engaged in the research and industrial sectors of the pharmaceutical industry, and it is in these areas of interest to the genomic and genetic engineering research is extremely high. Obviously, therefore, any progress plant biotechnology will depend on the development of genetic systems and tools that will enable more effective management of transgenes. For a clean cut of the transgenic DNA into the plant genome, are increasingly using borrowed from microbial genetics of homologous recombination, such as Cre-lox system and Flp-frt. The future is likely to be manageable for the transfer of genes from grade to grade, based on the use of pre-prepared vegetable material, which already contains the chromosomes in the right areas of homology required for homologous insertion Trang. In addition to the integrative expression systems will be tested autonomously replicating vectors. Of particular interest are 'artificial chromosomes of plants, which in theory do not impose any restrictions on the volume of theoretical information.

In addition, scientists are searching for genes encoding useful new features. The situation has changed radically, especially the existence of public databases that contain information about most of the genes of bacteria, yeast, humans and plants, as well as due to the development of methods to simultaneously analyze the expression of a large number of genes with very high throughput. Put into practice methods can be divided into two categories:

1. Methods that enable you to expression profiling: substraktsionnaya hybridization, electronic comparison of EST-libraries "gene chips" and so on. They allow you to set a correlation between that or other phenotypic characteristic and activity of specific genes.
2. Positional cloning is the creation by insertional mutagenesis mutants impaired in which we are interested trait or property, followed by cloning the corresponding gene itself, which certainly contains a known sequence (insertsiya1).

The above mentioned methods do not require any initial information about the genes that control a particular trait. The absence of a rational component in this case is a positive fact, because not limited by our current understanding of the nature and genetic control of specific interest to us trait.

Besides all this, a group of scholars such as Mark Adam (Senior Fellow at the Institute for Genomic Research in Maryland - USA, a private research company that exceptional performance in the field of gene mapping), Kreyk Venter (Director of the Institute) and colleagues, developed the project "Human Genome ". The purpose of this project is to determine the sequence of bases in all the DNA molecules in human cells. At the same time must be set localization of genes that would help determine the cause of many inherited diseases and this open the way to their treatment. International Society in February 1996, has decided that any sequence of nucleotides, 1-2 KB should be made public within 24 hours after its establishment.

Prospects of Genetic Engineering

Some features of the new technologies of the 21st century can lead to greater risk than the existing weapons of mass destruction. First of all - the ability to self-replicate. Destructive and avalanche self-replicating entity specifically created or happened to be out of control, can be a means of mass destruction all or selected. It does not require complex of factories, complex organization and big spending. Would represent a threat to the very knowledge: devices, invented and manufactured in single copies, can contain everything necessary for further breeding, actions, and even further evolution - change their properties in a given direction. Of course, the above describes the possible, but not guaranteed options for the development of genetic engineering. Success in this field of science can drastically increase productivity and contribute to solving many of the problems, especially the rise of the standard of living of everyone, but at the same time, and to create new means of destruction.

Conclusion

In conclusion, genetic engineering, opening up great potential in the treatment of hereditary diseases. Because she does not want to bring elite "breed" of people, as opposed to the bulk of the population, and aims to correct the deficiencies of nature, to help save mankind from hereditary diseases. Of course, we must not forget that our success is only possible while improving the living conditions and social rights. Only the favorable natural and social environment can be stabilized human genome and the gene pool.

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ACCOUNTING SYSTEM FOR THE DESIGN OF CLIMATE ENERGY-EFFICIENT BUILDINGS

R.S Fedyuk, A.V. Mochalov, Yu.Yu. Ilinskiy

Scientific advisor: Dr. V.A. Baranov

Linguistic advisor: Dr. V.A. Baranov

Far Eastern Federal University, Russia, Vladivostok, Sukhanova str., 8, 690090

E-mail: roman44@yandex.ru

Given the study of factors affecting the design of energy efficient buildings. The influence of climatic factors on the thermal efficiency of buildings.

Russian President proclaimed in 2006, Russia's energy security a key issue in the development of the Russian economy. For energy security also includes cost reduction in the consumption of energy [72]. One of the most energy-intensive sectors of the economy is a capital construction. Heating system only civic buildings consume up to 30% produced in our country, solid and gaseous fuels [46].

Since the mid 70-ies of XX century. began the development of the design energy efficiency of buildings, but the energy efficiency measures in the construction practice actually applied separately or simply summarized. In such cases, most often there is a reduction of some of the projected activities at the expense of other counter that not only has no positive impact of energy-efficient, but also can be of negative influence on the microclimate of premises. For example, the architect of the building is oriented so as to capture the maximum of the solar radiation and the designer at the same time minimizing the glass area to enhance thermal protection guards. In ito re-planned level of energy efficiency is not achieved.

Applicant believes that the latter is due to the following reasons we are:

1. Available scientific research (and, moreover, embedded in norms) for architectural and building climatology, climate zoning, the climatic typology is not fully cover the particular climatic conditions of specific regions construction, which allow for the full range of cyclic of impacts on the environment the heat balance of buildings.

2. The design process is performed narrow qualification professionals who are outside their field do not consider the impact of the consequences of their design decisions on the related parts of the project.

3. Regulatory and construction base is mostly recommended character. So, for example, regulated in Building regulations (SNIP) 23.02-2003 section of the project "Energy Efficiency" in most cases, be completed without proper consideration. For the same reason, design of the energy certificates for buildings virtually nonexistent.

Since 2002, the purpose of construction of energy efficient buildings is to identify the effectiveness of energy-saving technologies in the real world in relation to environmental and social aspects. Of energy-saving solutions such as finding a place, the account of the terrain and the local climatic conditions (solar radiation and wind), the choice of the shape, orientation of buildings, as well as the application of new technologies in developing a space-planning decisions of buildings (for example, double facade). In the functioning of power, ventilation and the heating of houses an important role is played by the photovoltaic panels. For heating homes are most often used-plane solar radiation heat the earth. It should also be noted that the home equipped with water-saving devices and separate counters distribution water flow. Special attention is paid to the removal and recycling of waste. [109]

In the global construction practice rapidly assimilated energy active building with ultra low power consumption due to the high demand for these homes. Autonomous energy efficient building low-cost building houses can be "zero energy" (ie, not requiring heating). In the case where the production building energy consumption is greater, the excess electricity can be delivered in the city network, then these homes have a «positive support energy consumption». Autonomous energy-efficient buildings with zero or plus-power built in the West while in the more experimental numbers, but the orientation of the construction industry in this area is evident [94].

Natural and climatic features raynona construction require comprehensive study. Exposure slopes of hills, the direction of the river valleys, the distance from the shoreline to create specific microclimatic conditions, which can not properly be characterized by the same data, even the nearest weather station. These causes of the climate change all three factors: solar radiation, atmospheric circulation and the underlying surface.

Thus, all the climatic factors (and their parameters) are related, and both have a mutual influence on each other and on the building. Now, despite a number of developments on the effect of individual climatic variables (solar radiation, wind, temperature, precipitation), there is no methodology of system analysis combined effect of these parameters on the microclimate of premises.

For thermal heat-affected building quality fences, heat transfer coefficients on the surfaces, and exterior design The inner conditions. Effect of wind on heat loss from buildings is shown in fig. 1.

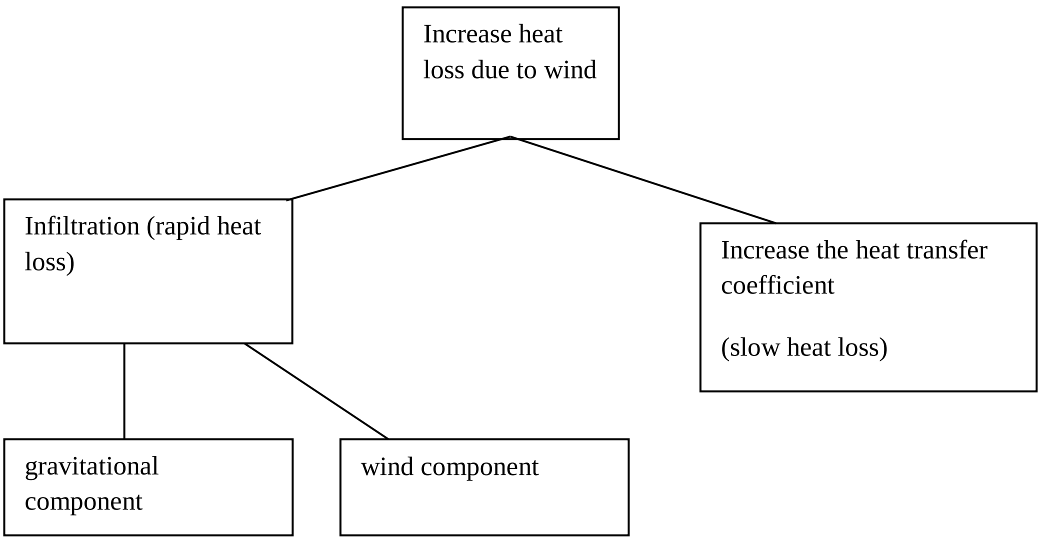

Рис. 1. Increase heat loss due to wind

Major loss in a typical high-rise buildings are responsible for hot water supply (47%) and for heating air infiltration (31%). It is here that the major energy reserves. Heat loss through the building envelope (walls, windows, roof, etc.) account for about 22%.

Of fresh air coming into the room as a result of infiltration depends on space-planning decisions of the building, as well as the density of windows, balcony doors, stained glass windows. Engineering design problem reduces to determining the flow rate of air infiltration G_{inf} , kg / h, a separate enclosure of each room.

Infiltration through the walls and cover the low, so it is usually neglected and calculated only after completion of skylights, as well as through closed doors and gates, including those that are rated at ordinary operating conditions do not open. Cost of heat for coming air through open doors and gates in a design mode included additions to the main heat loss through doors and gates.

Infiltration occurs under the influence of pressure differences Δp, Pa, from different sides fence. Pressure difference between the air inside and outside of the building is due, firstly, different densities of cold outside air and the warm inner (gravity component) and, secondly, the wind, creating a positive pressure in the incoming flow from the windward side of the building and negative pressure on the leeward (wind part).

$$p_{gr} = (H - h)(\rho_{ext} - \rho_{\text{int}})g$$

$$p_{wind} = \frac{\rho_{ext}\upsilon^{2}}{2}\hat{E}_{\hat{a}\hat{i}\grave{o}}\,(\tilde{n}_w - \tilde{n}_l)$$

Gravity and wind pressure acting on the components of the building by an independent from each other, so their values can be folded up and get the estimated total external pressure p_{ext}.

Solar radiation (insolation) are considered in the development of:

- Space-planning solutions for buildings (the presence of balconies, porches, bay windows, etc.);
- Engineering (material, thickness fences, filling window openings);
- Planning areas (shading buildings other buildings);
- Orientation of the building to the cardinal.
- Finishing (surface quality, color);

Temperature conditions in the building into the development of:

- Space-planning decisions of the building (the size and placement of the premises);
- Engineering (material and thickness of the fence, the type of glazing);
- Support (heating, ventilation, etc.).

Humidity and precipitation affected by:

- The choice of construction;
- The design solution envelope (material, thickness, presence and location of waterproofing layers);
- The development of protective measures (drainage);
- The choice of engineering equipment (heating, ventilation, air conditioning).

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PROBLEMS AND PERSPECTIVES IN CHEMICAL TECHNOLOGY

V. M. Pavlov, O. V. Fisher

Linguistic advisor: Teacher O.I. Shaikina

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: pavlovvladimir91@mail.ru, vahrein@mail.ru

Annotation

In this paper attempt to provide the concept of chemical technology and to review briefly the problems and perspectives of chemical technology.

Chemical engineering - natural methods of applied science and manufacturing processes of products (consumer goods and capital goods).

Studying chemical engineering processing, are prevalent chemical and physico-chemical phenomena that lead to a radical change in the composition, structure and properties of materials.

Improvement of existing and development of new technologies is a major concern of chemistry. Simple, one-step, reliability, low power consumption, high performance and efficiency, continuity, isolation (non-waste), low demand for raw materials and its preparation - these are the main criteria that must be met modern technology. Undoubtedly, the first stage in the creation of new technology is owned by catalysis. Suffice it to say that even now, 85% of all industrial processes, which account for 70% of all chemical products, based on catalysis. Only on the basis of catalysis can search and develop the processes with high selectivity, productivity, efficiency and low energy consumption. This task is a traditional and in heterogeneous and homogeneous catalysis. It has made significant progress, many highly efficient processes utilized by industry, but there is still much more untapped opportunities. First of all, they are related to catalysis by metal, allowing to develop direct methods for the transformation of raw materials into the desired products and eliminating many intermediate stages of synthesis.

No less acute and urgent problem of complex processing of inorganic materials - ores and minerals improve flotation technology, the development of floating selective reagents, extractants for the full recovery of non-ferrous and rare metals, fluorine and other elements. Chemical methods of extracting metals have long been used industry, however, they are currently of particular importance due to the depletion of rich ores. New technologies can be developed through the application of organic matter - a complexons and extragents that selectively react with certain metal ions and extract the metals from the polymetallic ore into solution. You can expect the development of a particular area - solvatometallurgii, which in contrast to the traditional metals, does not include the energy-intensive smelting process.

Important place in the chemistry of combustion processes take, and they are used in the chemical energy - for thermal and mechanical energy. These include combustion gases of internal combustion engines, gasification and combustion of liquid and solid fuels.

The main partner of the fuel in the combustion is oxygen - free or bound, and the main products -

water and carbon dioxide.

Combustion technology is constantly improving. Recently opened new perspectives in the use of the combustion processes in the chemical technology of inorganic synthesis.

Advanced scientific development open up new perspectives for the development of the chemical branch - coming era of nanotechnology. Composite materials coverings from ceramics, polycrystalline silicon, and products based on it, nano-membranes, and many other innovations will begin release of the chemical industry is fundamentally other production possessing earlier inconceivable properties.[1]

The development of nanotechnology will change the traditional idea of chemical enterprise. First of all, will be blurred the boundaries between the different branches of industry and science. At chemical plants could be not just produce, but also to "grow" previously unknown materials. The results of today's leading research allow, for example, adjust release of special medicinal formulations that will be capable selectively on disease organisms individual. The very promising and the development paintwork convoys and other types of materials that are capable not only enhance the protective properties of the coating, but independently will be able to restore the scratches and holes. Chemical additives will be demanded in the construction that improve the characteristics of concrete, bricks, rebar, asphalt and other materials.[2]

In the future chemical enterprises will be expected to evolve into safe multifunctional objects of, producing products, in demand in various industries.

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THE ACCIDENT AT THREE MILE ISLAND

A.A. Gubar, S.P. Golubev

Language advisor: Senior teacher N.V. Demjanenko

Tomsk Polytechnic University, Tomsk, Russia

E-mail: GubarAnnaAlex1993@gmail.com

Introduction

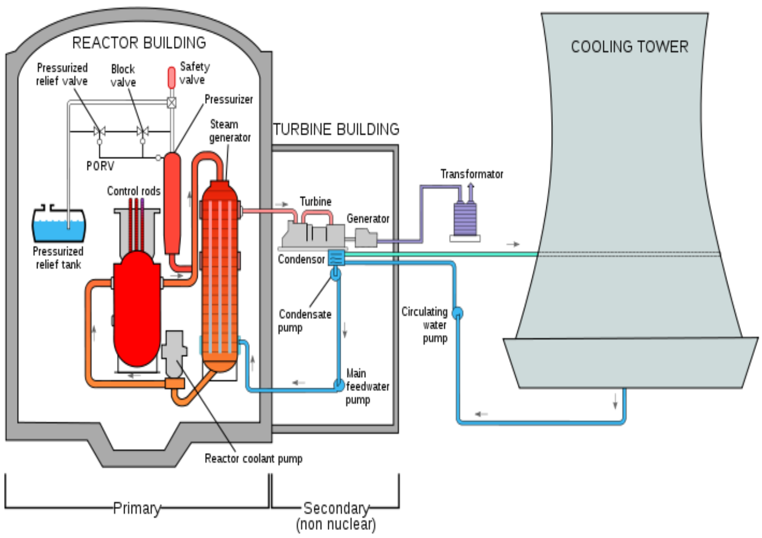
Man-made disaster is the most serious accident in the man-made objects that entails massive loss of life and the environment.

The first question that comes to mind, whether nuclear power is dangerous?

This question most often become set in recent years, especially after such a major accident in nuclear power plants of Three Mile Island, Chernobyl and Fukushima. The accident at the nuclear power plant Three Mile Island was the first major accident.

Main Part

The accident at the nuclear power plant Three Mile Island is one of the biggest failures in the history of nuclear power, which occurred March 28, 1979 at the nuclear plant Three Mile Island, located on the Susquehanna River, near Harrisburg (Pennsylvania, USA). The Chernobyl accident occurred after 7 years, the accident at the plant "Three Mile Island" is considered the largest in the history of the world nuclear energy and is still considered the most serious nuclear accident in the United States.



Pic.1. Simplified schematic view of a second unit of the plant.

The causes of the accident

- The human factor is the lack of appropriate institutional level of design, supervision and control over the design and approval of the project.
- Valves on the pump head were closed for the pressure of the emergency water pump in steam generators. They were closed on the day of the outage, which was held at the plant a few days before the accident.

In the event there has been a lot of mistakes. On the one hand there were errors of operators working at the station. On the other hand some of the equipment gave the wrong information. It was provided very little controls. Found error after a long time. Therefore, damage was considerable.

Consequences

- Nuclear fuel was melted partially , and it is not burned a reactor vessel and radioactive substances remained inside mostly .
- Station area was contaminated radioactive water leaked from the primary circuit.
- After the accident, changes were made in the training of operators.
- Part of radioactive water had soaked into the concrete containment, and this activity is almost impossible to remove
- The accident did not result in death or injury to plant workers and members of the nearby communities.

Feature of the incident

- In - the first, the accident was not accompanied by spontaneous acceleration of reactor, control under criticality wasn't lost.
- In - the second, an accident takes place at a smooth running of the reactor control personnel against refusal of a number of nodes of the reactor.

GLOBALIZATION OF SCIENCE AND TECHNOLOGY

I.A. Gubin

Scientific advisor: Asst. A.O. Semenov

Linguistic advisor: Teacher Y.V. Ermakova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: gubinilya@gmail.com

ABSTRACT

Globalization is one aspect of the larger phenomenon of modernization, which describes societies characterized by progressive growth in the complexity of communications. Despite its inevitable problems, globalization is a generally desirable phenomenon, since it enables increased efficiency, effectiveness and capability of societies and thereby potentially benefits most people most of the time. Scientific research was one of the first global communication systems, especially at its most advanced levels. And high quality scientific education at the post-doctoral level is also now essentially global. The next steps will be for lower level science education - at doctoral, undergraduate, and even school teaching levels - to become progressively globalized. Globalized education requires a common language for organizational communications, which is already in place for the quantitative and mathematical sciences, and will be increasingly the case as competence in a simplified form of international scientific English becomes more universal. As such a global science education system grows there will be increased competition and migration of teachers and students. The law of comparative advantage suggests that such mobility will encourage societies to specialize in what they do best. For example, some countries (even among wealthy nations) may provide little advanced scientific education, and import the necessary expertise from abroad - this situation seems to be developing in Germany and France, who lack any top-quality research universities. Conversely, just a few countries may provide the bulk of advanced science education teaching - as well as applied and pure research personnel - for the rest of the world: potentially China and India might supply most of world’s mathematical expertise.

Key words: Globalization, Science, Technology, High education, Multinational Corporation, R&D.

INTRODUCTION

Globalization is a process of global economic, political, cultural and scientific integration and unification. From middle XX the process of globalization was actively accelerated. Development of science and technology affected on speed of globalization in all areas (telegraph, telephone, internet).

The aim of the Project Work is to study the impact of globalization on science and technology.

The main objectives to be considered:

1) The effect of multinational companies to the globalization of technology.

2) The policy of developed countries in the context of globalization of science and technology.

3) The impact of globalization of science and technology on the globalization of higher education.

GLOBALIZATION OF SCIENCE AND TECHNOLOGY

The basis of the globalization of science and technology is the totality of scientific knowledge and technological principles. Historically, the first forms of globalization of science and technology have become noncommercial international contacts of scientists, whose cooperation is associated with a natural necessity to exchange ideas and research results. In the XX century scientists from different countries cooperated on a commercial basis, including the international research programs and projects. Commercial forms of international scientific cooperation were especially rapid development in last decades, in particular, has been reflected in a sharp increase in the number of scientific publications and patents, prepared by authors from different countries.

Commercial globalization in the field of science and technology to a large extent due to the increase in the scale of multinational corporation (MNC) activities that create worldwide regional offices, requiring for their work some scientific and technological base. MNC conduct investment policy, primarily aimed at the merger and acquisition of high-tech companies located in different countries. Absorption or merge with a foreign competitor, it is allowed to company increase owe science potential. Mergers and absorption are particularly characteristic of high-tech industries. For these sectors is also typically the formation of alliances of firms from different countries to conduct joint research, high-risk high-tech projects.

MNC create regional production units open science laboratories, the main function of which is to improve the existing and development of new products and technologies for the local market. In some cases, the discovery of these laboratories is the basis for the subsequent creation of the production units. MNC, expanding a grid of regional offices, on the one hand, tend to be shared widely and its technology, on the other hand, used to maximum benefit for them foreign technology. Thus there are good opportunities for promoting projects on the basis of the scientific and technological potential of the company in a fundamentally new for her intellectual environment. [1]

U.S. is a leader in investing in research and development. In 2011, the U.S. had to share 34% of global spending in this area. Total has invested $ 405.3 billion, accounting for 2.7% of the GDP of the country. The most active policy global spread of science and technology hold the U.S.A. On the other hand, is not as actively pursued the same policy in the U.S. and other countries. This two-way process began to grow significantly in 1950-1960-ies and now there is particularly intense in Western Europe (UK, France, and Germany), South-East Asia and Canada, to a lesser extent - with Latin America and almost done with Africa. In nowadays, there are 186 foreign research units of U.S. companies, primarily in the automotive, pharmaceuticals, computers and chemicals. Among the newly industrialized countries, the largest number of U.S. research centers located in Singapore, Taiwan, India, and China.[2,3]

In the European Union, the main task is to establish a common European policy of scientific and technological development in order to strengthen the economic and political power of the countries - members of the EU. The EU also solves the problem of integration of scientific and technological capacity of the countries of Eastern Europe in the context of EU enlargement to the east.[3]

Feature of the policy of globalization of science and technology in Japan is that it focuses primarily on cooperation with the U.S. Japanese MNC are leading companies of other countries in terms of Research and Development (R & D) carried out by their subsidiaries in the United States. Thus, the company "Matsushita" is one of the world's leaders in manufacturing of consumer electronics in the United States; it has about 20 scientific institutions. The most famous "Panasonic Digital Centre", which is operate since 1988 as both a venture fund and business incubator. Centre is investing new information technologies and aims to work closely with companies in Silicon Valley.[4]

The effectiveness of the processes of globalization of science and technology shows significant expansion of international scientific and technological cooperation, increase the rate of growth in world trade high-tech goods, and constantly expanding the number of countries that produce such goods. It should be emphasized that the internationalization of research and technological development does not change, but rather, enhances the value of its national aspects in connection with more opportunities to use local resources for development, combined with the global resources. At the same time, the promotion of scientific and technological activities of MNCs in other countries concerned about the leadership of these countries because they are afraid of weakening their own scientific and technological capabilities as a result of leakage of technology, reduction of the national research base. Each country determines the extent possible interaction with the scientific and technological systems MNCs within their own national interests.

Today despite the intensification of globalization of scientific and technological development, dominated by national factors of this development: most TNCs continue to carry the bulk of studies in their home country. This situation is typical for the U.S., Japan, Germany, France and Italy, which is stored in 80-90% of its own R & D capacity (except for Belgium and the Netherlands, where more than half of its R & D performed abroad). In recent years, a similar situation exists in the UK, Sweden, Finland, Denmark and Norway.

It should be noted that today, the globalization of science and technology in general inferior to its globalization of production activities. However, this trend is mainly for companies which produced no high-tech products.[5]

The globalization of research and technological development is closely linked to globalization of higher education, which, in particular, the experience of scientific and technological development of the United States. Before World War II the United States has developed a system of R & D aimed at the promotion of scientific and technological knowledge to the needs of a rapidly growing industry. Accordingly, American universities were preparing for more specialists primarily for industry. At the same time, to provide R & D personnel in the United States pursued an active policy on research training at leading European universities, as well as to attract European scientists to work in the U.S. academic institutions. This allowed the United States after the war, quickly catch up with Western Europe in scientific and technological development. The same path went in the postwar years, Japan and then South Korea, the first thing you mass training of technicians to ensure rapid development of the industry, and then gradually pulling its own database of basic science to the world level for the development of advanced high-tech industries.

MNC, opening research laboratories in other countries usually make contacts with local research centers and universities, providing an impact on the national system of science and education. Thus there is the inevitable leakage of scientific and technological information and experts from these countries. On the other hand, local research centers and universities have access to science and technology programs of the Corporation and, of course, for their financial and material resources.

Recently, the development of higher education as a whole, there were some definite trends. First, it increases the scope of higher education, it is becoming more widespread. Today there are more than 14 thousand higher education institutions, which is studying nearly 100 million students. In industrialized countries, the level of income of high school graduates in higher education is almost 60%, while in the U.S. and Canada - more than 80%. Secondly, there is a diversification of higher education in the institutional forms, levels and content. Third, more and more sharply, demand for university graduates, especially to their business activity and mobility, quality, expertise, proficiency in foreign languages, and new information technologies.

The main reasons for the internationalization of higher education are political (democratization of the international community, the development of integration processes in the political and social spheres), economic (economic globalization), ideological (the growth of international openness, increased interaction of national cultures), academic (international nature of scientific knowledge, the formation of universal basis of education and research activities), information (information technology, global information networks).

UNESCO intentionally initiates the development of recommendations for the development of processes of internationalization, a regulatory framework for international cooperation in higher education in order to increase the mobility of student learning within the national educational systems, as well as between them.

Such an educational policy, but perhaps in a more vivid forms for the European Union, which is actively forming supranational institutions (DG Education and Culture of the European Union, etc.), a unified system of higher education. Feature of this policy is in the interaction of supranational and national authorities in the development of pan-European information and coordination structures, as well as pan-European programs in the field of higher education.

The most important indicator of the effectiveness of higher education institutions is to train them to international students. Extension of their training is one of the state's educational policy important.priorities U.S., UK, France, Germany, Canada, Japan and Australia. Between universities in these countries is intense competition in the global education market, which has a number of reasons. First, training for other countries is a rather lucrative exports. The global education market is estimated at $ 35 billion, more than $ 12 billion each year in United States, where foreign students has become especially widespread. Second, the desire to attract foreign students is pushing universities to improve the quality of education with the requirements of the global labor market and international educational standards. Third, the training for the other countries is one of the components in the system of measures on realization of geopolitical and economic interests.[6]

CONCLUSION

The globalization of science and technology is not as fast as in economics or culture sphere, due to the fact that the state does not share strategic knowledge and technologies. However, MNC showed that combining scientific knowledge in local field allowed accelerating the development of technology. The trend of globalization has a significant influence on education - it is becoming more international. Year by year the number of students studying in universities of other countries are increased.

It is important to understand that then more scientists have the newest knowledge and technology, the faster growing scientific and technological progress.

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ON-LINE MONITORING TECHNOLOGY FOR SULFUR CONTENT IN THE OIL

N.N. Ismaylov

Scientific Supervisor: Prof., Dr. Yu.Yu. Kruchkov, As. professor N.A. Antropov

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: namik@vtomske.ru

This article depicts importance of determining sulfur content in the oil and developing device which will allow running on-line measurements of sulfur content in the oil.

Key words:

X-ray transmission method, oil, sulfur content.

Introduction

The concentration of sulfur and its proper determination play an critical role regarding fuels and products of petrochemical industry. The problem of appropriate determination of sulfur is important both from environmental and analytical aspects, since some specifications order to the compulsion decrease of the concentration of sulfur. Furthermore the reduction of sulfur content generates farther analytical problems.

Sulfur is important to vehicle emissions because it can poison a catalyst. The impact of sulfur on particulate emissions is widely understood and known to be significant. Sulfur in fuel is oxidized during combustion to form SO2, which is the primary sulfur compound emitted from the engine. Then SO2 is further oxidized to sulfate (SO4).

The energy dispersive X-ray fluorescence spectrometry method has been used for analyzing the sulfur content in the samples. This method is recommended by the standards. It has been widely used for identifying elements in petroleum. This method is used to analyze the sulfur content for large numbers of fuels and for crude oil. The results showed that the energy dispersive X-ray fluorescence spectrometry is accurate and precise for sulfur content higher than 100 ppm, and simple to use.

It is not left out of consideration that there are some part of industrial area, where diesel oils with high sulfur content are allowed and used (e.g. heavy special diesel engines). It means that a suitable technique for the determination of sulfur content in fuels has to possess measuring ability for the analyzing in a wide range of concentrations (from the unit of ppm to %). There are numerous spectroscopic techniques to analyze the qualitative and quantitative elemental composition of fuels and lubricants: inductively coupled plasma atomic emission spectroscopy (ICP-AES), inductively coupled plasma mass spectroscopy (ICP-MS), flame or graphic furnace atomic absorption spectroscopy (AAS) or by X-ray fluorescent spectrometry.

Each technique has advantageous properties in terms of analytical figures of merit. The atomic absorption and emission techniques are typically used for analysis of the products of hydrocarbon industry. The ICP technique is a fast analytical method, but needs preliminary sample preparation (e.g. digestion). Whereas the energy dispersive X-ray fluorescent spectrometry is a non-destructive, furthermore cost-effective method of elemental analysis of the samples. Main objective is developing device for on-line monitoring sulfur content in the oil using x-ray transmission.

Methodology

X-ray transmission - transmission of X-rays through the matter - is used in defectoscopy, x-ray tomography, thickness gauging. The weakening of the intensity depends on elemental composition, density of matter, thickness of sample. As analytical method, energy dispersive X-ray fluorescent spectrometry has not found wide application, because for substances with difficult chemical composition is almost impossible to determine the contribution of an individual element in common weakening of the intensity of original ray. At the same time, in special cases, this method has several advantages that put him out of competition compared to other analytical methods. One of these cases is determning the sulfur content in petroleum and petroleum products pipelines in the process. Currently x-ray transmission is the only method that can be used to solve this problem. The closest competitor to this method is the X-ray fluorescent analysis, however, it is not suitable for measurement in the technological pipe, because the energy of characteristic X-ray emission of sulfur is very small, ~ 2.3 keV, and it is completely absorbed by any window, separating the sample and the detector.

In the general case, the intensity of parallel monoenergetic beam after passing through a homogeneous layer of the sample is given by:

(1)

- intensity of X-ray beam incident on the sample, μ - mass attenuation coefficient, ρ - density of the sample; x - thickness of the material.

For multicomponent samples of variable composition like oil, mass attenuation coefficient for monoenergetic radiation is defined as:

(2)

mass attenuation coefficient of each element that is included in the sample.

The main components of commercial oil are carbon and hydrogen and, in some cases, may be sulfur. Comparing to the content of carbon and hydrogen, sulfur is macroelement. The mass attenuation coefficient for oil from the expression (2) is defined as:

(3)

mass attenuation coefficients for carbon C, hydrogen H and sulfur S, cm2 / g. Then the radiation intensity after passing samples with the oil can be calculated as (1):

(4)

For the determination of sulfur in petroleum and petroleum products monoenergetic X-ray line should be used. Kα1 line of silver with the energy of 22 keV is used as such line, it can be obtained either using a radioisotope source 109Cd, or, as in our case, using X-ray tube and an intermediate target of silver.

For the energy of 22 keV the values of mass attenuation coefficients for hydrogen, carbon, and amount of sulfur are: μC= 0,363 cm2 / g, μH = 0.366 cm2 / g, μS = 5.11 cm2 / g. Since the mass attenuation coefficients for carbon and hydrogen are close, then mass fraction of C / H has no effect on the value of the weakening of radiation beam. Thus, for the hydrocarbon component of the mass attenuation coefficient we can take the average arithmetic coefficients between the mass of carbon and hydrogen

$\mu CH = 0.3645$ cm2 / g.

Then the intensity of the radiation beam passing through sample, mainly depends on the impurity concentration of sulfur present in the sample.

Development

As you can see we can determine sulfur content using x-ray transmission. Next step is developing an experimental model which is quite simple. This model will have a small tube with pump to make oil flowing in the tube. Tube will be between x-ray tube and detector.

Using data from experimental model, ultimate device will be produced. Here is tentative scheme:

Conclusion

On-line monitoring technology for sulfur content in the oil is very important and we already have arrangements with oil companies.

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OPTIMAL MIXER FOR MULTI-GIGABIT SYSTEM

A. Kolomiets, Y. Konovalchuk

Institute of Telecommunication Systems, NTUU ‘KPI’, Kyiv, str. Metallistov, 7, 03057

E-mail: *anastasiya.kolomiets@gmail.com*

Abstract - This paper presents a model of subharmonic mixer, built on Coplanar waveguide coupler and Shottky barrier diodes. The mixer has a frequency of 80 GHz. The results of research of key indexes and characteristics are represented in the graphic form.

Demand for very high speed wireless communication is rising due to the increasing computer and fiber speeds. Multi-gigabit wireless applications include the backhaul and distributed antenna systems for the 3G/4G mobile infrastructure, enterprise connectivity, remote data storage and the short range wireless personal area networks (WPAN). The compact size, low manufacturing cost, low power consumption for the implementation of high-performance transceiver devices are the requirements for the majority of telecommunication millimeter waves systems [1]. So a mixer is an important part of these systems, it converts the frequency of a signal according to these requirements.

Frequency mixers can be classified: 1) by the principle of construction: - active - passive. 2) on the treatment of: - continuous - key mode. 3) by symmetry with respect to the output: - unbalanced - balanced. 4) due to frequency conversion : - frequency up-conversion (gain) - frequency down-conversion (conversion loss).

Local oscillator (LO) provides the mixing technique for most of mixers, allowing to achieve the desired frequency conversion. However, when the operating frequency increases, phase noise increases too and the value of the output power decreases. Usage of sub-harmonic mixer (SHM) is the most common approach, which allows the LO signal to lower frequency for two times compared to radio frequency (RF). This makes the LO sources more reliable and less expensive.

The scheme is designed for RF down-conversion by mixing with the second harmonic of the LO signal. Thus, the oscillator can operate on half power, which facilitates its implementation. Anti-parallel diode pair can suppress any even LO harmonics, and its does not require a DC supply. [2]

Considering [3], the Schottky barrier diodes are the basis of the SHM construction. The scheme is designed for RF down-conversion by mixing with a fixed LO. Coplanar waveguide coupler is a key component for SHM. Although usage of the coplanar waveguide coupler leads to heavy losses, it is necessary to achieve good isolation between ports.

PROBLEM STATEMENT

A mathematical model for device implementation can be represented as a function of three variables V:

$$V = (A, B, C), \qquad (1)$$

where A, B-input and output components, respectively;

C - method or technology of implementation.

Talking about the object of research, A and B represent the input and output quality parameters accordingly:

$$A = (f_{RF}, f_{LO}, LOpower, \dots)^T, \qquad (2)$$

$$B(A) = (f_{IF}, ConvLoss, I, \dots)^T, \qquad (3)$$

Where

f_{RF} - the frequency of the signal at the mixer input port;

f_{LO} - local oscillator frequency;

$LOpower$ - oscillator power;

f_{IF} - intermediate frequency;

$ConvLoss$ - conversion loss;

I - isolation.

The scheme of SHM is presented on Figure 1. It implements the problem (1-3) using a pair of antiparallel diodes due to [2].

The aim is to achieve the best quality and quantity indexes and match the requirements [1] of sub-harmonic mixer at high frequencies.

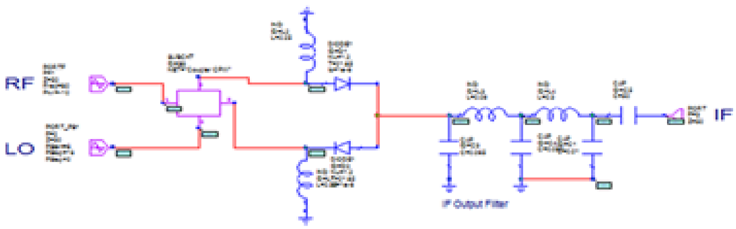


Figure 1. The scheme of sub-harmonic mixer

SIMULATION RESULTS

Sub-harmonic mixer has the following qualitative and quantitative indicators:

1) The operating frequency of RF = 80 GHz; LO = 39 GHz; IF = 2 GHz.

2) The passive mixers noise is numerically equal to the conversion loss.

3) Conversion loss. The SHM has conversion loss -11.5 dB at frequency of 80 GHz with a power level of 14 dBm (Figure 2).

4) Isolation. The isolation between LO-RF ports is about -2.4 dB at frequency of 40 GHz (Figure 3).

An important feature of the scheme is the ease of development and implementation. With these performance requirements we can conclude that the mixer has optimum performance for multi-gigabit systems due to the usage of key elements [2].

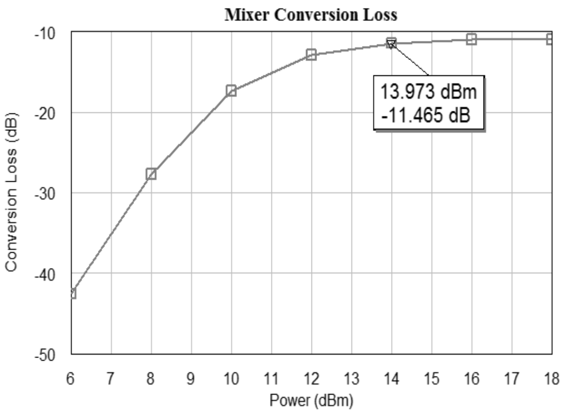
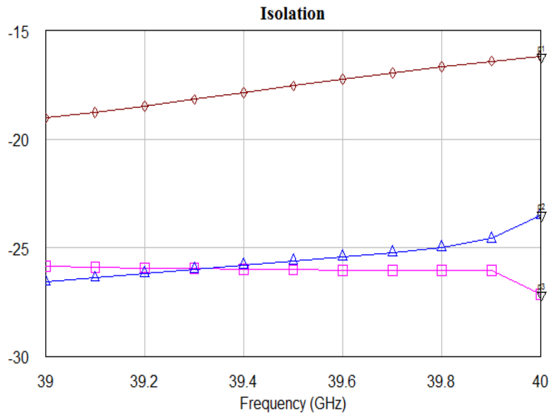


Figure 2. The conversion loss dependence on LO power.



Научное издание

Figure 3. Isolation between ports LO-RF, RF-IF, LO-IF.

CONCLUSION

Subharmonic mixer at frequency of 80 ghz for multi-gigabit systems is presented in this paper. Coplanar waveguide coupler and Shottky barrier diodes are key components of SHM, those help to get optimal indexes and characteristics of mixer. Based on modulated results show, this proposed SHM has significant advantages such as operation of high frequency signal, superior isolations, and permissible conversion losses which are relatively suitable for millimeter-wave applications.

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MODERN CHALLENGES TO THE NONPROLIFERATON REGIME AND NUCLEAR POWER FROM GLOBAL INITIATIVES

D.O. Kondratjev, M.P. Gritsevich
Scientific advisor: Senior teacher A.V. Godovykh
Linguistic advisor: Teacher A.V. Tsepilova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: thedk@inbox.ru

Annotation

The current historical period can be described as another stage of development of the regime of nuclear materials nonproliferation. This regime is constantly faced with new challenges and threats, and, consequently, should adapt to the conditions of the modern world. Therefore, nowadays there is an acute need to revise the traditional and customary social norms of approach to the nonproliferation regime and nuclear energy. Particular attention should be paid to global initiatives directly related to energy resources. The paper has identified the main challenges to the nonproliferation regime and nuclear energy and considered an initiative called «Desertec». The main issues which accompanied the project were:

- *Ecology;*
- *Economy;*
- *Energetics;*
- *Political issues;*
- *Security.*

Key words. Global initiative, the nonproliferation regime, Non-Proliferation Treaty, «Desertec», nuclear power.

Everything in this world is not constant, it has been changing since the moment our planet appeared and after technological revolution of the 20th century life has accelerated its pace many times. Despite the fact that "the atomic world" is a relatively young industry, it is not an exception [1]. The nonproliferation regime emerged and developed in parallel with the atomic world. Permanent technological discoveries and great breakthroughs in various fields forced it to adapt to the environment. This can be seen by considering the history of the regime.

The question of establishing a regime emerged even earlier than the creation of the first atomic bomb. The basic document of the regime is considered to be Non-Proliferation Treaty (NPT). Almost immediately after the NPT creation Infcirc 153 was approved and published («The structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons»). The need to improve the regime was brewing during the next 20 years. The result was Infcirc 540, which reflected these changes («Model Protocol Additional to the Agreement(S) Between States(S) and the International Atomic Energy Agency For the Application of Safeguard») [2].

The nonproliferation regime is entering a new stage of its development and therefore needs the next revision of the existing documents.

Global initiatives are projects of great importance on the global level affect the interests of many states. Positive aspects of such "cooperation" could be: general scientific and technical development, access to significant financial resources and raw materials, cultural rapprochement of cooperating regions.

German project «Desertec» is the location of solar panels on the most intense sunlight territory - in the Sahara desert. The scale and the financial side of the project excite the imagination and seem futuristic. Expectations of the project are creation of a large number of workplaces, desalination of water for the needs of Africa, electricity generation for the EU [3, 4].

Growing needs of humanity were a catalyst for all social processes throughout the history of social development. One of these resources is energy, which states sought to possess and often ignored human principles and foundations. Today the world is experiencing an energy crisis and one of the most effective ways to generate energy is using nuclear industry. These two facts suggest that the challenges faced by power engineering as a whole, either direct or indirect are challenges to "nuclear world". To put it mildly, the project «Desertec» is a lever that can change the world's attitude towards nuclear power.

«Desertec» is a source of clean energy, but if you include this project in large-scale production, it will lose that advantage. Turning to security issues, two types of security may be highlighted: physical security and energy security. The purpose of the first type is to protect the object from physical threat; the second one involves the state's energy self-sufficiency. Both of them are related to each other, so if it is impossible to provide physical security, energy security also suffers. It must be remembered that energy security was the reason for Europe to create the project. Physical security of the huge object will also be very difficult; therefore it will cause searches of alternative projects [5]. Probably it will be nuclear power, and thus have a direct impact on the non-proliferation regime. As mentioned above, energy is a catalyst for global processes; therefore, it is directly related to politics. Acute angle of the project is its vast scale, namely the large infusion of financial and technological flows into politically unstable regions with radical and terrorist movements, which can lead to increased probability of acquiring weapons of mass destruction by people who want to achieve illegal objectives [3, 6]. Also the presence of shadow players is not an obvious acute angle of the project «Desertec» that is connected to the scale of the project and its location. Today, many large states and coalitions are interested in the region, namely in the distribution of political influence. Techniques to achieve it can be very different, which can directly or indirectly affect the non-proliferation regime [6].

The main goal of our work was to analyze the factors influencing the non-proliferation regime from global initiatives. A distinctive feature of the study is the fact that it covers different aspects of the problem taken as a whole. One must admit that intersection of several aspects can generate some new threats or move from the known level to a new one. Any initiative, which operates a large amount of resources is potentially dangerous and requires in-depth analysis and control.

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NEUTRON BOMB AS THE MEANS OF SAFETY

N.Y. Kriulko, A.A. Arzamazov, V.V. Sheshnyov
Linguistic advisor: N.G Novikova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: vladimirsheshnyov@gmail.com

Abstract

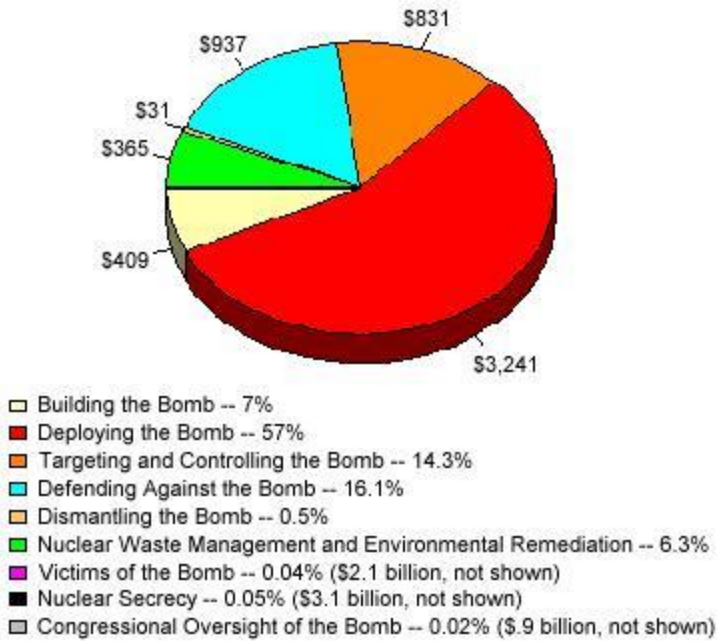
In the research work the authors would like to show how the nuclear energy can be used besides peaceful purposes. This question is very urgent, because nowadays the countries, which do not have any nuclear weapon, cannot feel themselves safe enough. But this is the opinion of the nuclear deterrent policy as lots of people disagree with it.

The neutron bomb has been chosen as one kind of nuclear weapons, because we wanted to find out how it differs from t other types of nuclear bombs in its structure and in its destruction factors.

Key words: acute radiation syndrome (ARS), radiation poisoning, radiation sickness, Neutron radiation, nuclear winter, nuclear darkness, neutron bomb

Introduction

Nowadays the nuclear weapon is a very actual question. All the leading countries in the world have this kind of weapon. This process of keeping a strong weapon without using it, only for intimidation, is called nuclear deterrence. Russia is one of the world leaders in this sphere.



The world leader is the USA. They try to place their nuclear missiles almost in each part of the world. making a bomb is not a cheap thing. On the following diagram you can see a pie chart, where you can see the distribution of money on making a bomb.

Up to the 2010 Russian Federation has the largest amount of warheads (11000 ones), the second is the USA with 8500 warheads, the third China (400) and the forth is France (350).

All in all there are less than 21000 warheads in the world nowadays.

Nuclear power is a very strong power, and using it to do harm to people and nature, is the last thing the human should do. But let's study, how do these weapons work [1].

Fig 1. The distribution of money on making a bomb

Nuclear weapon in general

A nuclear weapon is an explosive device that derives its destructive force from nuclear reactions, either fission or a combination of fission and fusion. Both reactions release vast quantities of energy from relatively small amounts of matter. The first fission («atomic») bomb test released the same amount of energy as approximately 20,000 tons of TNT. The first thermonuclear («hydrogen») bomb test released the same amount of energy as approximately 10,000,000 tons of TNT [1].

A modern thermonuclear weapon weighing little more than 2,400 pounds (1,100 kg) can produce an explosive force comparable to the detonation of more than 1.2 million tons (1.1 million tonnes) of TNT. Thus, even a small nuclear device no larger than traditional bombs can devastate an entire city by blast, fire and radiation. Nuclear weapons are considered weapons of mass destruction, and their use and control have been a major focus of international relations policy since their debut [1].

Only two nuclear weapons have been used in the course of warfare, both by the United States near the end of World War II. On 6 August 1945, a uranium gun-type device code-named «Little Boy» was detonated over the Japanese city of Hiroshima. Three days later, on 9 August, a plutonium implosion-type device code-named «Fat Man» was exploded over Nagasaki, Japan. These two bombings resulted in the deaths of approximately 200,000 Japanese people mostly civilians from acute injuries sustained from the explosions. The role of the bombings in Japan's surrender, and their ethical status, remain the subject of scholarly and popular debate [1].

There are lots of different types of nuclear weapons: Oralloy thermonuclear warheads, Neutron bombs, Fission fusion-fission bombs, Cobalt bombs, Clean bombs, Alarm Clock/Sloika, Hydrogen bombs, Plutonium pit etc. In this work the review of a neutron bomb will be made in detail.

A neutron bomb or enhanced radiation weapon (ERW) or weapon of reinforced radiation is a type of thermonuclear weapon designed specifically to release a large portion of its energy as energetic neutron radiation (fast neutrons) rather than explosive energy. Although their extreme blast and heat effects are not eliminated, it is the enormous radiation released by ERWs that is meant to be a major source of casualties. The levels of neutron radiation released are able to penetrate through thick, protective materials such as armor, making them useful as an anti-tank weapon[1-2].

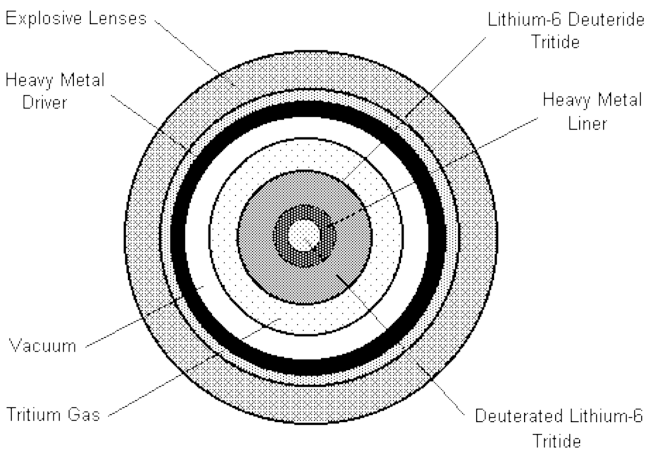


Fig. 2. Neutron bomb

Upon detonation, a 1 kiloton neutron bomb would produce a large blast wave, and a powerful pulse of both thermal radiation and ionizing radiation, mostly in the form of fast (14.1MeV) neutrons. The thermal pulse would cause 3rd degree burns to unprotected skin out to approximately 500m. The blast would create at least 4.6 PSI out to a radius of 600m, which would severely damage non-reinforced structures. At this distance the blast would cause very few direct casualties as the human body is resistant to sheer overpressure, however, the powerful winds produced by this overpressure are capable of throwing human bodies into objects or throwing objects at high velocity, both with lethal results, rendering casualties highly dependent on surroundings. The pulse of neutron radiation would cause immediate and permanent incapacitation to unprotected humans out to 900m, with death occuring in one or two days. The lethal dose would extend out past 1400m, where approximately half of those exposed would die of radiation sickness after several weeks [2].

While this would seem to support the notion of neutron bombs being capable of killing the population while leaving buildings standing, at least in the ring between 600m and 1400m, several factors argue against this interpretation. The thermal pulse would create a large fire that could easily spread outside the blast zone, and the relatively small area covered by the bomb would mean that any sizable target would need several dispersed hits to blanket it, with inevitable overlap. There would also be significant fallout, both from neutron activation of target materials and from the fission primary in the bomb itself [2].

Neutron bomb structure

A neutron bomb is a fission-fusion thermonuclear weapon (hydrogen bomb) in which the burst of neutrons generated by a fusion reaction is intentionally allowed to escape the weapon, rather than being absorbed by its other components. The weapon's X-ray mirrors and radiation case, made of uranium or lead in a standard bomb, are instead made of chromium or nickel so that the neutrons can escape. The bombs also require amounts of tritium on the order of a few tens of grams [3].

The «usual» nuclear weapon yield expressed as kT TNT equivalent is not a measure of a neutron weapon's destructive power. It refers only to the energy released (mostly heat and blast), and does not express the lethal effect of neutron radiation on living organisms. Compared to a fission bomb with the identical explosive yield, a neutron bomb would emit about ten times the amount of neutron radiation. In a fission bomb, the radiation pulse energy is approximately 5% of the entire energy released; in the neutron bomb it would be closer to 50%. A neutron bomb releases a much higher amount of neutrons than a fission bomb of the same explosive yield. Furthermore, these neutrons are of much higher energy (14 MeV) than those released during a fission reaction (1-2 MeV) [3].

Many neutron bombs are made in a so-called Teller-Ulam design. The **Teller-Ulam design** is the nuclear weapon design concept used in most of the world's nuclear weapons. A simplified summary of this design explanation would be:

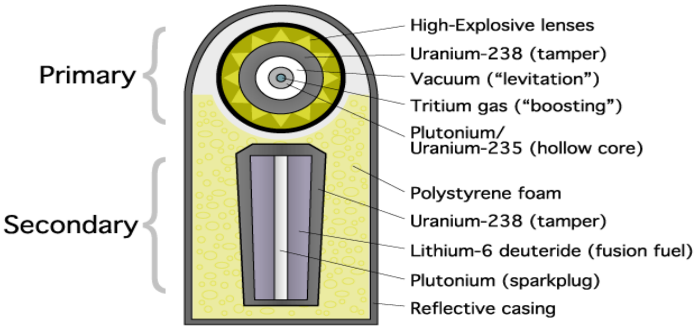


Fig.3. The Teller-Ulam design

1. An implosion assembly type of fission bomb is exploded. This is the primary stage. If a small amount of deuterium/tritium gas is placed inside the primary's core, it will be compressed during the explosion and a nuclear fusion reaction will occur; the released neutrons from this fusion reaction will induce further fission in the plutonium-239 or uranium-235 used in the primary stage. The use of fusion fuel to enhance the efficiency of a fission reaction is called boosting. Without boosting, a large portion of the fissile material will remain unreacted; the Little Boy and Fat Man bombs had an efficiency of only 1.4% and 17%, respectively, because they were unboosted.

2. Energy released in the primary stage is transferred to the secondary (or fusion) stage. The exact mechanism whereby this happens is unknown. This energy compresses the fusion fuel and sparkplug; the compressed sparkplug becomes critical and undergoes a fission chain reaction, further heating the compressed fusion fuel to a high enough temperature to induce fusion, and also supplying neutrons that react with lithium to create tritium for fusion. Generally, increasing the kinetic energy of gas molecules contained in a limited volume will increase both temperature and pressure (see gas laws).

3. The fusion fuel of the secondary stage may be surrounded by depleted uranium or natural uranium, whose U-238 is not fissile and cannot sustain a chain reaction, but which is fissionable when bombarded by the high-energy neutrons released by fusion in the secondary stage. This process provides considerable energy yield (as much as half of the total yield in large devices), but is not considered a tertiary «stage». Tertiary stages are further fusion stages (see below), which have been only rarely used, and then only in the most powerful bombs ever made.

Thermonuclear weapons may or may not use a boosted primary stage, use different types of fusion fuel, and may surround the fusion fuel with beryllium (or another neutron reflecting material) instead of depleted uranium to prevent further fission from occurring [3].

The potential consequences of the nuclear war

Nuclear winter is a hypothetical climatic effect of nuclear war. It is theorized that detonating large numbers of nuclear weapons has a profound and severe effect on the climate causing cold weather and reduced sunlight for a period of months or even years, especially over flammable targets such as cities, where large amounts of smoke and soot would be ejected into the Earth's stratosphere [4]. Similar climatic effects can be caused by comets or an asteroid impact, also sometimes termed an impact winter, or by a supervolcano eruption, known as a volcanic winter.

The nuclear winter scenario predicts that the huge fires caused by nuclear explosions (from burning urban areas) would loft massive amounts of dense smoke from the fires, into the upper troposphere / stratosphere. At 10-15 kilometers (6-9 miles) above the Earth's surface, the absorption of sunlight would further heat the smoke, lifting some, or all of it, into the stratosphere, to where the smoke would persist for years, with no rain to wash it out. This aerosol of particles would block out much of the sun's light from reaching the surface, causing surface temperatures to drop drastically [4].

The exact timescale for how long this smoke remains, and thus how severely this smoke affects the climate once it reaches the stratosphere, is dependent on both chemical and physical removal processes. The physical removal mechanisms affecting the timescale of smoke particle removal are how quickly the particles in the smoke coagulate and fall out of the atmosphere via dry deposition, and to a slower degree, the time it takes for solar radiation pressure to move the particles to a lower level in the atmosphere. Whether by coagulation or radiation pressure, once the particles are at this lower atmospheric level cloud seeding can begin, permitting precipitation to wash the smoke aerosol out of the atmosphere by the wet deposition mechanism. The chemical processes that affect the removal are dependant on the ability of atmospheric chemistry to oxidize the smoke, via reactions with oxidative species such as ozone and nitrogen oxides, both of which are found at all levels of the atmosphere. Historical data on residence times of aerosols, albeit a different mixture of aerosols, from megavolcano eruptions appear to be in the 1-2 year time scale. Aerosol atmosphere interactions are still poorly understood [4].

Firestorm formation

All the papers begin with the common premise: a large quantity of carbon aerosol has found its way into the stratosphere. As firestorm formation is clearly a necessity to generate the form of smoke discussed in the climatology models, this is the bedrock to all nuclear winter predictions. The 150 Tg carbon soot aerosol injection into the stratosphere, which the TTAPS paper required to cause nuclear winter, has been criticized on the basis of World War II firestorm ignition evidence from Japanese and medieval European wooden cities, Evidence exists in survivor testimony from Hiroshima that great quantities of Carbon soot was precipitated as rainout during the Hiroshima firestorm - in the form of the infamous *black rain*, a natural phenomenon produced by Pyrocumulus clouds. The *black rain* formed soon after the bombing, washing large amounts of carbon out of the atmosphere.

Unlike the Japanese city of Hiroshima where the only Nuclear weapon-triggered firestorm has occurred to date, modern cities are unlike the Hiroshima of 1945, that is they are not built out of predominantly 'flimsy' constructed flammable materials like wood, but built of mostly concrete and masonry brick [4-5].

The nuclear winter effect from the firestorm in Hiroshima blocked out the sun for 25 minutes (from burst time at 8:15 am until 8:40 am) as shown by the meteorological sunshine records printed in Figure 4 (3H) of the Report of the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan, Volume 1, Office of the Air Surgeon, report NP-3036, April 19, 1951, U.S. Atomic Energy Commission. The Hiroshima firestorm soot was hydroscopic, absorbing water and falling out in black rain, which limited the climatic effect. The fact that soot was rapidly precipitated in a self-induced rainout in Hiroshima was in 1983 used as a nuclear winter criticism by J. B. Knox of Lawrence Livermore National Laboratory in report UCRL-89907 [5].

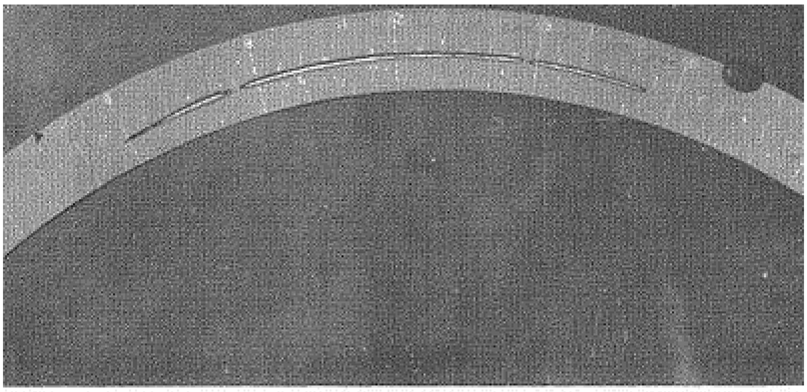


Fig. 4. Record of sunshine at Hiroshima Meteorological Observatory. Note that space at left indicates time when bomb dropped. This space resulted from a mass of clouds which darkened the sky from the sun's rays at 8:15 A. M. The sun coming out again, approximately 25 minutes later, further burned its track into the paper. (Photo File #HH 180.)

No other nuclear explosion ever created a firestorm, including detonations of up to 15 megatons beside naturally forested islands-Bikini and Eniwetok Atoll, which failed to ignite the trees due to the high (80%) air humidity and its effects both on ignition and thermal pulse transmission, instead simply badly scorching the trees. Targeting oil wells instead of cities, as was done in the final TTAPS paper to compensate for reduced estimates of city firestorm soot emission, reduces the moisture effect, but the soot doesn't rise high enough from burning oil wells for widespread climatic effects, as shown in 1991 when Iraq set fire to all of Kuwait’s oil fields [5].

Modern Weapon effects modeling has found that city structures including skyscrapers create a great deal of shadowing that further diminishes the probability of creating a firestorm directly from a nuclear weapons thermal effect. This has led to further downward revisions to Nuclear Weapons effects scaling laws.

Lastly, there is the question of whether the thermal pulse of a modern nuclear weapon is sufficient to ignite an entire modern city, or simply level most of it to the ground. The generating mechanism for the firestorm that engulfed Hiroshima was not (as some contend) directly linked to the thermal pulse from the atomic bomb, but in reality the major causative agent of the firestorm was the timing of the bombing, and to a lesser degree the exceptionally dry weather conditions preceding the bomb run. The fact that the bombing occurred at 08:15 local time meant the bombing occurred right around breakfast time, which importantly implies that the fires were secondary in nature, started from overturned cooking devices when the blast wave arrived, This is in direct contrast to the atomic bombing of Nagasaki, where no true firestorm formed [5].

The originally secret 6 volume U.S. Strategic Bombing Survey reports on Hiroshima and Nagasaki disclose that there had been no significant rain for 3 weeks prior to the Hiroshima bombing, and for 10 days prior to the Nagasaki bombing, except for one light shower on August 5. The May 1947 U.S. Strategic Bombing Survey report on Hiroshima lists all the factors that contributed to the firestorm on pages 4-6: «Six persons who had been in reinforced-concrete buildings within 3,200 feet of air zero stated that black cotton black-out curtains were ignited by flash heat... A large proportion of over 1,000 persons questioned was, however, in agreement that a great majority of the original fires were started by debris falling on kitchen charcoal fires ... There had been practically no rain in the city for about 3 weeks. The velocity of the wind ... was not more than 5 miles per hour.... Hundreds of fires were reported to have started in the centre of the city within 10 minutes after the explosion... almost no effort was made to fight this conflagration ... There were no automatic sprinkler systems in buildings...» [5].

Nuclear darkness refers to a predicted darkening of the Earth caused by the massive absorption of sunlight by a global stratospheric smoke layer created by the burning of cities and industrial areas following a nuclear conflict. Nuclear darkness resulting from a large nuclear exchange can produce a Nuclear winter effect, but nuclear darkness from much smaller nuclear conflicts, that do not produce the temperatures or conditions associated with nuclear winter, will still have catastrophic effects on global climate [6].

Research

New research indicates that much less than one percent of the current explosive power of the global nuclear arsenal, if detonated in cities of the sub-tropics, would put up to 5 million tons of smoke into the stratosphere, where it would reside for many years. Smoke from a regional nuclear conflict would block enough sunlight to drop average surface temperatures on Earth to pre-industrial levels, significantly shorten growing seasons, and cause catastrophic disruptions of the global climate, as well as massive destruction of the ozone layer.

A **Nuclear summer** is a hypothetical scenario resulting from nuclear warfare that would follow a nuclear winter, caused by aerosols inserted into the atmosphere that would prevent sunlight from reaching lower levels or the surface. In this scenario, following the settling out of most of the aerosols in 1–3 years, the cooling effect would be overcome by a heating effect from greenhouse warming, which would raise surface temperatures rapidly by many degrees, enough to cause the death of much if not most of the life that had survived the cooling, much of which is more vulnerable to higher-than-normal temperatures than to lower-than-normal temperatures. The nuclear detonations would release CO_2 and other greenhouse gases from burning, followed by more released from decay of dead organic matter. The detonations would also insert oxides of nitrogen into the stratosphere that would then deplete the ozone layer around the Earth. This layer screens out UV-C radiation from the Sun, which causes genetic damage to life forms on the surface. As the temperature rises, the amount of water in the atmosphere would increase, causing further greenhouse warming of the surface, and if it rose enough, it could cause the sublimation of methane clathrate deposits on the sea floor, releasing huge amounts of methane, a greenhouse gas, into the atmosphere, perhaps enough to trigger runaway climate change. Other more simplistic versions of the hypothesis exist: that Nuclear winter might give way to a nuclear summer. The high temperatures of the nuclear fireballs could destroy the ozone gas of the middle stratosphere [6].

Conclusion

During this work, the differences of the neutron bomb from other nuclear weapon were shown, the main information about the neutron bomb was studied. It becomes obvious that each coin has two sides. In our case, the nuclear power is very useful, because little amount of fuel can produce large amount of energy. That is very useful in places, where the energy must be produced for a very long time without refueling. But on the other hand, large amounts of energy can cause an enormous damage in the world, even changing climate on the Earth. Let's hope, that the presence of nuclear weapons in different countries is just for defense, and will never be used again.

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WIFI SECURITY SYSTEM ATTACK

R. Pavlyk
Scientific advisor: V.I. Novikov
Language advisor: Teacher: A.S. Nypadymka
National Technical University of Ukraine "Kyiv Polytechnic Institute", Institute of Telecommunication Systems, Ukraine, Kyiv, Industrialnyy prov., 2, 03056
E-mail: rommeras@bigmir.net

Abstract. The most important problems of WiFi security system, the most attackable security protocols are discussed step-by step in the present paper and the most widely-spread ways of attack are highlighted.

To start with, there are three main objectives fraudsters try to pursue.

The first is to block the hot spot. It is unpleasant to hear but it is not fatally.

Second is to access the Internet connection control or attack Local Area Network, which is distressing.

Finally, the third possible goal is to capture the traffic in order to get confidential data [1]. That is really distressing. Let's face the most well-known security protocols: WEP, WPA, WPA2 [5].

It is not quite difficult to get the WEP key. For the successful attack it is enough to install "aircrack-ng" program. Next, all we need to do is to intercept the required quantity of data packets from airwaves. Moreover, we need to know not all the data but only the initialization vector [3].

Hacking technique remains to be the same for WPA and WPA2. When you run "airodump-ng" our hot spot will look like this:

BSSID	PWR	Beacons	#Data	#/n	CH	MB	ENC	CIPHER	AUTH	ESSID
xx:xx:xx:xx:xx:xx	-64	82	18	0	1	54e	WPA2	CCMP	PSK	TEST

A successful attack can be started with getting so-called Handshake, which happens once, at the time of a client's connection to the hot spot. Accordingly, there are two ways how to do it: first is to wait for any of the clients gets connected, second is artificially reset the existing connection with the utility program "aireplay-ng". To the person from who we forcibly disconnected the access point, it will look as if the data channel faded for a few seconds [4]. In fact, at this moment his Wi-Fi-adapter reconnected to an access point, completing that "handshake", we need to capture. After having all necessary data, the only way to get the key is to sort out all the options in the dictionary. There is a statement that says that the probability of selection WPA2 key equals "zero" [6]. This means that for a sufficiently long key it is impossible to assort it because of the long duration of the process. For instance it may take 20-700 years to get the key which consists of 8 symbols and may contain small and large letters, as well as any numbers [2].

To sum up, nowadays Wi-Fi security is at a high level due to modern technology as well as denial of outdated protocols WEP/WPA and using WPA2, but even though we can not exclude the possibility to circumvent security system. That means there is something to strive for.

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RADIOPHOBIA AS A PROBLEM OF NUCLEAR ENERGY

S.V. Pykhtin, A.A. Sklyarov

Scientific Supervisor: T.G. Petrashova, Associate Professor

Linguistic Advisor: T.G. Petrashova, Associate Professor

National Research Tomsk Polytechnic University, 30, Lenin Avenue, Tomsk, 634050, Russia

E-mail: sklyarov.tsk@gmail.com

Annotation

The focus of this work is a public negative attitude to radiation. Thus, the paper is devoted to radiophobia. The main purpose is to study the issue and offer a possible solution to change the situation with radiophobia predicting consequences. In the introduction, the information about radiophobia is given, and the research methods are described: survey-questionnaire and trend analysis. Based on the data achieved, the present radiophobia situation in Russia and the Tomsk region has been analyzed. Not so much literature on radiophobia exists since the radiophobia effect has not been studied in depth in Russia.

Introduction

Nowadays, the use of nuclear energy is a very profitable solution for many countries, however not all countries want to build nuclear power stations. One of the main reasons for this in our country is radiophobia. According to Alexander Konstantinov (Professor of Russian Academy of Natural Sciences), radiophobia is a national problem of Russia. [1]

Radiophobia is the fear of radiation or x-rays. The origin of the word 'radio' is Latin (it means 'ray' or 'radiating') and phobia is Greek (it means 'fear').

Some people say that our aversion to nuclear energy goes further back than that. In the book "Nuclear Fear: A History of Images" a historian Spencer Weart argues that the way we think about nuclear energy has roots from even before radioactivity was discovered in 1896. Early alchemists, for example, were interested in transmutation, which Weart defines as "the passage through destruction to rebirth". Ideas about transmutation and doomsday scenarios came together and bubbled up around the potential danger of too much radiation, Weart says.

"By the 1930s most people vaguely associated radioactivity with uncanny rays that brought hideous death or miraculous new life; with mad scientists and their ambiguous monsters; with cosmic secrets of death and life; with a future Golden Age, perhaps reached only through an apocalypse; and with weapons great enough to destroy the world, except perhaps for a few survivors", Weart writes [3]. The atomic bombings of Hiroshima and Nagasaki confirmed this structure of hopeful and fearful images, and made such ideas prominent. Distrust grew into the early 1960s, with nuclear authorities regarded as "dangerous men not unlike mad scientists." A movement broke out against nuclear reactors in the 1970s, coupled with a fear of bombs.

"Nuclear power was this notion of something that was associated with death," John said [3].

Then there was Chernobyl in 1986, the world's biggest nuclear disaster, which further damaged perceptions of nuclear power. Today, people commonly go for diagnostic scan procedures called MRIs, but the technique was originally called "nuclear magnetic resonance imaging" or NMRI, with the first human testing in the 1970s. But because of this history of bad associations, "nobody wanted to get into a machine called a 'nuclear' anything," John said [3].

In this regard, the main aims of this work are:

1) to offer a possible way to change radiophobia situation;
2) to predict consequences of the method offered.

In order to understand the origin of radiophobia, it is important to have at least basic knowledge about radiation. Frequently, people do not have much knowledge in this area.

There are some methods which are used in this research. The most effective methods are survey-questionnaire and trend analysis. The problem of radiophobia is widely spread among the population. However, middle-aged people are supposed to provide unbiased and correct answers. Therefore this part of the population in Tomsk was interviewed. Based on the interview results, the future development of the events can be forecast. One hundred middle-aged people were interviewed about radiation. They were asked four questions:

1) What is radiation?
2) What is the reason for radiation?
3) What value of background radiation is normal?
4) Are you afraid of radiation?

The research showed that people know nothing about radiation. Moreover, wrong understanding of radiation is imposed by the Mass Media. In other words, the Mass Media do not try to fight with radiophobia.

The subject of nuclear power tends to provoke an even greater reaction. Part of this has to do with pop culture; the image of Homer Simpson asleep at his post in the Springfield Nuclear Plant is funny because it embodies the dim view that many people have of nuclear power in general. Indeed, the names of nuclear disasters have been burned into our minds through decades of slow repetition. Words like Chernobyl, Three Mile Island and now Fukushima resonate because they tap into two complimentary tendencies: first, the media’s fetish with sensationalism, and second, the vast human proclivity for fear of the unknown. Both of these tendencies came out in full force after the catastrophe in Japan.

Results and discussion

Trend analysis showed some unattractive perspectives. Nowadays, there are many protests and meetings against nuclear energy, especially in Germany and Japan. People are sure that nuclear power plants are dangerous. In future, it can lead to total refusal of nuclear power use. It means that Humanity will start using fossil fuel stations again. It will accelerate the global warming and initiate acid rains formation. Needless to say that fossil fuels stations produce not only carbondioxides but radioactive waste too. That is why radiophobia may lead to real ecocatastrophe.

How to prevent it? Obviously, that only publicity can stop and change influence of radiophobia.

There are eight main conditions to prevent it (in this topic «risk» means «risk of residing near a nuclear power plant»):[1]

1) Voluntariness of risk (it is perceived easier than a compulsory risk).
2) Risk should be controlled by people.
3) Compensations and privileges for this risk.
4) Trust to source of information.
5) Naturalness of danger (natural danger much more acceptable than technogenic).
6) Commonness of danger (usual danger much more acceptable too).
7) Danger availability for perception (knowledge about risk).
8) Breaking subjective and frightening associations (Chernobyl, Hiroshima, Nagaski)

As the matter of fact, these conditions are provided by some psychological aspects. Research into how people perceive and respond to risk has identified several psychological characteristics that make nuclear radiation particularly frightening:

- It is undetectable by senses.
- Radiation causes cancer.
- Radiation from nuclear power is human-made, and human-made risks evoke more fear than natural threats.
- Nuclear power plants can have accidents (many people still believe that plants can explode like bombs).
- Many people don't trust the nuclear industry, or government nuclear regulators, and the less we trust, the more we fear.
- Despite all these fears, public attitudes toward nuclear power are shifting. The psychology of risk perception explains that people are more aware of the benefits of CO2-free emissions, and when the benefits of a choice seem larger, the associated risks seem smaller.

The fact of the matter is that radiation is not a known thing but some kind of exotics for most people. Therefore, the following should be applied:

1) Lectures on radiation should be introduced in the elementary schools. Children will have an idea about the subject and nature of radiation.
2) Information on radiation should be available at any time to provide transparency.
3) Social advertising should be on TV or radio to increase trust in radiation in general.

Conclusion

To summarize, it is obvious that 'radiophobia' is a really important factor that may slow down the nuclear energy progress. If people change their attitude to this problem, and overcome their fear and prejudice, it will be the greatest step ahead towards the whole humanity progress. Oil and gas resources are limited and run out soon, but mankind can use nuclear energy as a main source of energy for a long time. That is why we should find methods to bring the right information about radiation and nuclear energy. Social advertising on radio and TV, meetings, seminars, public radiation monitoring and complete transparency of nuclear sphere and some other ways have to make radiophobia go down.

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THE IMPACT OF GLOBALIZATION ON THE WORLD OF SCIENCE

T.M. Semenenko

Scientific advisor: Ph.D., Associate Professor D.S. Isachenko

Linguistic advisor: Teacher Y.V. Ermakova

Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050

E-mail: dinamys0@gmail.com

Abstract

The impact of globalization on the world of science has various manifestations. It changes the concept and characteristics of mobility of scientific personnel, changes the subjects of research, and more and more interdisciplinary areas of the country get closer together in terms of attention to specific areas of research (controlled thermonuclear synthesis, biotechnology, nanotechnology, health research). The catching-up effect of globalization is further increased because of the great importance of borrowing elements of success stories and best practices from other countries. This article, briefly examines four areas of modern science policies in Russia, which affect the processes of globalization: new priorities to support scientific research, development of international relations, etc.

There are 6 keywords being used in this report: globalization, controlled thermonuclear synthesis, commercialize, *biotechnology, nanotechnology, RFBR (Russian Foundation for Basic Research).*

1. *Introduction*

1.1. Development of new research

The research in Russia is getting closer to the priorities of developed countries; government policy is aimed at supporting individual choice and rapidly developing areas of technology. Now, in response to the development of the world priorities, massive support of nanotechnology can be seen, along with increasing focus on biotechnology.

In Russia, the support for biotechnology began with creating a specialized organizational structure and allocation of a substantial budget for research and development. In 2007, in order to develop a functional State Corporation of Nanotechnologies («RUSNANOTECH»), the government has allocated 130 billion rubles to it. This exceeds the funding of nanotechnology in most of the developed countries in the world at the time, as budget funding for science in these countries is higher than in Russia. However, the basis for the commercialization of the results of this research in Russia is weak, which is reflected in terms of patent statistics. According to «Ruspatent», the received applications in nanotechnology are only about 300, and there is not a single «Nanopatent»; while there were about 10 thousand around the world.

Abroad, not only massive investment in research and development and infrastructure construction will determine the success of nanotechnology. Studying the experience of the most advanced countries in this area leads to several important conclusions.[1]

First, the creation of networks (nanotechnology project), as a rule, is funded on at the business level.

In Russia today it is not clear for the business community, and, most of all, judging by the reviews of officials and experts knowledgeable of the development of the Russian Nanotechnology Initiative, the business is still pending. Thus, the model, which was launched - the model for the «technological shock» which will be funded by the creation of new designs and products, and then looking for ways to commercialize them, or attempting to implement the already existing development. In this approach, the most likely consumer of the results of Russian R & D may be foreign businesses.

Second, the government regulatory measures applied flexibly and completely, are diverse and complementary. It has formed several funds and programs to support nanotechnology, different types of organizational structures, networks, various types of infrastructure, etc. An important development is the implementation of multi-measures, which serve simultaneously for several purposes - the development of working organizations, training, promoting interdisciplinarity, and the commercialization of research and development. Federal and regional authorities usually jointly participate in the implementation of such measures. Similar approaches are also used for the development of biotechnology, which is one of the most work-intensive area. Biotechnology is also among the priorities of scientific and technological development for Russia. This list was updated and approved in 2006.[1-4]

Such a significant funding for nanotechnology in Russia, is a factor that certainly affects the relationship and possible rates of development of different areas of research. Experts estimate that more than 700 organizations in the country are engaged in nanotechnology. A growing number of scientists, scientific groups and organizations are actively implementing research in the field of nanotechnology. A similar pattern can also be seen in high schools – which, also, are beginning to modify and add courses and programs on topics of nanotechnology. Thus, the impact of globalization manifested in the allocation of a considerable budget for the chosen direction of research. However, in the meantime, little attention is paid to the way in which it is necessary to support it for economic returns.[2]

Such a large-scale trend in the development of complex scientific work in the field of nanotechnology is not without danger, as it reshapes research and growth in other industries and this may lead to delays in the field of nanotechnology.

2. *Main part*

2.1. International scientific cooperation

International cooperation is an important factor in the acquisition of new knowledge, competitiveness and performance in science. In this area, government policy is aimed at promoting the development of relations, including through various schemes and forms of co-financing. The russian governmental structures such as ministries and agencies, and especially the Ministry of Education and Science, as well as the russian state, fund operations in the field of science and technology, actively developing various cooperation programs with foreign funds. Because a steady increase in budgetary allocations for science began in 2003, the format of international cooperation began to change. In the past, the russian state co-financed or not-at-all funded programs; or allocated funds in small amounts. Later, gradually, it began to increase the number of programs implemented through equitable funding.[3]

In terms of trends in the development of government policy in the field of international cooperation, there are several new aspects:

Along with the co-funding, it came the related requirement for joint management programs. Earlier in many programs funded by foreign funds, the russian participation was limited, involving scientists who conducted initial evaluation of applications, while the planning, organization, implementation and monitoring of the programs was carried out entirely by the funding organizations.

The next trend is improved choice and equal cooperation. The Ministry of Education believes that there is a great interest for collaborative research on nanotechnology, biotechnology, metrology, as well as research in the field of chemistry. There are also regional priorities more favorable to the interconnections with the European Union. The collaboration with the U.S. is complicated by a number of problems, both legal and purely political.[1-4]

In general, cooperation with foreign funds increasingly acquires a partnership nature, since it is based on mutual interests. For the russian side, it allows to generate new knowledge, especially in the field of technology management, technology commercialization, mutual scientific expertise, and access to foreign expertise. For foreign partners the knowledge and skills of russian scientists is the main attractive factor in the collaboration. Therefore, cooperation in the field of basic research is constantly evolving, which can clearly be traced in the dynamics of the international programs implemented by the Russian Foundation for Basic Research (RFBR).[5]

The amount of international initiatives for funding is growing every year: in 2004, the funding was 66.4 million rubles; later, for 2007, 240.3 million rubles were planned to be spent. Characteristically, competition for international financing is increasing both in absolute and relative scale. In 2005, 2.2% of the RFBR budget was allocated for international projects. In 2007, it was 4.5%. At the same time, there were increases in the number of competitions. In 1998, there were two joint projects. By 2005, the number had risen to 13.

RFBR data suggests that the most actively developing contacts with russian scientific research groups are in Germany, USA and France. These countries account for, respectively, 19%, 15% and 11% of all publications on the RFBR projects, supported in the framework of international programs. Total joint publications with scientists happen in more than 70 countries. Of all of them, the "important" partners are research teams located in 21 countries.

The second direction is the support for initiatives in Russia, small high-tech business are one of the necessary elements to establish the commercialization of research and development. An increasing number of foreign-fund programs offer training and education in the field of technology management and technology commercialization.

Thus, the country's openness and the offer of opportunities for international cooperation in research and innovation areas contribute to the emergence of new scientific findings as well as it allows the output of the russian developers to find new markets for its high-tech products.[6]

Conclusion

The analysis of selected science policies suggests that the processes of globalization have both positive and negative effects on the sector of research and development. As positive results, there can be noted:

- Attention to the development of modern research areas
- Introduction of new forms of organization and financing of science,
- increased mobility of scientific personnel, improvements in their quality and efficiency,
- Offers from russian developers to new markets of high technology products.

The negative effects of globalization are determined mainly by how you use the foreign experience. Attempts to introduce new elements of the organization of science in the old practice of decision-making could have a negative impact on the science situation, including the resulting technologycal «brain drain» and the ineffective use of technology.

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PROTECTION FROM RADIATION

A.S. Torpov, M.N. Chaykin
Scientific advisor: Assistant V.A. Kudryavcev
Language advisor: Senior teacher N.G. Novikova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: lexatorpov@gmail.com

This article discusses the basic methods of radiation protection. The paper presents the main stages of each method. In addition, it focuses on the knowledge of specific methods to protect against certain types of radiation. Types of materials used for the protection of their use are discussed in paper. Application protection in emergency situations. Finally, innovations in the development of dosimetry are presented in the article. The article is of interest to scholars and students related to nuclear technology.
Keywords: Radiation protection; Innovation.

As is known, the effect of radiation on the human or animal can be of two kinds: from the inside or the outside. Health does not add any of them. How to protect yourself from radiation? Despite the high risk posed by virtually any source of radiation, radiation protection methods do exist. All the ways to protect against radiation can be divided into three types: time, distance, and special screens. [1-2]

Protection by time

The meaning of this method of radiation protection is to minimize the residence time near the source of radiation. The less time a person is near a radiation source, the less harm he had caused. This method of protection is used, for example, the liquidation of the accident at the Chernobyl nuclear power plant. Liquidators of the explosion at the nuclear power plant will only be given a few moments to do its work in the affected area and get back to a safe area. Timeout leads to increased levels of radiation and could be the beginning of the development of radiation sickness and other effects that can cause radiation.[2-3]

Distance protection

If you find yourself close to the object that is the source of radiation - one that may be dangerous to life and health, you need to get away from him at a distance, where the background radiation and the radiation is within acceptable standards. You can also display the source of radiation to a safe area or a disposal facility.

Fallout screens and clothing[2]

In some situations, just need to carry out any activity in the area with high background radiation. An example would be the elimination of the consequences of the accident at the nuclear power plants or industrial jobs where there are sources of radiation. Being in such areas without the use of personal protective equipment is dangerous not only for health, but also for life. For this reason I have developed personal protection from radiation. These screens are manufactured from materials that retain different types of radiation and special clothing.

Protective suit against radiation

As you know, radiation is classified into several types depending on the nature of the charge and particle radiation. To counter the particular kinds of radiation protection against it are made using different materials:

Protect people from the radiation of alpha, help rubber gloves, the "barrier" of paper or a regular respirator.[3]

If the infected area dominated by beta radiation, in order to protect the body from the harmful effects of its screen is required of glass, thin aluminum sheet or a material such as plexiglass. To protect against beta radiation respiratory conventional respirator is not rid of. There need a gas mask[4].

The most difficult to protect yourself from gamma radiation. Uniform, which has the shielding effect of this kind of radiation is made of lead, iron, steel, tungsten and other metals with high mass. That clothes of lead used in the works at the Chernobyl nuclear power plant after the accident.

All sorts of barriers made of polymers, polyethylene, and even water effectively protect against the harmful effects of neutron particles.[5]

Japanese scientists have invented a fabric absorbing radioactive Cesium

Scientists at Tokyo University invented a fabric that could absorb radioactive cesium from contaminated water and soil. Experts point out that such an invention would be useful in the decontamination of areas of Japan affected by radiation from the accident at the nuclear power plant "Fukushima".

Active "soaks up" the substance in the tissue became Prussian Blue - material used in medicine as an antidote. The first experiments with this "miracle cloth" was conducted last fall in the village Iidate affected by the accident at the plant.

As rain water containing radioactive cesium, dropped a piece of cloth, measuring 60 to 40 cm and weighing only 18 grams. The next morning measurements showed a decrease in radioactivity in the water three times! In addition, the researchers argue that the material can be used for decontamination of soil.

Development costs are also very attractive - the creation of a square meter of fabric leaves no more than six dollars. Another advantage of the web is its easy transport.

Scientists at Tokyo University have begun actively preparing for production test batch "wonder fabric" together with universities and Isinomaki Fukushima.

These innovative development have a great positive role in the nuclear industry as well as the staff working will receive less radiation dose or will not receive it.[6]

Neither one protection clothing can’t completely resistant to radiation. According to the experts is the best way to protect against radiation - not to have contact with contaminated objects and not in areas with high background radiation.

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OBTAINING HYDROGEN FLUORIDE FROM WASTE ALUMINIUM INDUSTRY.

Y.V. Ushakov, V.Y. Gulyaev, E.O. Grigorieva
Scientific advisor: Assistant I.V. Petlin
Language advisor: Senior teacher N.N. Zyablova
Tomsk Polytechnic University, Russia, Tomsk, Lenin str., 30, 634050
E-mail: evgenyi_ne_@mail.ru

Keywords: hydrogen fluoride, aluminum industry, cryolite containing waste, fluorspar, nuclear industry.

A method for comprehensive recycling aluminum industry to produce hydrogen fluoride, aluminum oxide, sodium sulphate and coal crumbs was considered. The reasoning of the possibility of transition to a new production of hydrofluoric kind of stuff - cryolite containing waste, which can save considerable resources in production and processing of fluorite ores and significantly reduce the negative environmental factors of aluminum production was done. The thermodynamic parameters of the process sulphatization cryolite containing wastes issuing the heat of reaction and the energy costs of the process, in comparison with the existing technology of production of anhydrous hydrogen fluoride were calculated.

Introduction

Fluoride is extracted in the form of natural minerals of fluorite and cryolite and removed during processing. Despite significant reserves and resources of fluorspar in reserve there is the lack of viable deposits of high-fluoride material.

Nowadays, the main source of fluoride is fluorspar. The overwhelming volume of industrial fluoride products is produced from fluorspar [1, 2]. Poor quality of Russian mineral resources of fluorspar can not establish the necessary amount of raw material extraction and production fluorspar products [3]. There is shortage of fluoride minerals consumption overlapped by Russian sources by 55 ... 60% [4].

The production cycle of most industrial enterprises is an open unbalanced system characterized by the formation of large amounts of solid, liquid and gaseous waste. Industrial waste is a serious environmental threat to the regions located in the vicinity of the emission sources. The aluminum industry makes significant contribution to pollution, the waste of which account for about 20% of all waste generated in the production of non-ferrous metals in the country [5]. Aluminum production has losses of fluoride in the amount of 85 thousand tons per year in the form of solid, liquid and gaseous waste.

It is encouraged to use cryolite containing waste of aluminum industry to produce anhydrous hydrogen fluoride. The use of wastes will allow to refuse from buying expensive fluorspar, solving the ecological problem of recycling waste of aluminum fluoride production.

The concept of hydrogen fluoride production technology using cryolite containing waste implies its complex processing by the decomposition of sulfuric acid followed by capture, condensation and rectification of produced hydrogen fluoride, and release of aluminum oxide (Al_2O_3), sodium sulfate (Na_2SO_4) and coal crumbs from the solids (Figure 1).

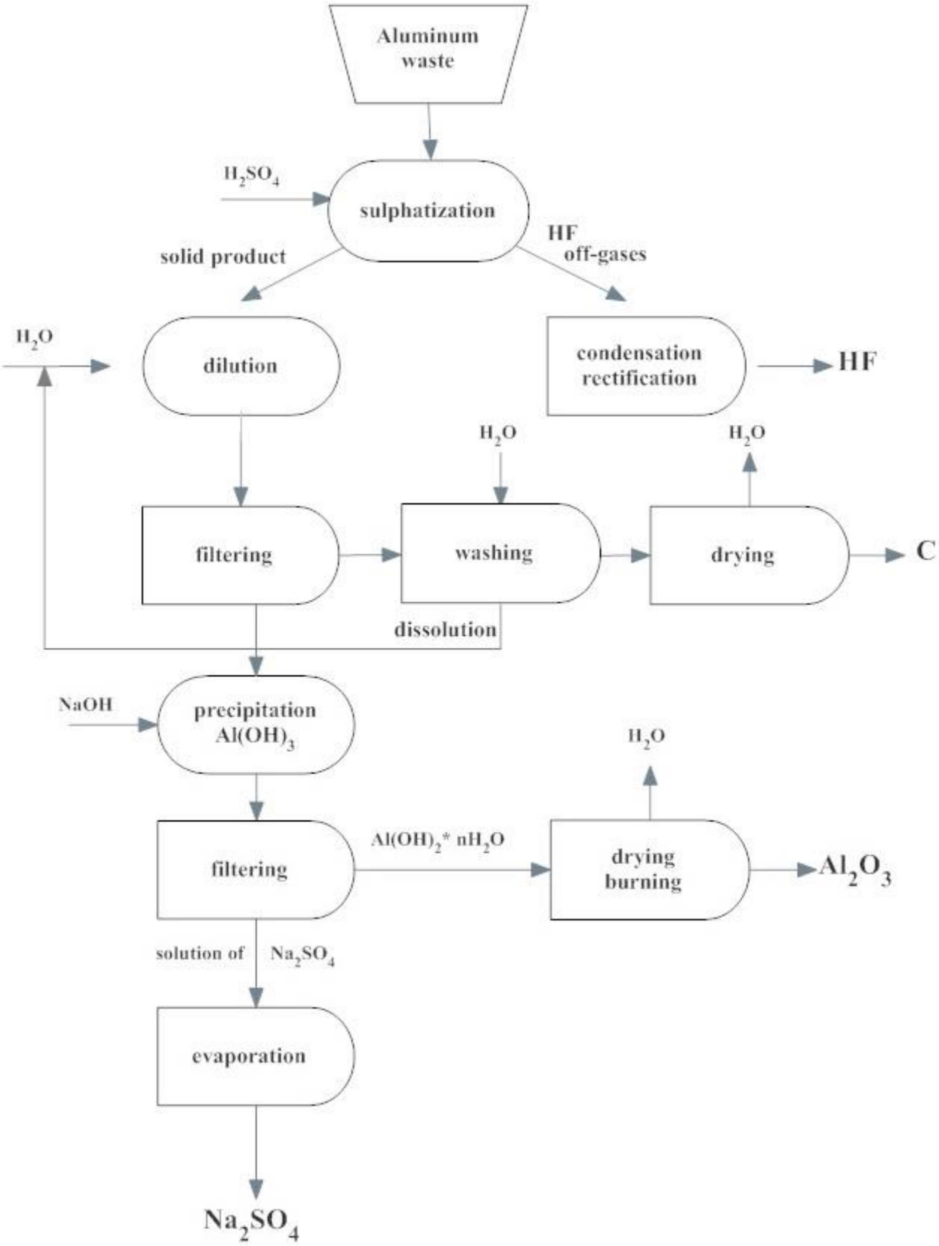

Figure 1. Cryolite containing waste recycling scheme

Fluoride contained in the waste in the form of compounds such as cryolite (Na3AlF6), can be isolated from the reaction of sulfuric acid by the following equation:

$2Na_3AlF_6+9H_2SO_4=12HF+6NaHSO_4+Al_2(SO_4)_3$

$Na_2SO_4+H_2SO_4=2NaHSO_4$

$Al_2O_3+3H_2SO_4=Al_2(SO_4)_3+3H_2O$

$Fe_2O_3+3H_2SO_4=Fe_2(SO_4)_3+3H_2O$

$SiO_2+4HF=SiF_4+2H_2O$

Carbon fraction being in the waste is chemically inert and, is formed together with solid reaction products without affecting the process of decomposition of sulfuric acid.

Fluoride gas produced after steps of cleaning, condensation and rectification may be transferred into waterless hydrogen fluoride and sent to the production profile production of the nuclear fuel cycle.

Solid production of sulphatization after melting and filtration from carbon and inert precipitation can be carry-down of sodium hydroxide with aluminum oxide evaporation sodium sulphate as a result.

Results

To investigate the possibility of the process of sulfuric acid decomposition of waste aluminum production thermodynamic calculations of equilibrium chemical reactions components of sludge by Temkin - Schwartzman was performed [6]. The results of thermodynamic calculations are presented in Table. 1.

Table 1. Gibbs energy, equilibrium constant and the heat of reaction components sulphatization sludge

T, K	298	300	400	500	600
$2Na_3AlF_6+9H_2SO_4=12HF+Al_2(SO_4)_3+6NaHSO_4$					
ΔH, KJ/mole	420,24	420,59	443,99	477,83	521,23
ΔG, KJ/mole	66,437	64,061	-57,999	-187,21	-324,14
K_P	$2{,}26\cdot10^{-12}$	$7{,}02\cdot10^{-12}$	$3{,}75\cdot10^{7}$	$3{,}61\cdot10^{19}$	$1{,}65\cdot10^{28}$
$Al_2O_3+3H_2SO_4=Al_2(SO_4)_3+3H_2O$					
ΔH, KJ/mole	-181,33	-181,35	-63,024	-76,261	-89,409
ΔG, KJ/mole	-159,71	-159,41	-153,67	-170,84	-185,94
K_P	$9{,}87\cdot10^{27}$	$5{,}69\cdot10^{27}$	$1{,}17\cdot10^{20}$	$7{,}04\cdot10^{17}$	$1{,}54\cdot10^{16}$
$Na_2SO_4+H_2SO_4=2NaHSO_4$					
ΔH, KJ/mole	-68,880	-68,584	-51,894	-32,300	-10,390
ΔG, KJ/mole	-52,413	-52,303	-49,297	-50,863	-56,598
K_P	$1{,}54\cdot10^{9}$	$1{,}28\cdot10^{9}$	$2{,}74\cdot10^{6}$	$2{,}06\cdot10^{5}$	$8{,}46\cdot10^{4}$
$Fe_2O_3+3H_2SO_4=Fe_2(SO_4)+3H_2O$					
ΔH, KJ/mole	-182,00	-182,05	-63,651	-73,809	-80,554
ΔG, KJ/mole	-161,75	-161,62	-163,16	-186,80	-208,70
K_P	$2{,}25\cdot10^{28}$	$1{,}38\cdot10^{28}$	$2{,}03\cdot10^{21}$	$3{,}27\cdot10^{19}$	$1{,}48\cdot10^{18}$

The reaction of sulfuric acid decomposition of cryolite is endothermic and require heat input. The probability of their occurrence in the direction of formation of the products of the reaction increases with increasing temperature. Starting temperature of direct reaction is 81 ° C. Reaction of interaction between aluminum oxide, sodium sulfate, and iron oxide (III) in sulfuric acid are exothermic and proceed with heat toward the formation of reaction products at room temperature.

Conclusion

Thus, cryolite containing waste can replace natural fluorspar in the production of hydrogen fluoride, as it does not require the purchase of new raw materials, and solves the problem of waste disposal of aluminum. Making profit of by-products is an easy task, because the aluminum oxide, sodium sulphate and coal crumb are a scarce commodity in the market.

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МЕТОДОЛОГИЯ ПРОЕКТИРОВАНИЯ МОЛОДЕЖНОГО НАУЧНО-ИННОВАЦИОННОГО ПРОСТРАНСТВА ДЛЯ РОССИЙСКОЙ ЭНЕРГЕТИКИ

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ИЗДАТЕЛЬСТВО ТПУ. 634050, г. Томск, пр. Ленина, 30
Тел./факс: 8(3822)56-35-35, www.tpu.ru