

ГЕОЛОГИЯ И НЕФТЕГАЗОВОЕ ДЕЛО

(на английском языке)

PRELIMINARY EVALUATION OF CORROSION FACTORS IN SOBOLINOYE OILFIELD

E.S. Bubnova

Scientific advisor doctor L.V. Shishmina
Tomsk polytechnic university, Tomsk, Russia

Pipeline internal corrosion, transporting oil-water products, is a widely complication of pipeline, especially in western Siberia. It is known, that water corrosion aggression is characterized by quantity of natural and dissolved salt, pH, water hardness, sour gas content, presence of microorganism. The influence degree of these factors on pipeline electrochemical metal corrosion depends on transported medium temperature, pressure, gas-fluid flow pattern, quantity ratio between water and hydrocarbons in the system. Pipeline internal corrosion has its peculiarities in West Siberian conditions. Steel destruction process occurs under the following conditions: oil watering <50 per cent, non-stable emulsion, low-degree mineralization (20 – 40 g/l) of chloride - calcium water, neutral water pH, temperature 40 °C, CO₂ in water phase of oil emulsion and associated gas, according to CO₂ cycle. Besides, salt precipitation in water phase of well products.

It is important to know the flow pattern, because it defines characteristic localization of corrosion defects and, consequently, the methods of treatment and prevention.

The investigation object is oil & gas pipeline, connecting gage stations (AGZY) with oil & gas gathering plant.

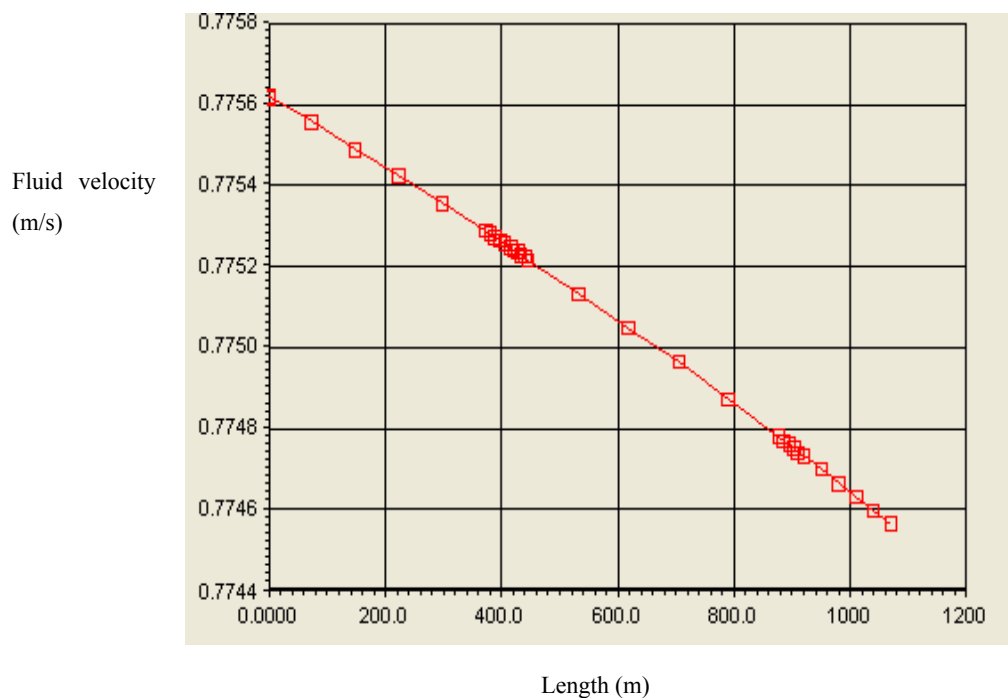


Fig. 1. Changing of fluid velocity changes to pipeline length

Based on flow rate, oil density, formation water density, well stream watering, density and water-oil emulsion watering were estimated. The result was mixture density - 990 kg/m³, watering – 80,9 %. The result: the “oil in water” emulsion type is transported through oil and gas reservoir. This result indicates the fact that the emulsion inversion point has been achieved and that the “water in oil” emulsion is being transported. So, water has come into contact with the pipeline internal surface. According to Sulin classification water is of the chloride - calcium type, where mineralization is 14 – 18 g/l, and pH = 6,5. To determine gas-fluid flow conditions in a pipeline, we considered the following parameters: pipeline diameter (D) = 159 × 6mm, pipeline length – 1070 m. Modeling and hydraulic calculation in HYSYS program was carried out under conditions: pipeline trenching at 1,8 m. The following factors were also taken into consideration: tees, valves and elbows as they could cause a certain amount of resistance. The component composition of formation oil under P_{bed} = 21 МПа, и T_{bed} = 76 °C, as seen in table 1. The estimated results are presented in table 2 and fig. 1.

Based on calculation results (table 2), it can be stated that the gas-fluid flow temperature changes slightly, fluid velocity is low - 0.77 m/s, and gas flows quicker, than does the fluid. Under such conditions such gas-fluid discharge ratio develops an intermittent flow pattern (fig 2).

Table 1

Formation Water Content

Compounds	Content, % molar.
Dioxide carbon	0,07
Nitrogen	0,16
Methane	16,53
Ethane	2,16
Propan	5,68
Isobutanol	2,27
N- butane	6,10
Isopentanol	2,82
N - pentan	3,96
Geccan +	60,25
Molecule mass	163, gr/mole
Density	766, kg/m ³
Molecule mass of residuum	245, gr/mole

Table 2

Results of hydraulic calculations in oil & gas pipeline

Phase	Fraction of stream		Pressure, MPa		Temperature, °C		Re		Speed, m/s	
	Initial	Final	Init.	Fin.	Init.	Fin.	Init.	Fin.	Init.	Fin.
Liquid	0,0061	0,0065	0,65	0,53	39,95	39,56	108600	107740	0,776	0,774
Gas	-	-					64000	71300	0,800	1,040

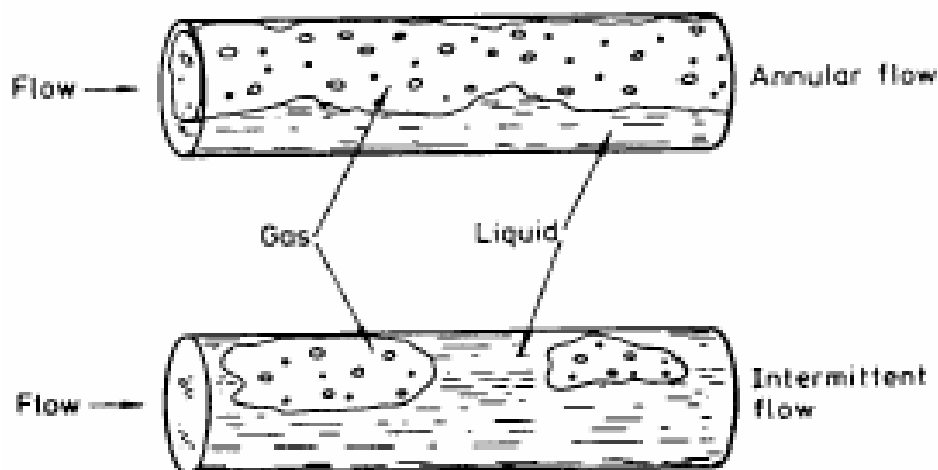


Fig. 2. Intermittent flow pattern

Thus, formation water type and mineralization, high well stream watering, flow pattern and steel material Type 20 (low corrosion resistance) create conditions for salt precipitation and pipeline internal corrosion. For verify the above-mentioned conclusion, it's necessary to measure corrosion velocity from selective pipeline samples.

References

1. Лебедев Б.А. Геохимия эпигенетических изменений. М., Недра, 1992, 126с.
2. Справочник по литологии / Под ред. Н.Б. Вассоевича, В.Л. Либровича, Н.В. Логвиненко и др. - М.: Недра, 1983. - 509 с.
3. Перельман А.И. Геохимия эпигенетических процессов. - М.: Недра, 1965. -210 с.

THE NEW TECHNOLOGY – UNDERWATER PIPELINE RECONSTRUCTION

S.V. Draygin

Scientific advisor doctor V.G. Krezh

Tomsk polytechnic university, Tomsk, Russia

Our country is covered with a wide water network, including thousand kilometers of underwater pipelines of different purposes (sewerage system, water-pipe, gas-pipeline etc). However they have one thing in common, they are made from steel and their operation life exceeds all possible limits. Some underwater pipelines were built as early as the 40's – 60 of the last century and it necessary to reconstruct them or substitute them.

Up to recent times all worn-out underwater pipelines were simply removed and new ones were near by, sometimes it was necessary to construct new extra underwater pipelines, extending it several hundreds of meters. At the same time, old underwater pipelines were left on previous place and gradually became destroyed, resulting in additional damage for the environment and shipping. For example, underwater pipelines floated to the surface because of destruction cantledge or it's washing out of the trench at the river bottom.

According to recent research, the most perspective method is based on the installation of polymeric sleeve into existing pipelines. The reconstruction of pipeline includes the following:

- sleeve is wound on a transport drum, which is installed on a platform for dragging;
- sleeve is connected by coupling unit to drawworks;
- by electric drive the top sleeve is unwound from along supporting roller;
- passed to underwater pipelines for dragging.

Then water is pumped into the sleeve, which make it «twist» into the previous pipeline. After some time the sleeve is «twisted» completely. Water, fills up the sleeve and is warmed up by boilers (necessary time: 6 to 24 hours; temperature level about 80 °C). When the process is finished, water cools gradually and is removed (air can be used instead of water). As a result, resin, which covers the sleeve, hardens and acquires durability, necessary for external and internal pressure. Polymeric sleeve is made of synthetic high-strength fiber «Kevlar», which is covered on both sides with thermoplastic synthetic material. The internal layer serves as a diffusion cutoff.

German company Ruhrgas conducted several experimental tests with polymeric sleeve – Raslinger system. Two types of the sleeve were tested:

First type:

passage diameter - 400 mm;
working pressure - 25 bar;
length 6 m.

Testing conditions:

regime alteration;
fatigue strength under;
oscillatory stress (load) cycles.

Second type:

passage diameter - 400 mm
working pressure - 25 bar;
length 62 m.

Testing conditions:

operation testing.

Also the following testing conditions were taken into consideration: fatigue strength; fracture; bending. The testing result can be seen in table № 1.

Table 1

Sleeve Dp 400, two-layered, P_{operating}=25 bar

Temporary discontinuous pressure	105,3 bar
Peripheral extension (pressure 38 bar)	2,2 %
Longitudinal extension (pressure 38 bar)	0,36 %
Gas permeability (natural gas, 32 bar, 4°C)	0,17 cm ³ /bar·h·m ²
Fatigue strength test (19 000 cycles)	realized
Testing on bending / deviation (max 500 mm)	realized

Corrosive characteristics of non-cemented polymeric sleeve illustrated the following:

1. On pipelines with passive and active cathode protection, corrosion can be neglected;
2. Without cathode protection, but with electro-drainage corrosion breakdowns (about 50 mm in diameter) may appear in 40 years.
3. Without cathode protection and electro-drainage – in 15 years.

Consequently, for pipeline sanity is necessary to take into consideration, minimum electro-drainage and if necessary low cathode protection.

There were also testing in swelling under pressure relief, where the following problems were discovered:

1. Significant swelling - diameter about 20 cm.

2. Weak swelling - diameter about 5 cm.

To prevent swelling it is necessary to:

1. Improve pipeline cleaning-treatment and preliminary treatment: max water pressure + jet treatment by granulator.

2. Improve material by impregnation applying low-viscosity two- component cement.

3. Decrease speed inversion.

4. Increase pressure inversion.

5. Sanitation at temperature more than 5 °C.

6. Increase pressure at cement hardening.

Thus, pipeline sanitation method with flexible polymeric sleeve was successfully tested.

At the present time «Gasprom» Company, Radlinger and E.ON Ruhrgas are working together, working conditions of underwater gas pipeline to Kolpashevo (Dp 200 P_{operating} =1,2 MPa), extension 2463 m. Polymeric material sleeve model was produced by Germany company Primus Line. This enormous work is being done for the first time in the history of domestic and foreign gas industry. Such a new technology innovation – reconstruction of worn-out pipelines – makes it possible to increase underwater pipeline workovers efficiency.

References

1. Проект производства работ «Санация дюкера через р. Обь на г. Колпашево».
2. Нормативная инструкция Primus Line «Гибкий полимерный рукав для бестраншейного ремонта напорных трубопроводов».
3. Beloborodov V.N., Lee A.N., V.T.Savchenko. Бестраншейная технология восстановления трубопроводов // Gazovaya promyshlennost. – 2005. - №8. – P.29-30.

ANTICORROSION PROTECTION OF STEEL CONSTRUCTIONS OF OIL & GAS PIPELINE TRANSPORTATION

A. Jurov

Scientific advisor doctor R.N. Abramova
Tomsk polytechnic university, Tomsk, Russia

Corrosion is one of major problems of oil and gas pipeline transportation. Owing to corrosion reliability and durability of pipelines are reduced, that result to increase expenses of exploitation of pipelines.

Corrosion is a natural electrochemical process. Pipelines are usually coated to protect the external surfaces of steel pipe against corrosion.

There are essentially two methods: 1) impressed current method;
2) sacrificial anode method.

For onshore pipelines it is common to use an impressed current method. In this system, a DC current is supplied to the pipeline and is made to flow between the pipe and an anode ground bed via the soil. The current is adjusted to generate higher driving potentials in the pipe than those existing naturally in the corrosion cell. This neutralizes or reverses the effects of corrosion. This system requires transformer stations and is usually monitored by output voltage readings. A sacrificial anode system, on the other hand, relies upon the installation of anodes on or near the pipeline. The pipeline becomes the cathode of the system and the anodes, which corrode, are sacrificed to arrest corrosion of the pipeline. When water is present in the transported fluid, corrosion of the internal pipe surfaces can also occur. Water may be present, either alone, or in combination with CO₂, H₂S, O₂ or other salts. The severity of corrosion depends upon the operating temperature, pressure, conductivity, soil condition, pH, and fluid velocity and composition. Corrosion control measures include water removal and drying, chemical injection and corrosion allowance on wall thickness.

Coating specifications (tank corrosion protection)

The primary use of internal coatings is to protect the inside surface of the tank against corrosion and also protecting the stored contents from contamination.

Coating specification should be a clearly defined list of requirements or instructions. Just as a drawing must give exact dimensions, so must a coating specification state the exact system to be used. In the preparation of such a specification, consideration must be given to such factors as types of coating available, types of surfaces to be coated, compatibility of coatings, and number of coats required on the various types of surfaces for maximum protection.

Many types of internal coatings are available for numerous protection requirements. Because of the unlimited types and applications, only a few are described here: 1) coal tar; 2) epoxy resin; 3) rubber lining; 4) galvanized; 5) external.

1. Coal tar

Among the oldest and most reliable coatings, coal tar has extremely low permeability, protects the surface by the mechanical exclusion of moisture and air, is extremely water resistant, and resists weak mineral acids, alkalis, salts, brine solutions, and other aggressive chemicals well.

2. Epoxy resin

Epoxy resin gives excellent adhesion, toughness, abrasion resistance, flexibility, high gloss and durability, and good chemical and moisture resistance. Typical applications include linings for sour-crude tanks, floating roof tanks, solvent storage tanks, drilling mud tanks, and pipelines.

3. Rubber lining

Rubber lining is used as internal lining for storage tanks that are subjected to severe service, such as elevated temperatures, or for protection from extremely corrosive contents such as concentrated chlorides, and various acids, such as chromic, sulfuric, hydrochloric, and phosphoric.

4. Galvanized

Galvanizing (zinc coating) is highly resistant to most types of corrosion. Bolted steel tanks are ideally suited for galvanizing since all component parts are galvanized by the hot-dip process after fabrication before erection. Galvanized bolted tanks are recommended where sulfur oil is produced and associated with hydrogen sulfide gas. Galvanizing is also very effective against corrosion in seacoast areas where atmospheric conditions present difficulties in maintaining tank life.

5. External

The basic needs for external coatings are protection against weathering exposure and appearance. Many types of external coatings are available, ranging from basic one-coat primers with one or more top coats. Environmental conditions usually dictate the extent of coating applied. Offshore and coastal installations require more extensive coatings compared with inland locations.

Mechanism of cathodic polarization

Cathodic polarization can be applied to control corrosion that is electrochemical in nature, whereby circulating current is forced to flow onto the entire surface area of the steel structure making it cathodic and thus in a noncorroding state (fig. 1).

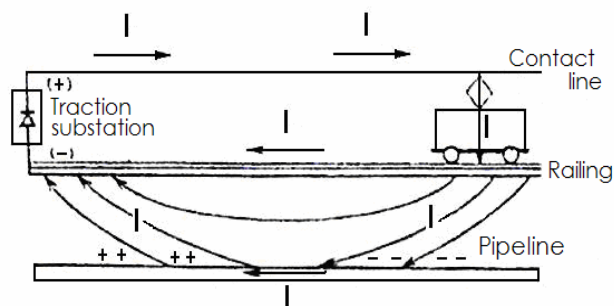


Fig. 1. Scheme of the leaking of circulating current at underground pipeline

Self-contained sacrificial anodes are recommended for protecting the interior of tanks and pipelines. An impressed-current system is recommended for pipe storage, pipelines, casing in producing wells, etc. In this system, the current is furnished by an AC power system, then rectified to DC current and fed to the structure by the use of a semipermanent anode.

Wall thickness

The most important element in pipeline mechanical design is the determination of pipeline *wall thickness*. Wall thickness is a function of the pipeline maximum allowable operating pressure and the yield strength of the steel pipe used (fig. 2).

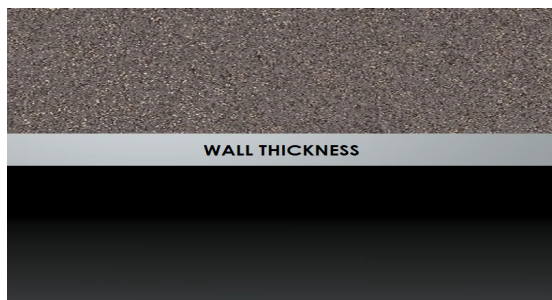


Fig. 2. Pipeline wall thickness

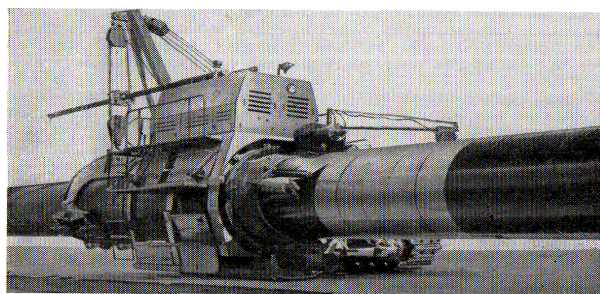


Fig. 3. Surface preparation by refinement facility RF-1420

Operating pressure and wall thickness determine the number and locations of pump or compressor stations along the pipeline. If a pipeline operating pressure is chosen, the power at each station can be greater, and the stations can be farther apart.

Surface preparation (before infliction of isolation)

The importance of surface preparation would seem so fundamental that it would not deserve mention in specifications: however, poor surface preparation is a major contributing factor of many coating failures. Detailed instructions should be given all along the line and steps taken to see that they are carried out properly. Basically, no coating can be better than the surface over which it is applied. If that surface is dirt, grease, moisture, mill scale, rust, concrete dust, or any other foreign or interference material, failure can be expected. These substances, forming a film between the surface and the coating, soon break down and fall away, taking the coating with them. Such failures cannot be called coating failures. The type of surface preparation required on various surfaces is determined by the nature of the surface itself, the operating conditions to which such surfaces will be subjected, and the type of coating to be applied to the surfaces. As a general rule, metal surfaces that are to be submerged require more thorough surface preparation than those areas that will be nonsubmerged (fig. 3).

The more severe the corrosive atmospheric elements will be, the more thoroughly surface preparation must be carried out. Isolation is the most important element of pipeline construction, because only it can extend the term of pipeline operation life.

References

1. A.M.Kolotirkin Metal and corrosion. – M.: Metallurgy, 1984.
2. V.F.Novosiolov Anticorrosion protection of pipelines and tanks. – M.: Nedra, 1992.
3. G.G.Ulig Corrosion of the metals. – L.: Chemistry, 1989.
4. V.I.Hijniakov Anticorrosion protection of oil and gas pipelines. – Tomsk City: TPU, 2005.

ROCK FORMATION PROCESSES AND RESERVOIR PORE VOID FORMATION CHARACTERISTICS IN TECTONIC ZONES THROUGH OIL MIGRATION

Y.M. Karychev

Scientific advisor doctor N.M. Nedolivko
Tomsk polytechnic university, Tomsk, Russia

Void space formation in the oil-saturated sandstone layer U³¹ of the Vasyganski suite (well 31R, Western Moiseevski Section, Dvyrechenski Field) is determined by the response to different processes during sedimentogenesis, diagenesis, katagenesis and superposition epigenesis. Rock compaction density decrease and secondary reservoir capacity (fracturing, micropores in and along grain boundary, sinu-packed pores in kaolinite cement) were formed as a result of tectonic deformation and carbon dioxide solution during faulting in the well influence zone. After intensive solution, rocks contain monomineral fragments (quartz), and after redeposition of these dissolved products, the pore spaces are filled with recrystallized biomimetal quartz-kaolinite cement. Rock samples from several wells of Zapadno-Moiseevsk and Srednenurolsk deposits (Tomsk region) were investigated.

Well №31R (exploration well which becomes later a production well) of Zapadno-Moiseevsk deposit is located close to tectonic disturbance and it indicates high oil production index due to good reservoir properties of productive rocks. Rock samples were examined by lithology-petrographic analysis in TPU in order to study factors of pore-void space formation.

Rock samples were made from mud and core. They were studied by using an optical microscope. Rock samples are characterized by high value of porosity (up to 23 %), high conductivity value (up to 300 millidarsi) and good fissure system. The studied rock is sandstone.

Quartz grains in samples are subjected to the solution process and their surfaces chiefly are rough. Sometimes grains represent quartz remains with dissolved edges but untouched cores. Feldspars dissolve easier than quartz and their solution often is accompanied by secondary transformation processes – fissures, corrosion, ironization, etc. Quartz content in such rocks is high because of more intensive solution of other minerals. Solution process becomes intensive with grain size increase due to improvement of solutions circulation.

Mineral grain regeneration is accompanied by solution process. New mineral substance crystallizes from solutions therefore secondary mineral formation takes place. New quartz substance form regeneration borders around grains. These regeneration borders often are separated from original grains by clay particles, mica crystals or oil pellicles. In addition, secondary cement formation is noted in rock samples.

Pore-void space in studied sandstones chiefly consists of chiefly primary intergranular voids. They can have isometric or irregular shape but all these pores are interconnected. Intergranular voids have flat and smooth surface in grain regeneration zones. Besides, there are intercrystalline voids in samples, fissure voids and leaching voids in samples. As a result the porosity of these sandstones has rather high value – about 23%. Nevertheless, rock porosity is often decreasing due to presence of mica wreckage or plant remains.

Additional pore space was formed after solution of oil oxidation clastic products in the ancient water-oil contact.

Intercrystalline voids in mineral grains are related to cleavage and twin contact lines. It is a result of solution.

Solution voids in calcite cement penetrate the granular mass forming a cell-net pattern.

Fissure voids are widely spread in feldspars. These pores are related to cleavage planes, twin contact lines and fissures across cleavage.

Fissures through mineral grain and cement were observed in rock samples. They can be filled with silicon or chlorite.

Deformation of grains is characteristic for rock samples. The possible cause of deformation is rock compaction during catagenesis. On the other hand, subparallel or transparent linear fissures are present in rock grains without cleavage. That is why these rock samples can be evidence of stress tectonic processes. Void space formation in the oil-

saturated sandstone layer U³¹ of the Vasyganski suite (well 31R, Zapadno-Moiseevsk deposit) is determined by the response to different processes during sedimentogenesis, diagenesis, katagenesis and superposition epigenesis.

Sedimentation environment determined large confined cross-sections of sedimentogenic pores in relation to coarse-grained sandstones. Compaction was produced as a result of facies changes (such as conformal incorporative contacts and polymictic cement). Rock compaction density decrease and secondary reservoir capacity (fracturing, micropores in and along grain boundary, sinu-packed pores in kaolinite cement) were formed as a result of tectonic deformation and carbon dioxide solution during faulting in the well influence zone. Hence, after intensive solution, rocks contain monomineral fragments (quartz), and after redeposition of these dissolved products, the pore spaces are filled with recrystallized biomimeral quartz-kaolinite cement.

Factors of good reservoir properties forming in zones of tectonic disturbances:

Solution and extraction of cement.

Increase of pore-void space volume.

Increase of pore connection.

Fissure system forming.

Oil and gas reserves are often located in fault zones due to good reservoir properties. On the other hand tectonic disturbances can destroy oil and gas deposits. In that case hydrocarbons (oil and gas) migrate to surface from deposit along disturbance. Oil migration will take place if fault penetrate Earth's crust to the surface. If tectonic disturbance don't extend through the Earth's crust oil and gas deposits wouldn't be destroyed.

In this article rock samples from Zapadno-Moiseevsk deposit were described. Nevertheless, rock samples from Srednenurovsk deposit were also examined during this research. Results of the lithology-petrographic analysis of these samples were the same as for Zapadno-Moiseevsk deposit. It confirms regularities of rock secondary transformation processes in fault zones.

References

1. Serduk Z. Y., Factors of mineral-petrographic rock and underground water composition transformation and their role in reservoir and hydrocarbon deposits formation (West Siberia) // Materials of regional geological conference of Siberia, Far East and North-East of Russia – Tomsk, 2000. –V. 1. – p. 173 – 174.
2. Dergacheva T. N., Kondrina K. S., Yarakinsko-Ayansk and Shamanovsk deposits reservoir rocks comparative characteristic // Reservoir rocks of Siberian formations. – Novosibirsk, 1984.–p. 51 – 60.
3. Lebedev B. A., Epigenetic processes geochemistry, Moscow, Nedra, 1992, 126 p.

PROBABLE APPLICATION OF LIGNITIC PEAT IN RESTORATION OF OIL-CONTAMINATED AREAS

A.S. Kremis

Scientific advisor doctor N.V. Chukhareva
Tomsk polytechnic university, Tomsk, Russia

More than 35 % of Russian pipeline system have been exploited during the past 20 – 25 years and need accurate and operation reliability. Excessive pipeline wear out may lead to pipeline break age and, as well as, a result oil loss and environmental impact. Besides, highly-develop oil industry and oil-refining industry showed the inefficiency, high cost of existing technologies in oil contamination solution. That is why problem №1 - environment pollution in construction pipeline, construction and maintenance is an urgent question today.

The major ecological problem in oil spills is the development of effective and economical environmental-proofed technologies. One of the solutions during oil spills may be considered to lie environment restoration.

Today [1] the existing methods of oil spills elimination into can be divided several groups:

- 1) thermal method;
- 2) physical-chemical method;
- 3) biochemical method (hydrocartion oxidation breakdown by special bacterium);
- 4) physical- mechanical method;
- 5) chemical method of oil-containing waste processing.

Modern oil industry requires not only new technologies of oil spill elimination, but also land restoration.

Land restoration where oil spills have occurred must be established according to the soil-climatic conditions, landscape damage level, geochemical environmental conditions of a specific area.

Today, there are the following land restoration methods:

- Biologic;
- Aeration;
- Bioventilation;
- Two-phase extraction;
- Horizontal drilling;
- Methods of oil spill elimination by sorbents.

When oil film thickness is less than 2 mm and small depth waters sorbents are more effective [2]. The main quality standards for sorbents are:

- oil capacity;
- buoyancy (in a initial state and in saturated state);
- regeneration capability;
- production technology, easily application and low cost.

Another important factor is the accessibility of raw materials, simplicity of production technology, usage and utilization. Based on these factors the efficiency of sorbent usage must be determined.

From the table 1 [3], one can see that organic sorbents on peat basis in comparison to organic foam sorbent have equal oil extraction ratio (74 %) and have rather a high oil absorption index (17,71 g/g). Organic sorbents are available and cheaper. However, there is one fact that must be considered - utilization of sorbents, because not all sorbents can be used again and, as a result, additional economic expenses bills and, arise even sometimes, ecological damage can happen.

Table 1

Characteristics of organic sorbents

Sorbent	Oil absorption, g/g	Oil extraction ratio, %
Industrial organic sorbents		
carbamide formaldehyde resin: powder	39,6	60
foam-rubber	14,55	74
Sintepon	46,31	94
Organic sorbents		
peat	17,71	74
«Lessorb»	9,1	66

It is well-known that the main constituent – humic substance determines absorption of peat, lignite and oxidated coal. The content of humic substance in peat is up to 50 – 60% in eroded lignite and coal from 0 – 100 %, depending on the degree of weathering [4]. Nowadays does not only use peat, lignite, but also humic sorbents. They are used in land restoration (revegetation of oil-polluted lands, soil cleanage technology of developing fertile technogeneses soil).

According to the latest research [5] data (AgrosynteZ), humic sorbents, based on lignite or oxidated coal and containing reactive and bioactive humic acids can activate soil microorganism activity which are effected by different toxic (including oil). Furthermore soil microorganisms provide the mineralization and humification of oil.

According to the latest data (AgrosynteZ), humic acids are non-toxic. In applying humic acid based sorbents, the soil reverses to normal conditions during 1-2 vegetation periods. Applying humic sorbents automatically excludes the transportation problem of polluted soil for further reworking. As must pipelines lay in peat swamps, so the development of new natural humic sorbents based on peat raw material, could solve the existing ecological problems in oil industry. Enormous peat resources (more than 24 billion tons in Tomsk region) can be unique raw material for the production of humic sorbents.

As all pipeline lies mainly on swampy peat soil, so creating new natural humic sorbents on basis of peat raw material, which can decide existent ecological problems of oil industry, present a great interest. Huge resource of peat (more than 24 billion tons only on area of Tomsk region) is unique raw material base for producing humic sorbents.

According to the latest research [6] the acid-containing groups (COOH (carboxyl) and OH (phenolic) groups) are determined sorption activity of humic acid. So the modification of humic acids to increase active acid content groups makes it possible to increase humic sorbent reactivity.

There are two ways for humic acid modification:

Modification of humic acid by chemical, mechanical, mechanochemical and thermal treatment;

Modification of peat raw material.

According the data of Fuel material laboratory TPU [7], one way for activate humic acid is preliminary thermal treatment of peat up to 250 °C in its own gas decay environment. Peat heating in its own gas decay environment is significantly effects the humic acid chemical structure to utilize and increase its thermal resistivity.

On the one hand, preliminary thermal treatment increase the humic acid output from peat. On the other hand the physical-chemical characteristics and their properties are altered. So, the function composition changes: carboxyl groups increases from 11 to 15%; carbon content increases up to 5%, while oxygen and hydrogen content decreases, paramagnetic centers increase, which result in the rise of reactivity of humic acids. Quantity output of humic acids after thermal treatment increases up to 1½ times.

Thus, we can state that peat thermal – treatment is a means to regulate the humic acid content and properties, which may lead to new possibilities in humic substance application [9]. Practical application of sorbents based on modified humic acids in the oil industry is possible in view of the fact that humic acid properties are highly bioactive during the restoration period of oil contaminated areas.

References

1. Робет С., Чарльз Т. Планирование операций при ликвидации последствий возможных утечек нефти из трубопроводов // Нефтегазовое дело. – 1999. - № 2. – С. 34 – 36.
2. А. Н. Набаткин, В. Н. Хлебников. Применение сорбентов для ликвидации нефтяных разливов // Нефтегазовое дело. – 2000. - № 11. – С. 61.
3. Р. Н. Хлесткин, Н. А. Самойлов, А. В. Шеметов. Ликвидация розливов нефти при помощи синтетических сорбентов // Нефтегазовое дело. – 1999. - № 2. – С. 46 – 49.
4. Ляштан И.И. Исследования физических, химических свойств торфа и его биологической активности// Химия твердого топлива. – 2002. – №1. – С.5-19.

5. Ю. Г. Пуцыкин, А. А. Шапавалов. Использование гуминовых сорбентов для решения экологических проблем // Транспорт и хранение нефтепродуктов. – 2003. - № 11. – С. 17 - 19.
6. Н.В. Чухарева, Л.В. Шишмина, А.А. Новиков. Влияние термообработки торфа на состав и свойства гуминовых кислот // Химия твердого топлива. – 2003. – №4. – С.37-43.
7. Тарновская Л.И. Закономерности изменения группового состава торфа в процессе термолиза/ Дис. на соиск. учен. степ. канд. техн. наук. Томск: ТПИ, 1985. 199 с.
8. Чухарева Н.В. Исследование кинетики термически активированных изменений состава и свойств торфяных кислот/ Дис. на соискание учен. степени канд. хим. наук. Томск: ТПУ, 2003. 154 с.
9. Наумова Г.В., Стригуцкий В.П., Жмакова Н.А и др. Связь молекул структуры гуминовых кислот и их биологической активности// Химия твердого топлива. – 2001. - №2. – С.3-18.

PIPELINE WALL DISINTEGRATION DEFECT ANALYSIS BASED ON INTERNAL PIPELINE DIAGNOSTICS

A.V. Nazarov

Scientific adviser doctor V.I. Hizhnyakov
Tomsk polytechnic university, Tomsk, Russia

Intensive ageing of pipeline systems dictates necessity of their reconstruction. Practically the unique cardinal means providing the decision of a problem of maintenance of highly reliable and effective transport of oil and gas, becomes transition on a new alternative system of service. It causes necessity of development of theoretical methods and practical recommendations standing the value of a technical condition of long maintained pipelines with defects. Calculating intensive development of intrauterine diagnostics the quantitative estimation of a mode of deformation of metal of a wall of a pipe and a technical condition of a linear site gives an opportunity to realize the most effective programs of selective repair of pipelines that will allow operating a resource of a design economically and safely.

Thus, to provide safety for these oil pipelines it is necessary:

- To analyze negative factors of operation life.
- To develop methods for estimating operation reliability.
- To improve technology of pipeline corrosion protection based on modern experimental researches.

The decision of these problems will allow providing safety of pipelines during all term of operation; to determine the most effective ways of maintenance of their operational reliability, not demanding of excessive repair work at the same time.

Taking into account significant extent of pipeline systems not only in Russia, but also abroad, researches in the given direction are extremely relevant, in fact only pipeline transport provides uninterrupted and equal delivery of significant freight traffics of oil and oil products.

Nowadays, pipeline defects are caused by metal loss, pit and general corrosion, scratches, and also defects such as parallel pipeline wall breaking, fault in the pipeline wall at the surface exit. Defectoscope gauges are used for internal pipeline inspection. On the basis of received information it is possible to conduct control calculations in durability of damaged pipeline sections estimating parameters of its technical condition.

Today some physical methods are used to control pipeline destruction, such as television, magnetic, eddy current and ultrasonic methods.

Ultrasonic method of monitoring of pipeline consist of converters radiating pulses of ultrasonic fluctuations, accepting and registering the signals reflected from internal and external surfaces of the pipeline, and also from a surface of the defects formed in the pipeline.

Defectoscope devices consist of one or several modules flexibly connected together, carrying out certain functions, for example transportation of storage batteries, data-acquisition equipment, etc. To move defectoscope device inside the pipeline energy of fluid medium in the pipeline (oil, gas, condensate, etc.) is usually used. At the same time, rubber (or elastic) collar is installed to overlap – the across-sections between module pipeline frames and internal pipeline surface.

Two oil pipeline sites were, where pipeline length of 10 km. The investigated oil pipeline had the following specifications:

- Diameter of oil pipe is $D = 1220$ mm (48 ").
- Thickness of pipeline wall is 11.1-16.3 mm.
- Length of surveyed site is 10 km.
- Product is oil.
- Flow speed is 0.46-1.35 km/s.
- Operation pressure is 4 MPa.

The data, testified that pipeline wall fault is important (10, 8 %) there was such a defect as metal loss (80,2 %). The reason is active corrosion processes on external pipeline surface.

As seen from this table interwall faults are twice in number than other defects. Interwall (internal wall) corrosion defect is the most dangerous one and can cause pipeline damage (breakage).

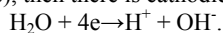
In the following diagram the overwhelming numbers of faults are those that are more than 200 mm. According to diagnostic result we have the following oil pipeline faults internal pipeline perimeter. The largest numbers of defects are in the bottom perimeter (180-270 °). Why?

It is known, that pipeline protection from subsurface corrosion is in dependence of group corrosion; however there should be a two-sided protection program: coating and electrochemical protection means (ESP).

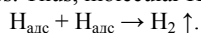
ECP of pipelines is carried out by cathodic polarization. If cathodic polarization is accomplished by a direct current it is cathodic, which was used in our case.

The principle of cathodic protection is similar to the electrolysis process. Under influence of an electric field semi-free valent electron begins to move in sacrificial anode direction - current source. Losing electrons, metal atoms of sacrificial anode transfer to ions - atoms in a electrolyte solution, i.e. sacrificial anode collapses. Ions - atoms are exposed to hydration and settle in the solution. At protected construction due to the direct current source, a surplus of free electrons is observed, i.e. conditions for oxygen and hydrogen depolarization are created. Let's observe in more details, how Cathodic Protection Station works on the pipeline.

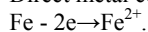
When the cathodic protection station works at a limited regime (i.e. voltage more than 2V on copper sulfide electrode), then there is cathodic water decomposition:



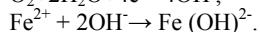
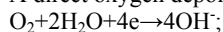
Allocated hydrogen ion through micro voids penetrates into iron crystal lattice as the distance between molecules of iron is more, while diameter of hydrogen ion is less. When one more hydrogen ion penetrates into the crystal lattice, it is molaring, forming a molecule, diameter 20 thousand times more than the distance between iron molecules. Thus, molecular H_2 is inhibited in the metal. Accordingly there are than the ions more hydrogen molarities:



Direct metal corrosion will be at transition of two ions valent iron in electrolyte (soil):



A direct oxygen depolarization:



Practical significance of the following research is:

Plan maintenance service for pipeline transportation.

Develop new diagnostic ultrasonic method defectoscope.

Monitor pipeline corrosion.

ALTERNATIVE WAY OF OIL TRANSPORTATION

J.N. Pichugina

Scientific advisor doctor R.N. Abramova

Tomsk polytechnic university, Tomsk, Russia

New transportation methods of aggressive fluid (including oil) are now being considered. Such problems as environmental impact resulting in land restoration and also transportation convenient are in the near future. Attempts to show the possibility of moving oil in balls, in clay wrapper or in the spherical container with hydrolifts, etc. are well-known.

The following article describes a non-standard transportation method – aggressive fluid transportation as capsules (capsule oil – container).

Capsule material should have the following characteristics:

long – term storage;

easy capsule release.

The main problem is the fact that oil is complex multi-component mixture of different substances, having various chemical properties impurities, gas factor and other features.

First of all, one can use a capsule from natural material. Clay was formed into rounded balls with thick walls, were the empty space was filled with oil. There were six capsules made of white clay kaolin. These capsules began to leak in 6 – 7 hours.

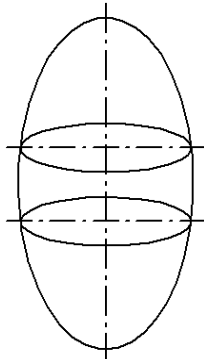


Fig. 1. Capsule production “dipping”

The experiment was repeated, using natural clay, which has a high density. The result was the same as in the previous case. It must be stated that wet clay was a perfect container, but as it became dry oil began to leak out. It's impossible to create reservoir conditions – optimal temperature, pressure, solidity, etc.

Paraffin (or germetic for core samples) was the next material. The advantage was that no oil leakage occurs. Because of its high fragility, it was practically impossible to melt as simply soften to form the capsule. Low melting temperature – at 40 degrees the capsule will become a mixture of components, however for northern areas it is possible to use. If technology allows to make chocolate containers, then it is possible to create and of paraffin ones.

The mixture of the above – mentioned material (clay + paraffin) could form an ideal capsule. However, in reality, clay and paraffin cannot be a perspective mechanical mixture. Oil is an aggressive medium. So, to interlock oil into gelatin capsules was considered, as such capsules can easily swell and

dissolve in water. The experiment was performed very carefully. The final stages included:

- internal surface of the capsule was covered with a paraffin layer;
- the edges were slightly welded.

Because of a technology defect – the capsule began to leak. The last experiment showed that oil can be interlocked into a gelatin (without paraffin) capsule. The form and encapsulation were for 6 months (fig. 4). Gelatin basically consist of carbon, hydrogen, nitrogen, it can be created evaporating bones, cartilages and sinews. The advantages of gelatin are:

- process is fully-automated;

- despite high sensitivity of gelatin to moisture and acids, treating gelatin with formalin, dissolved spirit;
- gelatin capsule is impenetrable for volatile liquids, gases, oxygen and air;
- hides the smell;
- high availability;
- the low cost;
- the low material consumption for one barrel of oil.

There are three ways of producing capsules: “dipping”, “pressing” and “dropping”.

Capsule production “dipping” cooled frameworks duralumin oval pegs into a mass. Consequently, secondary cooling takes place and the capsules are filled by electronic dosimeter (fig. 1).

Second method: “pressing” method: forming a gelatin tape then stamping capsules which are filled with oil. As a result slight melting holes are formed (fig. 2).

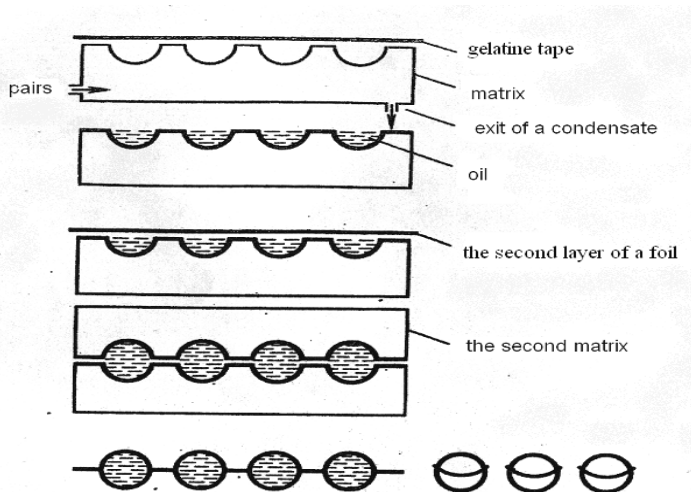


Fig. 2. Capsule production “pressing”

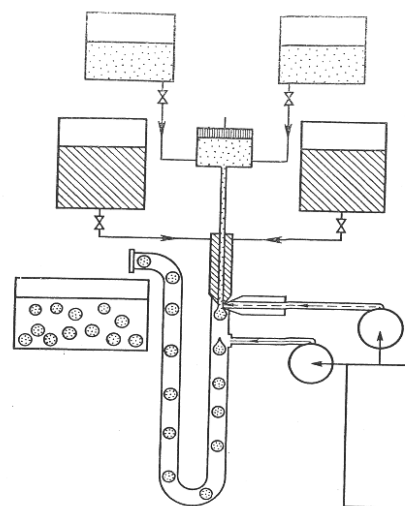


Fig. 3. Capsule production “dropping”



Fig. 4. Gelatin capsules with oil

The “dropping” consists of simultaneous formation of capsule and filling it with oil. There are two concentric streams: external – heated gelatin and internal – oil, which undergoes a circular pulsation and other cooling mass. Formation of balls occurs due to a natural superficial (fig. 3). 24 thousand capsules can be produced an hour with applying Capsule production “dropping”.

The capsule transportation has a number of advantages:

- ecological (preventing oil spills and leakages);

- compactive (simple in transportation storage and availability to remote areas, such as North and Far East);
- convenience of transportation.

Thus, capsule oil – containers can be transported pneumatically, in a machine, any other container or by railway, aircraft, or stored in a usual container.

References

1. Muravjev I.A. «Technology of medicines»: Moscow "Medicine", 1980 - 1,2 volume.
2. Chueshov «Industrial technology of medicines»: Kharkov, publishing house NFAU " MTK-BOOK ", 2002 - 1,2 volume.
3. Proskurjakov V.A. «Chemistry of oil and gas»: Leningrad "Chemistry", 1981.

APPLYING FUNDAMENTAL DRILL CASING TECHNIQUES TO IMPROVE THE TECHNICAL-ECONOMIC COEFFICIENT IN DRILLING

S.V. Pozhenko

Scientific advisor doctor R.N. Abramova
Tomsk polytechnic university, Tomsk, Russia

The use of casing for drilling is an emerging technology that can reduce well-construction costs, improve operational efficiency and safety, and minimize environmental impact. Fundamentally simple in principle, this drilling technique uses the large-diameter tubulars that will be permanently installed in a wellbore in place of conventional drillpipe. The economic demands of complex geologic settings, smaller reservoirs with limited recoverable

reserves, and the need to optimize development and exploitation of mature fields make drilling operations with casing increasingly attractive to operating companies.

A conventional rotary drill bit or a special drilling shoe can be attached to the end of a casing string to drill vertical wells. For additional flexibility and for those applications that require directional control, a retrievable bottomhole assembly (BHA) for drilling can be deployed, locked in place and then retrieved by wireline cable. Running and retrieving this BHA through casing eliminate tripping of drillpipe into and out of a wellbore and provide added protection for the advanced systems used in downhole measurements and directional-drilling applications.

Minimizing the number of pipe trips during drilling operations reduces incidents of hole collapse from swabbing and surging, decreases the chance of an unintentional sidetrack and minimizes wear inside previously installed surface or intermediate casing strings. After reaching total depth (TD), the casing is already in place, eliminating the need to pull drillpipe and then run permanent casing.

This reduction in pipe handling improves wellsite safety and allows drillers to use standard-size rigs or smaller rigs built specifically to drill with casing. New compact rigs for drilling operations with casing require lower horsepower, less fuel, produce fewer emissions, operate from smaller surface locations, and can be moved more quickly and easily than larger conventional rigs.

Compared with traditional drilling operations, casing while drilling minimizes rig downtime resulting from unexpected occurrences, such as stuck pipe or well control loss from an influx, or kick of formation fluid. Anecdotal evidence indicates that drilling with larger diameter tubular connections reduces lost circulation by mechanically plastering cuttings and drilled solids into the borehole wall.

It is possible that this "smearing" effect builds an impermeable filtercake or creates a solid surface finish that may allow weak, low-pressure and depleted intervals to be drilled without significant drilling fluid loss.

Casing strings have longer joints than standard drillpipe, which means that drillers make about 25% fewer connections. Another benefit is less time spent circulating fluid or backreaming to maintain hole stability while making pipe connections. In addition to improving drilling efficiency, both these advantages further reduce overall cost and environmental impact.

Drilling operations with casing eliminate several steps in the conventional well-construction process and provide other critical advantages, including better fluid circulation and removal of formation cuttings for more effective hole cleaning.

Analysis of wells drilled to date with casing indicates that this technique can reduce nonproductive rig time up to 50% and cut drilling time by a nominal 10 to 35% per well in some applications. About one-third of this reduction results from decreased tripping of pipe; the remainder comes from avoiding unexpected drilling problems and eliminating the time required to install casing in a separate operation.

This faster, simpler and more efficient process translates into fewer drilling surprises and lower costs. Advances in tools, equipment and procedures are expanding the use of this technology for drilling soft and hard formations both onshore and offshore, and, most recently, for casing directional drilling.

Some operators now view this technology as a potential solution in a variety of commercial applications, ranging from drilling entire onshore wells to drilling just one or two hole sections in offshore wells that require multiple casing strings. Drillers categorize the downhole systems that are used to drill with casing as nonretrievable or retrievable. A nonretrievable, or fixed, assembly can be used to drill with short liners or full casing strings.

Conventional rotary bits that remain in the wellbore after reaching total depth have been used in some applications. The bit can remain on the casing and be cemented in place, or it can be released and dropped into the bottom of the hole to allow logging. Drillable drill bits, such as the Weatherford Type 11 or Type III DrillShoe or the Baker Hughes EZ Case, have external cutting structures for drilling, but can be removed by milling. These specially designed casing shoes allow drilling and completion of subsequent borehole sections.

A retrievable system allows the bit and BHA to be deployed initially and replaced without tripping casing into and out of the hole. This option is the only practical choice for directional wells because of the need to recover expensive BHA components, such as downhole motors, rotary steerable systems or measurements-while-drilling (MWD) and logging-while-drilling (LWD) tools. A wireline-retrievable system facilitates replacement of equipment that fails before reaching TD, and allows quick, cost-effective access to log, evaluate and test formations.

Several service providers are committed to developing tools, techniques and equipment for drilling with casing. Tesco, for example, offers Casing Drilling services, comprising purpose-built rigs, surface equipment and downhole tools for onshore applications.

To facilitate the use of casing for drilling, Tesco designed robust, reliable, surface equipment and downhole systems that efficiently and effectively are attached to and released from casing. A wireline-conveyed drilling assembly is typically suspended in a profile nipple near the bottom of a casing string. The Tesco Casing Drilling system uses a Drill Lock Assembly (DLA) to anchor and seal the BHA inside casing.

Each BHA component must pass through the casing string that is used for drilling, including an underreamer with retractable pads. A pilot bit initiates a small hole, which then is enlarged by cutters on the expanded underreamer pads. Drillers commonly use a 6 1/8-in. or a 6 1/4-in. pilot bit and an underreamer that expands to 8 7/8 in. when drilling with 7-in. casing. The underreamer can be located immediately above the bit outside the casing or above other BHA components in the pilot hole. A topdrive unit rotates the casing and applies torque to make tubular connections.

The Tesco quick-connect Casing Drive System, which is operated by the topdrive hydraulic control system, speeds up pipe handling and prevents damage to casing threads by eliminating one cycle of making and breaking connections at tubular joints. A slip assembly grips either the exterior or interior of the casing, depending on pipe size, and attaches the casing to the topdrive without threaded connections. An internal spear assembly provides a fluid seal inside the pipe.

Initially, drilling operations with casing were performed onshore in vertical wells to avoid the additional complexity of offshore operations. As a result, casing vertical drilling advanced to a point where it routinely rivaled the

efficiency of operations with conventional drillpipe. Tesco Corporation and ConocoPhillips have drilled more than 100 vertical wells in south Texas.

Operators in the USA and Canada have drilled commercial vertical wells with casing sizes ranging from 4 1/2 in. to 13 3/8 in. The deepest well drilled to date was just over 13,000 ft [3,959 m]. Directional wells have been drilled with casing and steerable motors, but success is difficult to achieve in hole sizes of less than 8 1/2-in. because a smaller PDM supplies suboptimal torque for drilling.

Experience gained from vertical and directional testing of rotary steerable technology while drilling with casing proved that a 4 3/4-in RSS can effectively drill 8 1/2-in. holes with 7-in. casing. Directional control in the pilot hole is sufficient to guide larger diameter underreamers and casing to a directional target. Schlumberger is currently conducting field trials of a 3 1/4-in. ultraslim RSS for drilling with 6-in., 5 1/2-in. or 5-in. casing.

Acquiring well logs for formation evaluation is a key consideration when evaluating casing while drilling. Because casing remains in the wellbore after reaching TD, operators must identify the best methods for logging these wells to take full advantage of casing while drilling and its capabilities to reduce nonproductive rig time. Currently, there are four options to run: 1) conventional openhole wireline logs; 2) memory logging tools in a retrievable BHA; 3) LVD system in the drilling BHA; 4) new wireline logging systems that acquire measurements behind pipe.

To run openhole or memory logs, the casing must be pulled into the previously cemented casing. The casing has to be pulled above the zones of interest, but does not have to be tripped completely out of the well. If a kick occurs during logging, it can be circulated out down to the top of the openhole section. However, if the borehole collapses, it may not be possible to acquire a log across the entire interval.

Memory logs are acquired as the casing is pulled back into the preceding casing string by deploying logging tools in a retrievable BHA after retrieving the drilling assembly. This approach ensures that the entire openhole section can be logged and evaluated. Continuous fluid circulation keeps logging tools cool and reduces the chance of a kick during logging.

LWD tools have been used in vertical wells during drilling operations with casing, eliminating the need to pull casing before logging. However, the addition of LWD tools to a retrievable BHA adds cost, weight and length, which must be balanced against wireline retrieval risks and vibration problems in longer BHA extensions.

Thus, new technology now makes logging behind casing possible. Schlumberger ABC Analysis Behind Casing services are a cost-effective alternative to openhole, memory or LWD formation evaluation, allowing operators to minimize nonproductive rig time by assessing potentially productive intervals after reaching TD without pulling or manipulating the casing. In addition to acquiring resistivity, porosity, sonic, bulk density, lithology, pulsed neutron and reservoir pressure measurements behind cemented pipe.

The capability of drilling directional wells makes casing while drilling attractive for offshore applications in areas prone to lost circulation and previously uneconomic to drill using conventional processes and techniques. Modifications of current systems are under way to allow casing while drilling in deepwater applications. Most deepwater casing strings are set, as liners.

There are several potential applications that require additional advances in equipment and techniques. Research and development are under way to allow underbalanced drilling using casing and drilling with air. An obvious advantage of using casing for air and underbalanced drilling is that wells do not have to be balanced with heavier mud, or killed to trip drillpipe out of the hole.

In the future, this technique may be used to drill high-pressure, high-temperature (HPHT) and geothermal wells. The combination of casing while drilling and expandable tubulars ultimately may provide a unique well-construction solution, but additional hurdles must be overcome for this to be practical. As casing directional drilling becomes more common, market pressures will likely stimulate the development of additional systems and technologies specifically for use in casing-while-drilling applications.

AUTHIGENOUS MINERAL FORMATION INFLUENCE ON CAPACITY – FILTER ROCK PROPERTIES IN NIJNETABAGANSK OILFIELD

K. Smirnova

Scientific advisor doctor R.N. Abramova
Tomsk polytechnic university, Tomsk, Russia

The influence of authigenous mineralogenesis on capacity-filtration characteristics of terrigenous environments based on gas-saturated sandstones, Nijnetabagansk deposits.

Gas-saturated sandstones in well № 8 were exposed at the depth interval of 2576,0 m and 2585,0-2590,0 m. Rocks were light-grey fine-medium-grained, homogeneous different, rarely weak-layered structure and plentiful inclusions of diagenetic pyrite. Porosity of sandstones is 13,0-19,1%, permeability is about 1,7-190,1*10⁻³ mkm², density changes from 2,01 to 2,28 g/sm³, carbonaceous is measured by the first percentage, and rock residual water-saturation is 2-34,1 %.

Microscope rally, one can observe a rather even distribution of detrital matrix, about 82-92 % from the area has rather good sorting (S₀ = 2,0). Clastic material is mainly of quartz 56 %, field spar-30 %, clastics of different origin-14 %. The size fragment is also rather constant and poorly varies within the limits of 0,5-0,08 mm, prevalence fraction of 0,1-0,25 mm.

In well productive gas-bearing interval at the depth of 2575,0-2599,1 m was exposed. Rocks were fine-grained sandstones, less often medium-grained ones. According to reservoir properties the interval is rather monotonous. Capacity-filtration characteristics of sandstones are characterized by poor porosity varying within the limits of 13,8-16,4 % and low permeability. The last is from 0 up to 3,3*10⁻³ mcm², and only in separate cases up to 23,5*10⁻³ mcm². The water-saturation rocks is rather low and is about 22,5-38,5 %.

The basic cementing material is hydromica-clay cement, in comparison to sandstones in well № 8, Nijnetabagansk deposits. Its content is up to 4,1-12,4 %, where total cementing mass is 10,8-23,1 %. Other mineral components of cement according to average content in a layer are kaolinite (3,6 %), leucocsen (1,4 %), regenerated quartz (1,1 %), pyrite and hydromicas (a %). Other minerals (siderite, chlorite) contain insignificant quantities (a %), or (calcite) is found in the cross-section of some layers, forming basal-poikilitic cement.

The distribution features and mineral associations are similar to those in sandstones in well №8: kaolinite is pore space, formed due to the recrystallization of primary clay cement; leucocsen and pyrite are as isolated grains; hydromicas form a film around fragments or guided lists; siderite can be as pelitomorphous aggregates.

The distribution of authigenous minerals in sandstones and their capacity-filtration property alteration is defined in a cross-section hydromica-clay content component and kaolinite, where the first component by undergoes synchronous transformation. The gradual alteration of capacity-filtration characteristics of reservoir can be disturbed in two cases: increase of kaolinite content, or increase of calcite content.

Table

Correlation coefficient between authigenous mineral content and capacity - filtration rock properties

Minerals/parameters	Porosity, %	Permeability, C•10 ⁻³ mcm ²	Density, g/sm ³	Carbon-aceous, %	Water - saturation, %
Well № 8					
kaolinite	0,65	0,73	-0,75	-0,23	-0,79
calcite	-0,33	-0,10	0,28	0,90	0,10
pyrite	-0,43	-0,17	0,25	0,56	0,09
leucocsen	-0,22	-0,21	0,20	0,27	0,24
clay cement	-0,54	-0,50	0,51	0,28	0,73
hydromica – clay cement	-0,41	-0,31	0,26	-0,11	0,35
regenerated quartz	0,19	0,40	-0,31	0,56	0,09
amount of authigenous mineral	-0,35	0,04	0,15	0,63	0,08
Well № 10					
pyrite	-0,55	-0,32	0,77	-0,30	0,04
leucocsen	-0,70	-0,54	0,86	-0,09	0,57
calcite	0,06	-0,10	-0,04	1,00	-0,29
hydromica – clay cement	-0,05	-0,33	0,40	-0,10	0,43
kaolinite	0,54	0,30	-0,48	-0,66	-0,15
regenerated quartz	-0,10	-0,13	0,21	0,83	0,15
clay cement	-0,59	-0,62	0,74	-0,40	0,65
amount of authigenous mineral	-0,56	-0,68	-0,53	-0,07	-0,27

To define the influence on changes of reservoir properties for one or another cement mineral in considered sandstones, a correlation analysis was performed. The results are seen in table.

Table shows that the most significant on sandstone porosity improvement (in both well) is the amount of kaolinite. If (% of) kaolinite increases in cement, then the above-mentioned influence increases. This is characteristic for sandstones with high granular composition. Generally, the coarse-grained differences have higher reservoir properties. The fact is that the coarse-grains are not only connected with rock the configuration and pore space size, but also have a higher degree of kaolinite diversification, with formation of uniform and vermiculite kaolinite aggregates. These kaolinite aggregates are between separate grains which have free pore space like cracks and interstitial intervals. Rock transformation processes when oil migrates in a reservoir also promote kaolinite structural transformation in pore space, increasing a mineral degree.

The increase of secondary minerals: leucocsen and clay cement minerals (well №10) and all authigenous minerals reduce porosity in gas-saturated sandstones.

Comparing correlation factors between permeability and amount of authigenous minerals distinctly indicates positive correlation ratio of permeability importance to kaolinite amount. The higher the crystallizing degree and uniform kaolinite distribution, the higher the correlation bond between kaolinite content in rocks and rock permeability. Hydromica-clay cement and all secondary minerals have negative influence on permeability which increases the amount of clay minerals in cement.

Density also essentially depends on clastic distribution and structure and authigenous rock component. The increase in % of pyrite, siderite, calcite, clay cement conducts increases sandstone volumetric density. The amount of authigenous minerals in gas-saturated rocks is not a reliable parameter for growth of density rock.

In investigated sandstones it is observed that practically 100 % dependence carbonaceous rocks depend on the amount of calcite and significantly from regenerated quartz. Although the amount of kaolinite rocks in well № 10 is insignificant, there is a negative effect on carbonates.

Residual water-saturated rocks depend on the ability of minerals to hold connate water. Clayey field spars, clay clastics, hydromica-clay cement, crustified chlorinated cement have such properties.

In Table 1 one can see that practically all secondary minerals (except kaolinite and calcite – well № 10) are characterized by a positive bond with residual rock water-saturation are beyond the mineral threshold of the importance, clay cement and leucosen. Negative correlation dependence was established only from kaolinite (well № 8).

Thus, it should be stated that the investigated racks independent of authigenous association content, hydromica-clay cement increase and total amount of cement mineral rock in pore cementation leads to deterioration of their capacity-filtration characteristics, which increase of % kaolinite improve these characteristics.

Based on research data, it can be stated that besides formation of rock reservoir properties, sedimentogenesis factors and further rock compaction, new mineral formations in the existing rocks also have a significant affect.

This difference includes not only the existence and amount of cement material, but also quantity ratio between separate mineral components, uniform distribution of authigenous minerals, structure features of authigenous minerals and other factors.

References

1. Лебедев Б.А. Геохимия эпигенетических изменений. М., Недра, 1992, 126с.
2. Справочник по литологии / Под ред. Н.Б. Вассоевича, В.Л. Либровича, Н.В. Логвиненко и др. - М.: Недра, 1983. – 509 с.
3. Перельман А.И. Геохимия эпигенетических процессов. - М.: Недра, 1965. –210 с.

RESOURCE-SAVING TECHNOLOGY FOR GAS PIPELINE MAINTENANCE

M.P. Zhdanova

Scientific advisor doctor V.G. Krezh

Tomsk polytechnic university, Tomsk, Russia

Russian natural gas flows extraction through Russian Unified Gas Transportation Pipeline System (UGPS). UGPS is the largest gas transportation pipeline system in the world. Nature, emergency shutdown of facilities, resource incomplete delivery, and incorrect staff action can exert influence on error-free performance of UGPS objects. During last years, the main cause of major accidents and disasters on UGPS's objects is an impossible high level of basic production assets depreciation in power engineering.

At present, basic assets deterioration of gas-transport system is about 56 %. Depreciation period of 14 % gas pipeline has come to the end, 64% was exploited from 10 to 32 years. Average operation life is about 23 years. Providing operational pipeline security is the key condition of economic and environmental safety of any state. Russia, a state which possesses strategic hydrocarbon resources and influences of the world energy market, the workover of existing pipelines and construction gas pipeline is an essential task for further economic development.

At present, Gazprom main strategic aim is to begin a new resource-saving technology of facilities and pipeline exploitation according to “technical state”. Reliable gas transportation for both domestic and foreign consumers can exist under conditions of adequate pipeline technical condition information data and their diagnostics. Based on investigation results, the following operation are considered workover programmes, re-coating, annual preliminary workovers, scientific and technical evaluation of operation life. Diagnostic program system of transport and gas transportation and storage includes:

- internal defectoscope inspection;
- compressor station, gas-distributing station and underwater crossings diagnostics;
- surface inspection of **gas pipeline**, crossings under highways and railways, junctions and **gas pipeline intersections**.

Today the most considerable progress was achieved in gas pipeline internal defectoscope inspection. All up-to-date fault detectors depict with reasonable defect probability and determine their characteristics. Internal pipeline inspection is about 15-20 thousands kilometers a year, where about 80% stress-corrosive gauges are used. This allows satisfactory and maintenance level of reliable level of gas pipeline system.

To raise the reliability level of gas pipelines, Gazprom is presently focusing its efforts on parallel realization and gradual transition from selective repair workovers according to technical conditions to complex workovers of trunk pipelines portion. Let's consider the effect of different factors of gas pipeline the reliability and safety “Nizhnevartovsk gas-refinery plant – Parabel” 133-135km.

In 2005, 100 % total pipeline control was performed (pipeline diameter 1020mm, “Parabel” pipeline). In accordance to workover plan of linear trunk pipeline portion on project TomskTransGaz in 2005, 100 % total pipeline control was performed.

Pipeline control was performed by metal magnetic receiver method, scanners and stress concentration measuring gauges, in order to sort out suitable, unsuitable and pipes, requiring additional control and repair. Pipes were considered to be suitable after the following control-measuring methods: no indication of stress concentration zones with limiting field gradient $= dH/dx$, corresponding to initial failure stage. Construction Standards 39-1.10-009.2002 – no

admissible defect according to document norms (standards) the above mentioned. Pipes were considered as unsuitable for further exploitation under the following conditions: limited field gradient in stress concentration zone; different defects (such as bumps on internal and external surfaces, metal breakage, mechanical failures, crimps and so on); wall thinning in separate sections from 10-20 % correspondingly. Metal magnetic send-receiver method control is based on the Russian State Standard Requirements 52005-2003 and Management Regulations 51-1-98, approved by Gazprom.

Gas pipeline of Nizhnevartovsk gas-refinery plant – Parabel 133-135km. was recognized as unsuitable for further exploitation therefore, major repairs workovers were completed from 01.06.06 to 25.08.06 according to TomskTransGaz program.

In view of special conditions of gas transportation in this area, gas pipeline were constructed in single-lane without emergency values, the project was to replace substitute the pipes by pipe laying in a new 1630m. trench, with further opening up and dismantling old pipeline. It should be mentioned that this project method allowed minimizing additional stresses, which resulted in execution of works, when performing selective repair maintenance. Let's examine results of pipeline internal defectoscope inspection:

- spiral pipe with total extension 753m. (picket from 140+28 to 141+05; from 145+07 to 149+54; from 151+30 to 153+59);

- 2 corrosion defects 30-40 % (picket from 143 to 145);

- 67 corrosion defects <30 % (picket from 143 to 145; from 161 to 162);

- 1 anomalous joint.

Spiral-jointed pipe were used under high pressure about 40 years ago. Considering the disadvantages of such pipes, it can be stated that there is a large number of welded joint in comparison to single welded pipeline joints. Because of the unsatisfactory quality of moulding and welding spiral pipes 20-30 years ago, corresponding to high safety requirements makes it impossible to guarantee trunk pipelines reliability. So, it is reasonable to replace them spiral pipes.

Let's estimate external metal loss based on anticorrosion protection. There are different reasons for corrosion on gas pipelines: insufficient cathode protection, atmosphere corrosion, corrosion, produced by high voltage alternating current, etc. Also another factor may be unsatisfactory technical state of insulated coating, caused by low quality gas pipeline system construction and design at the end of 70's, and beginning of 80's XX century. The 135km. pipeline route at the intersection of highway Aleksandrovskoe-Medvedevo, the corrosion on section 161 to 162 picket could have been caused by screening effect in and around the casing. In this case water in tubular space may prevent cathode protection. Manufactured pipes with coating (polyethylene coating) have been used in pipeline construction since 2001, where operation coating life equals pipeline operation life. In the investigated pipeline section manufacture pipes coating according to Russian State Standard 51164-98 was used. Also, it is necessary to create an effective anticorrosion pipeline protection. It should be mentioned that intensive monitoring of pipeline welds allow to prolong operation life of repaired sections, with the assistance of radiographic and ultrasonic diagnostics.

Gas pipelines, crossing motorways and railway tracks or running parallel to them, should be protected by a casing, which the requirements meets the durability and time conditions and protect pipelines from surface loads and damage. Application on pipeline coating protection previous technology and providing reliability of screen in pipeline system casing – pipe – soil, which were of antiseptic wood have become out-dated.

Nowadays, to prevent pipeline-casing contact, special facilities supporting centering rings of different designs, made from various materials, are widely applied.

During the pipeline construction through Aleksandrovskoe – Medvedevo highway, spacers - dielectric safety collars, produced by Metafrax, were used to separate pipe and casing. These spacers offer a reliable protective screen casing – pipe – soil. The spacers have been successfully tested, showing high quality and reliability. New pipeline construction with spacers can be used in different climatic environments. Application of dielectric safety collars increase pipeline construction period through passages and increases operation life up to 30 years.

Conclusion: predominant numbers of defected faults are a result of those factors in pipeline construction quality, pipe quality, technologic service, etc. Consequently, resource-saving technology is important for gas pipeline maintenance.

References

1. Achmaturov A.M., Demin Y.N. Gas pipeline recoating experience without gas transportation break // *Gazovaya promyshlennost.* – 2006. - №9. – P.106-107.
2. Dedeshko V.N., Salyukov V.V. Key diagnostics areas for major gas pipelines // *Gazovaya promyshlennost.* – 2006. - №8. – P.44-46.
3. Dubov A.A., Markelov V.A., Kotov V.D., Usenko Yu.I. Assessment and monitoring of long sections remaining life // *Gazovaya promyshlennost.* – 2006. - №8. – P.46-49.
4. Kotova I.S., Mitin A.S., Чернышов S.G. Spiral pipes for trunk pipeline // *Gazovaya promyshlennost.* – 2006. - №8. – P.16-19. Mayer V.V., Novoselova T.B., Sessin I.V., Koval I.V., Botov V.M. Metafrax spacers employed as mantle centering collars // *Gazovaya promyshlennost.* – 2006. - №12. – P.72-75.
5. Kanaikin V.A., Chaburkin V.F., Pakhomov V.P. Experience with, and future prospects for pipeline monitoring – driven by internal diagnostic // *Gazovaya promyshlennost.* – 2006. - №10. – P.18-22.
6. Zagorinsky E.E., Krasavtseva E.Yu. Gas transmission diagnostics: economic aspects // *Gazovaya promyshlennost.* – 2007. - №1. – P.16-19.
7. Gubanok I.I. How adequate repair practices assist longer pipe service life // *Gazovaya promyshlennost.* – 2007. - №1. – P.51-54. Kharionovsky V.V. Operating challenges with gas pipelines aged 30 or more // *Gazovaya promyshlennost.* – 2006. - №10. – P.23-24.
8. Spacers designing, construction and exploitation direction (Technical Requirements 2291-034-00203803-2005), installable on underground pipeline passages.
9. Результаты визита делегации менеджеров ООО «ТомскТрансГаз» фирмы «E.ON Ruhrgas AG».