KEYS TO THE BAZHEN

SELECTION OF A WELL SYSTEM

HIMMASH APPARAT

10 years

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OIL AND GAS INDUSTRY EPOCHS

753 years ago

In 1264 the Italian traveler Marco Polo, while traveling through the territory of modern Azerbaijan, said that local residents collected oil leaking from the earth.

517 years ago

In 1500 the well drilled in Krasnodar region was the first in Russia to start flowing.

168 years ago

In 1849, commercial production of oil was started in the USSR on the Cheleken peninsula on the territory of today's Turkmenistan.

131 years ago

In 1886 the first world's massive fire on oil mines occurred in Baku.

112 years ago

In 1905 the first in the world's history large fire occured in Baku on the oil field.

99 years ago

In 1918, Soviet Russia caused a precedent for the nationalization of oil companies.

97 years ago

In the 1920s, the first major ecological disaster took place on an oil platform near the California coast.

85 years ago

In 1932, oil deposits were discovered in Bahrain.

61 years ago

In 1956, the Suez crisis erupted. After the invasion of Anglo-French troops in Egypt, the world oil prices doubled.

42 years ago

In 1975, the US Congress decided to create a strategic oil reserve in the country to reduce the dependence of the economy on export oil in the future. Reserves of 700 million barrels of oil are stored in deep caves.

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Vladimir Putin has approved the strategy of Russia's economic security


One of the global threats is the desire of developed countries to use their technologies as a competition instrument


Interstate economic associations are created without Russia's participation


Russia has no access to foreign technologies

A DANGEROUS SECURITY STRATEGY

Anna Pavlikhina

In the middle of May, Vladimir Putin approved the strategy of Russia's economic security for the period until 2030.

The purpose of the document is to prevent crisis phenomena in resource, industrial, scientific, technological, and financial spheres, as well as to improve the citizens' living standards. The goal is decent, and what is most important – it is understandable and logical. One can say that it is the only necessary goal considering the existing facts of life. The questions are triggered by another issue, namely by the ways of achievement of this goal by the country. These ways are determined by the problems of the state policy, as well as by "external and internal threats".

Along with the changes at the world trade and financial markets, the creators of the document consider think that the main threat is the desire of developed countries to use their advantages, including information technology, as a tool for global competition. Then a question arises immediately: why the conditions of healthy competition, without which the market cannot exist, are interpreted as a threat. The competitive spirit has always been the basis of progressive development, and the availability of technologies and advantages of competitors should be considered as a challenge rather than a threat, as an incentive to one's own development.

Simultaneously, the enhancement of sovereignty was identified as one of the first tasks in the list of state policy objectives. If sovereignty is viewed as some kind of autonomy, then certainly it is needed in terms of the availability of strategic plants. However, this formulation of the problem raises fears of further isolation from the rest of the world – including the isolation of the economic, social and, above all, the scientific space that has long existed as an international one.

The processes of globalization link different aspects of the life of states according to the principles of the membrane theory, it is impossible to exist in isolation. Realizing this, the authors of the concept mark one of the "threats" that requires the greatest attention: the creation of interstate economic associations without the participation of the Russian Federation. Obviously, it is possible to correct this situation only by changing the behavior on the international stage, and for this, changes must begin far beyond the strategy of economic security – they must set in within the limits of the power mentality.

In addition, the strategy provides for the improvement of the response mechanism in the case of Western sanctions. Nevertheless, it does not provide for the development of measures that would help to avoid these sanctions.

Also, the Strategy mentions a danger associated with the restriction of the access to modern technologies. It is difficult to argue, but it is necessary to paraphrase: the danger is not the restricted access to foreign technologies, but the absence of own technologies. It seems that this way the formulated problem will change the ways of finding a solution, it is one thing to struggle for the access to foreign technologies, the other is to create one's own. But for this end it is necessary to create conditions, to invest, to train specialists. At the traditional business breakfast of Sberbank of Russia G. Gref called "a barbed wire" a condition for the growth of the intellectual economy and noted that "all the largest companies grow up in Russian abroad, the application-oriented solutions have been fulfilled abroad", because "it was uncomfortable here".

By the way, one more threat is the lack of labor resources. According to the Russian Federal State Statistics Service, at the end of 2016, more than 4 million people of working age in Russia have never worked anywhere. This, for instance, is like the sum of the populations of Libya, Estonia, Kuwait and Bahrain. If we are talking not just about labor resources, but about highly qualified specialists, who can be called "craftwork goods", then here we rest again on the absence of conditions in which this "product" can be manufactured (we already wrote about an incomprehensible reform of the universities union, as a result of which the unique institutions practically disappeared, about the curtailment of foreign grants, not to mention the underfunding of science).

In response to the fears of the authors of the Strategy that the export-raw material model is becoming obsolete, we would like to assure them of the opposite: the sooner this model becomes inefficient, the faster the country will begin to develop high-tech, knowledge-intensive industries. At the St. Petersburg International Economic Forum that took place in June, R.P. Tillerson said: "People who say that we need to give up fossil fuels, in fact, just do not believe in technology".

In general, there is a feeling that the focus of the document is not the improvement of economic and political mechanisms, not the development of own productions and science, but gaining the access to others' expertise. The danger of such a strategy is that it does not alter the existing approach to the changed conditions, but only the methods of maneuvering in an already outdated system.

FOCUS ON HRR

Elena Alifirova

Scientists of the Institute of Oil Geology and Geophysics of the Siberian Branch of the Russian Academy of Sciences have completed work on a draft strategy for the development of the mineral resource base of Russia until 2030, which indicates the most optimal directions for the search for hydrocarbons.

According to Professor L. Eder, unconventional reserves of hydrocarbons will be the main source of the growth of Russia's reserves. Work on the strategy for the development of the mineral resource base of the Russian Federation until 2030 has almost been completed. Now scientists are waiting for expert opinions of the main specialized organizations to submit the strategy to the government of the Russian Federation. According to the scientists IOGG SB RAS, today in Russia there are weakly explored territories, which in the future will help to increase the mineral and raw materials base of the Russian Federation.

In East Siberia – this is the Krasnoyarsk Territory, the Republic of Sakha, the Irkutsk Region, and the North Tunguska Province – these are areas where there has not been exploratory drilling yet.

Another strategy's direction will be geophysical surveys on the shelves of the Arctic seas, where large hydrocarbon reserves are likely to be discovered. The strategy consists of several blocks, one of which is hard-to-recover oil reserves. The scientists refer to them the Bazhenov formation and its analogues – the Domanic and Khadumsk formations in the European part of Russia, the Kuonam formation on the Siberian platform.

According to scientists, it is HRR that will provide the main increase in hydrocarbon reserves in the long-term perspective. According to Rosnedra (Federal Agency for Subsoil Usage), the degree of depletion of explored reserves in Russia reaches 55%, the degree of exploration of initial total resources is 46%. And the share of HRRs is steadily growing due to preferential development of easily recoverable reserves. Only about 12 billion tons or 66% of the total balance reserves of oil of A+B+C1 category, which in Russia exceed 18 billion tons, are referred to the HRR category. Without HRR involvement in the development, it will be practically impossible to keep the achieved level of production after 2020. ●

Neftegaz.RU ratings

Gazprom oil and Halliburton, Rosgeologiya and Copelouzos Group, Rosneft and ExxonMobil – even major companies cooperate to perform joint surveys in the field of geological prospecting. What country can become the major partner of Russia in the field of geological prospecting of resources?

What Country Should Russia Consider to Be Its Main Partner Regarding Geological Prospecting?

33%
Norway, as major reserves are concentrated in the northern shelf and Norwegian companies have the most extensive experience in the region

9%
USA, as American companies are equipped with the most research-intensive technologies

10%
China, as it is a strategic partner in major oil and gas projects

48%
Russian companies need no partners, we will explore our wealth independently

Today, leading Russian companies perform in prospecting and development of large hydrocarbon fields in Iran under contracts signed before. Zarubezhgeologiya, which is a part of Rosgeology, completed the first stage of works on creation of the central laboratory base in Sudan. And Rosgeology and JOGMEC (Japan) intend to implement joint projects in the field of prospecting. So why do Russian companies perform geological prospecting abroad?

Why Do Russian Companies Perform Geological Prospecting of Resources Abroad?

9%
The entire territory of Russia has been explored already

56%
The Russian school is one the top world schools and foreign companies request for assistance

6%
Russian companies possess the best technologies for geological prospecting of resources

29%
In Russia, major companies do not outsource prospecting works

Oil prices

Duty abolition

Presidential elections

Increase in production capacity

Gas wars

Nord Stream

The new head of "Gazprom"

Launch of new production

Stock market crash

Gazprom Neft Develops New Assets in YaNAO

Gazprom Neft enlarged its acquisitions in Yamal-Nenets Autonomous Okrug with new assets received from Gazprom: the company received the right to develop the Tazovskoye and Severo-Samburskoye deposits.

The license for the first deposit is issued for a period till 2025, for the second deposit – till 2027.

The Tazovskoye oil and gas condensate field (OGCF) is located 500 km northeast of Salekhard.

As early as in the beginning of 2016 in the village of Tazovsky, Gazprom dobycha Yamburg carried out public hearings on the arrangement of the oil rim of the Cenomanian deposit of the Tazovskoye OGCF.

Then Gazprom planned to drill 9 producing and 3 injection wells by 2018. Oil in the Tazovskoye OGCF is referred to hard-to-recover reserves – heavy, high-viscosity, but low-sulfur oil. As of January 1, 2016, the recoverable reserves in the field are estimated as follows: oil in the amount of 72 million tons, condensate – 4.6 million tons, free gas – 183.3 billion cubic meters. The field has been in operation since 1971, it is likely that the gas amount is depleting, and it is beneficial to concentrate on oil.

In 2016, on the cluster of wells No.1, which was arranged in 1998, which includes one oil well drilled for monitoring, and 3 producing gas wells, only one gas well was used to supply gas to the villages of Gaz-Sale and Tazovsky, the remaining two were in reserve.

In the 1st quarter of 2017, Gazprom Neft, having received the operator status, re-tested two wells and began preparation for cluster drilling.

The Severo-Samburgsky license area is located in the Purovsky District, 100 km north of Novy Urengoy. Previously, this subsoil area was developed by Gazprom dobycha Urengoy.

Reserves grow faster than production

As of December 31, 2016, the explored reserves of Gazprom natural gas of categories A+B1+C1 according to the Russian classification are 36.4 trillion m3, which is 72% of Russian reserves or about 17% of world reserves. Moreover, Gazprom annually conducts an independent assessment of the raw material base according to the international standards. In 2016, DeGolyer and MacNaughton conducted an audit of 95.4% of gas reserves, 93.5% of gas condensate and 93.3% of oil of A+B1+C1 categories according to PRMS standards. Proved and probable reserves of hydrocarbons of the Gazprom Group amounted to 23.9 trillion cubic meters of gas, 1018.9 million tons of gas condensate and 1378.7 million tons of oil. In 2016, according to the results of geological exploration, the increase in Gazprom's gas reserves in Russia amounted to 457.4 billion cubic meters.

The main increase in gas reserves in 2016 was obtained at Yuzhno-Kirinskoye (187.9 billion cubic meters), Kovykta (138.2 billion cubic meters) and Chayandinskoye (86.6 billion cubic meters) deposits. The volume of gas produced by Gazprom in 2016 amounted to 419.1 billion cubic meters.

Thus, the gas reserves replacement ratio in relation to production volumes was 1.1. Gazprom has been providing exceeding the growth in natural gas reserves over its production for 12 consecutive years.

NGL: to be or not to be

Nord Stream built

Reached his hands up in the Arctic

Stock market crash

The second wave of crisis

Gas prices

Russia has joined the WTO

Boguchany HPP launched

Gazprom returns to the Kara Sea

In the village of Yar-Sale, public hearings were held on the materials of the work program for engineering surveys at exploration well No. 3 of the Rusanovskoye gas condensate field in the Kara Sea. During the hearings, Gazprom geologorazvedka, Gazprom's subsidiary, presented the sequence, technology and volumes of engineering surveys at the facility. The site under exploration is located in the southwestern part of the Kara Sea, its remoteness from the port of Sabetta is 450 km. In the end the participants of hearings approved the presented work program, including data on environmental impact assessment. At the next stage, the project will be sent to the state environmental expertise. The customer of the project is Gazprom geologorazvedka, and the developer is the Marine Arctic Geological Exploration Expedition. The explored and previously estimated reserves in the ABC1+C2 category are 779 billion cubic meters of gas and 7.8 million tons of gas condensate. The gas of the Rusanovskoye gas condensate field is methane, sulfur-free.

Gazprom within its shelf program sets the priorities for the territories adjacent to Yamal: incl. Rusanovskiy and Leningradsky (gas reserves of 3 trillion cubic meters) subsoil areas.

Rosgeologiya will attract subsoil users to the Azov-Black Sea basin

To study the prospects of the oil and gas potential of the Azovo-Black Sea basin, Soyuzmorgeo (part of Rosgeologiya) began collecting, analyzing and generalizing geophysical and geological materials for the northern shelf and adjacent continental and deep-sea zones of the Black Sea basin. According to the company's information, this is done to update the structural and geological model of the Azov-Black Sea basin and to clarify the prospects of its oil and gas potential. The research, which begun in 2017, is planned to be completed by the end of the year. The work is carried out at the initiative of the enterprise. After receiving the data, the company expects to involve interested subsoil user customers for further implementation of geological exploration projects in this territory. It was in 2016 when Rosgeologiya spoke about the necessity to explore the Russian shelf and continental waters.

Then the corporation announced its intention to conduct a series of works in order to form the mineral resource base of the Russian Federation.

The main goal of the research is updating of representations about the features of the structure of the foundation and the sedimentary mantle of potentially oil and gas bearing sedimentary basins of the Russian and foreign regions of the Azov-Black Sea water area, including the areas of articulation of the southern part of the East European Platform, the Scythian plate, folded orogenic structures of the Black Sea lacune and its deep-water part.

Based on the results of the work, Soyuzmorgeo hopes to obtain a balanced unified structural and historical & geological model of the entire region and its basin structure that will help in future to simulate hydrocarbon systems in the territory, to clarify the prospects of oil and gas potential for productive and potentially productive Mesozoic-Cenozoic deposit complexes, and to determine what geological exploration and in what areas should be carried out first of all. ●

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BUSINESS-ACCENT

KEYS TO THE BAZHEN

GAZPROM NEFT LAUNCHES A NATIONAL PROJECT ON THE DEVELOPMENT OF THE HRR

Maria Kutuzova

THE BAZHENOV FORMATION (THE HORIZON OF ROCKS FOUND ALMOST THROUGHOUT THE WHOLE WEST SIBERIA, AS WELL AS IN OTHER REGIONS OF RUSSIA AT DEPTHS OF 2-3 KM) BELONGS TO THE CATEGORY OF NON-TRADITIONAL RESERVES, ITS DEVELOPMENT IN RUSSIA TODAY IS AT THE STAGE OF SELECTING TECHNOLOGICAL SOLUTIONS. ACCORDING TO OPTIMISTIC FORECASTS OF GEOLOGISTS, OIL RESOURCES IN THE RESERVOIRS OF THE BAZHENOV FORMATION ONLY ON THE TERRITORY OF WEST SIBERIA CAN AMOUNT TO UP TO 100-170 BILLION TONS. THE DEPOSITS ARE DISTRIBUTED OVER AN AREA OF ABOUT 1 MILLION SQUARE KILOMETERS, WITH A THICKNESS OF 10 TO 100 M. IF TO PUT BAZHENOV DEPOSITS INTO INDUSTRIAL DEVELOPMENT, THEY CAN BECOME THE "SECOND STAGE" FOR THE DEVELOPMENT OF TRADITIONAL RESERVES OF THE MAIN RUSSIAN OIL AND GAS PROVINCE. BUT UNLIKE THE SO-CALLED GREENFIELDS – NEW DEPOSITS IN NEW REGIONS – IN CASE OF WEST SIBERIA, THE DEVELOPMENT OF THE BAZHENOV FORMATION WILL NOT REQUIRE THE CREATION OF INFRASTRUCTURE FROM SCRATCH

Resource base

Gazprom Neft has been exploring the Bazhenov formation for several years and has made significant progress in developing technologies for exploring and extracting oil from this formation. In particular, significant results were obtained by the subsidiary of Gazprom Neft – Gazpromneft-Khantos, at the Palyanovskaya area of the Krasnoleninskoye field in the Khanty-Mansiysk Autonomous Okrug.

Thus, in 2016, a subsidiary of VINK has implemented the full cycle of development of the Bazhenov formation on the Palyanovskaya area of the Krasnoleninskoye field in Khanty-Mansi Autonomous Okrug: Two high-technology horizontal wells with multi-stage hydraulic fracturing of the formation were drilled and an industrial inflow of 45 tons of oil per day was obtained. Accumulated production from these wells reached 10 thousand tons, which allowed to confirm the technological efficiency of the basic technology, adapted for the Bazhenov formation.

This year, Gazpromneft-Khantos plans to carry out a well test at the Salym field to assess the geometry of hydraulic fracturing cracks and to construct a geomechanical model that will determine the optimal design of a horizontal well with multi-stage fracturing.

“Gazpromneft-Khantos was established in 2005 and is one of the main producing assets of the largest Russian Vertically Integrated Oil Company (VINK) – «Gazprom Neft». At the beginning of April 2017, Gazpromneft-Khantos produced 130 million tons of oil since the company was founded. “Achieving a milestone in extraction is an indicator of effective development of the company's assets. Thanks to the implementation of innovations and modern technologies in the field of field development, Gazpromneft-Khantos has a leading position on the rate of production growth in the region. The staff of the enterprise successfully contributes to the achievement of the strategic goal of Gazprom Neft – 100 million tons of oil equivalent by 2020”, says Sergey Doktor, Director General of Gazpromneft-Khantos.

FACTS

In 2016

a subsidiary of Gazpromneft-Khantos has implemented a full cycle of development of the Bazhenov formation

80 %

of oil production extent are provided by the largest deposit of Gazpromneft-Khantos – Yuzhno-Priobskoye

1.6 billion

tons of oil constitute the geological reserves of the South Priobskoye field

Today, the subsidiary of the leading domestic company develops eight deposits, daily production at which exceeds 41.5 thousand tons of oil equivalent. The company's tasks include geological exploration and exploitation of deposits located in the Khanty-Mansiysk Autonomous Okrug and the Tyumen Region: The Southern licensed territory of the Priobskoye field, Krasnoleninskaya area of the Palyanovskoye field, Yuzhnoye, Orekhovo-Ermakovskoe, Zimneye, Yuzhno-Kinyaminskoe, Zapadno-Zimneye, Maloyuganskoye deposits.

In order to fulfill the plans of increased oil production Gazptom Neft intensively cooperates with oil services contractors.

For several years now Gazpromneft-Khantos has been contracting with Siberian Service Company (SSC).

Choosing of JSC SSC is quiet obvious. For many years now, the SSC company effectively has rendered complete services of geological support of drilling, testing, liquidation and conservation of wells. JSK SSC not only ensures obtaining detailed geological structure of the lands with finding promising blocks but producing gushing oils as well. SSC company has been repeatedly awarded for its conscientious work in geological industry of Russia.

Chief Geologist of Tomsk branch of SSC Mrs. T. Telnova was awarded with the Certificate of Honor. This way the Government acknowledged her long-term activity and professional management of tests which resulted in gushing oil

wells in Tyumen and Ust-Balyk oil fields in Khanty-Mansiyskiy Autonomous Region.

More than 80% of the oil production is provided by the largest field of the enterprise – Yuzhno-Priobskoye, where the milestone of 100 million tons of oil was recently completed from the beginning of industrial operation. The geological reserves of the field are 1.6 billion tons of oil, 465 million tons of which are initial recoverable reserves. However, deposits of the field are characterized by a complex structure and low filtration and capacitance properties. The main part of residual reserves are referred to hard-to-recover reserves.

To develop such reserves, technologies and technical solutions are needed that will allow to develop them on an industrial scale in a profitable way.

To build the wells the experienced contractors are needed with Siberian Service Company among them. It was SSC company which was entrusted to perform directional drilling of production oils wells in Yuzhno-Priobskoye oil field.

In 2014 Gazprom Neft started the analysis of geophysical data, specialized investigations of core and repeated interpretation of the data of 3D seismic survey in Bazhenov-Abalak suite of Yuzhno-Priobskoye oil field. Based on the results of these studies 11 directional wells were drilled to estimate the potential of non-traditional resources, hydraulic fracturing was performed, oil inflows were obtained.

Gazpromneft-Khantos adapts and implements innovative methods of hydrocarbon production, applies the best practices in the field of working with HRR. In 2016, at the Yuzhno-Priobskoye field it was for the first time in Russia that a 30-stage hydraulic fracturing of the reservoir was successfully carried out using the "ball-free" technology. In the future, the method will not only reduce the costs, but will also provide the opportunity to re-stimulate horizontal wells.

Since 2013, the company has actively been working with unconventional hydrocarbon reserves. In 2014, the first industrial oil inflow was obtained at the Palyanovskaya area of the Krasnoleninskoye field. Here in 2016, the technology of high-speed fracturing on horizontal wells of the Bazhenov formation was successfully applied. As a result of using this approach to stimulating horizontal wells, the technical and economic feasibility of extracting non-traditional hydrocarbon reserves was confirmed. “As a part of its Technology Strategy, Gazprom Neft is exploring the possibility of involving in the industrial development of non-traditional reserves, the largest source of which in the territory of Russia is the Bazhenov formation. We conduct a consistent search for the most effective methods of working with this category of hydrocarbons,” says Vadim Yakovlev, First Deputy General Director of Gazprom Neft. The main task that the company faces is to reduce to the maximum the cost of developing the bazhen.

FACTS

45 tons

of oil per day is an industrial inflow of 2 wells of the Palyanovskaya area

In **2005**

one of the main production assets of Gazprom Neft- Gazpromneft-Khantos was established

As it was explained in the company, in 2014, Gazprom Neft approved a strategy for developing a resource base for unconventional sources of hydrocarbons. The strategic goal for extraction from the Bazhenov formation is estimated at 2.5 million tons per year by 2025. Within the framework of the strategy for the development of the resource base, a portfolio of projects for the development of the Bazhenov formation in the perimeter of Gazprom Neft’s operating assets and new exploration projects on the territory of KhMAO and Yamal were created between 2014 and 2016”. “17 wells were drilled in two pilot sites in Palyanovskoye (KhMAO) and Vyngayakhinskoye fields (YaNAO), 617 m of core samples were sampled and explored, specialized studies and an expanded program were carried out for experimental and field work aimed at exploring the Bazhenov formation. The results confirmed the resource base of the Bazhenov formation and the technological efficiency of the basic technology – multi-stage hydraulic fracturing, carried out in two high-technology horizontal wells. The structure of these wells and the design of hydraulic fracturing have been adapted to the conditions of the Bazhenov formation. During the development, an inflow of 45 tons of oil per day was achieved. Accumulated production from these wells has now exceeded 10,000 tonnes, was told in Gazprom Neft to our magazine.

The tasks of development of technologies for development of the Bazhenov formation are being solved within the framework of the Gazprom Neft’s Technology Strategy, which allowed achieving a qualitatively new technological level in 2015-2016. In the construction of wells on the Palyanovskaya area, a unique technology for the domestic oil industry was tested which consisted in cementing of the horizontal well shaft with elastic cements with a rotation of the tail joint. This technology provides a qualitative separation of stages in multi-stage fracturing. The following technologies to create a branched crack system were applied: Plug & Perf finishing, SlickWater high-speed injection technology, as well as hybrid fracturing optimized for the Bazhenov formation. In addition, a new method patented by Gazprom Neft was used for exploration of hydrocarbon deposits in unconventional reservoirs of the Bazhenov formation, and a domestic software package has been developed to determine the optimal system of multi-stage fracturing cracks in the development of non-traditional reserves (the ROST calculation module).

National project

In May this year, the Russian Energy Ministry approved the application of Gazprom Neft and assigned the status of the national project to the project of "Creation of a complex of domestic technologies and high-tech equipment for the development of reserves of the Bazhenov formation". Within the framework of the national project, it is planned to develop and to implement technologies for exploration of oil and gas bearing Bazhenov deposits based on domestic methods of seismic, magnetic, gravity prospecting and specialized core sample research, as well as geological and hydrodynamic modeling of reservoirs.

The national project will be implemented in the Khanty-Mansiysk Autonomous Okrug on the territory of the Palyanovskaya area of the Krasnoleninskoye field. The main task of the project is the creation of at least 15 new technologies for the development of the Bazhenov formation, including several areas, including new equipment and software. Among the partners of Gazprom Neft in this project are engineering center MFTI, Skolkovo Institute of Science and Technology, Moscow State University, RSU named after Gubkin, MSTU named after Bauman.

According to Alexey Vashkevich, the head of the Directorate for Exploration and Development of the Resource Base, domestic companies are again ready to become not just "smart buyers" of services and equipment, but also "smart customers" of new technologies. "Today, the Russian oil industry has the opportunity not only to be in the role of catching-up, but in some key areas to become leaders in innovative development. We are starting to develop technologies and I would not be surprised if in a few years we announce that we were the first in the world to find a solution for such a task. In Russia we are proud of our fundamental science and talented scientists. The oil industry collects the best students and the best graduates. For today in general there is no such concept, as scarcity of talents", – notes Vashkevich.

FACTS

130

millionth ton of oil was produced in April 2017 by Gazpromneft-Khantos since the company was founded

465 million

tons constitute the recoverable reserves of the South Priobskoye field

In **2014**

the first industrial inflow of oil was received at the Palyanovskaya area of the Krasnoleninsk deposit

617 m

of core was selected and examined at the Palyanovsky and Vyngayakhinsky pilot sites

Thanks to a close partnership with the country's leading research institutes, during the implementation of the national project, it is planned to create Russian technologies for the construction of horizontal wells with multi-stage fracturing, optimized for the mining and geological conditions of the Bazhenov formation, and to develop methods for developing light oil reserves from shale rock formations with help of thermochemical stimulation techniques. In case of successful implementation of all the created technologies, according to the strategy development of the resource base for non-traditional sources of hydrocarbons approved by Gazprom Neft, the target level of production of the VINK from the deposits of the Bazhenov formation in 2025 may be about 2.5 million tons per year.

According to Kirill Strizhnev, the head of the Bazhen design office of Gazprom Neft, the replication (widespread use) of technologies can lead to making them cheaper. So, in the United States, 7-8 years ago, the average price of a well for the development of shale reserves was $ 12 million, now this figure has dropped three times, to about $ 4 million. In the case of the Bazhenov formation, Russian companies will have to go their own way from the creation of technological solutions and testing thereof to the implementation of domestic innovations on an industrial scale. It is necessary to find the optimal technical solutions that will make it possible to profitably develop these colossal potential resources.

As noted by Strizhnev, the national project of Gazprom Neft was supported by other oil producing and service companies. In 2015–2016, the application passed a detailed expert

examination in the relevant state departments and Russian scientific centers. According to the company, a separate legal entity will be created to develop each technology, which as a result will become the owner of this technical solution or the owner of the know-how. Among the participants of these joint ventures within the national project there will be research organizations, external investors, oilfield service players and VINK. Currently, Gazprom Neft is negotiating with about thirty equipment manufacturers and service providers, discussing joint plans with leading Russian mining companies. It is planned to finish the concept by the beginning of the autumn this year, to create a plan for implementing the “road map” and to sign the main documents necessary for the implementation of the national project.

The established term of its implementation, during which it is assumed to perform the basic research works, covers the next four years so far (until 2021). Without a doubt, this is an ambitious task for the Russian conditions. The total investment sent to the project, according to Gazprom Neft, will amount to 8.5 billion rubles, 7.5 billion rubles of which wil be invested by VINK itself.

A special license will be in effect on Palyanovskaya area, which will make it possible to carry out a pilot development of reserves legally. Up to 2021 it is planned to drill more than 50 wells. Already in 2022-2025 it is planned to move to the industrial implementation of technologies and their replication for the domestic market and the transition to technological exports. Gazprom Neft plans to drill even more than 50 wells with hydraulic fracturing until 2027 and produce 7.5 million tons of Bazhenov oil in the next 10 years. System testing and development of new domestic technologies is planned to be carried out on the basis of the "HRR extraction technology development center", which Gazprom Neft together with the administration of KhMAO-Yugra is establishing in the Khanty-Mansiysk Autonomous Okrug.

In order to attract investments from other mining companies, there will be applied a mechanism of creation of a technology facility, in which several oil companies will operate. Gazprom Neft is going to work in Palyanovskaya area in the framework of the national project as an operator, and the testing facility will become an industry platform where any company will be able to test its technologies for the Bazhenov formation. Authorities of the Autonomous Okrug will act as a curator. According to the representatives of Gazprom Neft, in fact, a new type of subsoil use is being created in the form of a technology facility: a special-purpose license for technology development.

According to Yakovlev, the national project for the study of the Bazhenov formation, combining the technological and scientific potential of Gazprom Neft, as well as the experience of leading research centers, service companies and equipment manufacturers will allow the development of technologies for accurate localization of reserves, optimization of drilling, and to study the efficiency of thermochemical stimulation techniques. “Thanks to the implementation of the planned projects, we plan to transfer the Bazhenov oil to the category of reserves ready for industrial development, which will be a new impetus for the development of the entire Russian oil and gas industry," Yakovlev says.

Through a national-status project, Gazprom Neft creates a venture site for the development of technologies for the development of the resources of the Bazhenov formation. The specialists of the company perfectly understand that for the implementation of such an ambitious project VINK will not have enough their own forces and resources: It is not possible to solve a problem of such a level alone. The format of the national project will allow its participants to apply for state support: as Gazprom Neft suggests, such instruments can be a big help as special investment contracts, preferential financing and additional tax incentives. But venture capital investments, as a rule, have high risks, so joining forces of several players, including the government, can significantly reduce them.

According to Gazprom Neft estimates, thanks to the consolidation of the efforts of leading industry players, by 2025 the volume of Bazhenov oil production in Russia will grow 10 times up to 10 million tons per year (now it is about 1 million tons), the company itself will account for up to 2,5 million tons. Even taking into account the tax incentives, income to the budget (taxes and duties) from the development of the bazhen will amount to 30 billion rubles.

FACTS

More than 41,5

thousand tons of oil equivalent is the daily production of eight Gazpromneft-Khantos fields being developed

2,5 million

tons per year is the strategic target for extraction from the Bazhenov formation by 2025

15

new technologies for the development of the Bazhenovskaya group is the goal of the national project

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CONTINUOUS IMPROVEMENTS:

FROM THEORY TO PRACTICE

Denis Yuryevich Kuksgowzen,
Acting Director of the GPNKH project Services of drilling operations services of Nefteyugansk branch of JSC "SSC"

"LEANiYA" («ЛИНИЯ») PROJECT (AFTER ENGLISH WORD "LEAN") WAS LAUNCHED IN GAZPROMNEFT-KHANTOS IN 2016. WITHIN THE FRAMEWORK OF IMPLEMENTATION OF LEAN MANUFACTURING PRINCIPLES, A PROJECT OFFICE FOR DEVELOPMENT OF THE CONTINUOUS IMPROVEMENT SYSTEM WAS CREATED IN THE COMPANY, THE SPECIALISTS OF WHICH TEACH NOT ONLY COLLEAGUES, BUT ALSO THE EMPLOYEES OF CONTRACTING ORGANIZATIONS THE INSTRUMENTS OF LEAN MANUFACTURING. THE EMPLOYEES OF SIBERIAN SERVICE COMPANY ARE ACTIVELY INVOLVED IN WORK. DENIS YURIEVICH KUKSGAUZEN, ACTING DIRECTOR OF THE GPNKH PROJECT OF THE DRILLING OPERATIONS SERVICE OF NEFTEYUGANSK BRANCH OF JSC "SSC", TELLS ABOUT THE PROGRESS OF THE WORK AND ABOUT THE RESULTS, WHICH HAVE BEEN ACHIEVED

KEYWORDS: *Siberian service company, Gazpromneft-Khantos, drilling, lean manufacturing, tejpreet, drilling on paper.*

– Denis Yuryevich tell us how the Gazpromneft Company started its participation with SSC in the project of "Continuous improvements"?

– In December 2015, I participated as a representative of our branch in conference on technical limit ("Tejpreet") held by the Gazpromneft Company in Orenburg town with contractors involved in well sites construction. Specifically from its asset in Orenburg, Gazpromneft began to implement the project "Tejpreet".

For implementation of this project in all its assets, Gazpromneft invited a foreign company and after several months our partners from Gazpromneft-Khantos has already started the implementation in their premises, surely, involving their contractors in the process.

– What is the main purpose of inviting contractors?

– About 90% of all operations are carried out by contracting organizations that is why it is out of the question to start the productivity enhancement without enhancing the operational efficiency of contractors.

The project "Tejpreet" implied the implementation of different instruments such as "drilling on paper". The representatives of the office Gazpromneft-Khantos visited our facilities, production fields to drilling-rig crews for conducting session "drilling on paper". We also realize training in the office of GPNKH LTD.

– Tell us specifically about "drilling on paper"?

– It's an instrument of "Technical limit" ("Tejpreet") giving possibility to analyze the construction of previous wells and to plan the construction of future ones. We carry out a careful analysis; reveal moments thanks to which it is possible to reduce time of operations, in other words, to exclude nonproductive and inefficient time. Representatives of all services take part in this process because the construction of wells happens on the principle of separate service, and everybody brings forward their own suggestions. Often, there are disputes but finally all opinions consolidate in one common decision.

– What else specialists of SSC were taught within the first stage of "Technical limit"?

FACTS

More than **90** %

of all work on the field is performed by contractors

"Drilling on paper"
It is a technical limit (tejpreet) instrument, when analysis of construction of previous wells is carried out and construction of further wells is planned

– During the first stage, "drilling on paper" was a main instrument. Then the company implemented some more projects, and finally now, it is combined in the project "System of continuous improvements", lean manufacturing. The company invited people responsible for implementation of the System of continuous improvements. Their set of instruments is much more various. The representatives of SSC completed training on implementing lean manufacturing instruments. These were Drilling Foremen, Drilling Manager, Project Director.

– What changes happened on the project in connection with introduction of training?

– We introduced such instruments as 5 C method (selection, maintenance of order, maintenance of cleanness, standardization and perfectibility). At the primary stage, the simplest method is introduced that doesn't require any financial investment. The purpose of this method is reduction of things to order in the workplaces, making things as clear as a bell aimed at enhancing manufacturing efficiency. For office employee it's an order at desk, in the workplace; for blue-collar jobs we imply a continuous systematization and process standardization. It is one of the first introduced instruments. We also introduced stands for planning meetings. It's a usual announcement board displaying operating plan for several days ahead and plan-assignment for following 12 hours of drilling shift operation. Upon completing of operation shift, we consider in cooperation with workers a plan/actual of task performance, reasons for speed-up or, vice

versa, less successful completion of works. We also use stand to mark best workers, “leaders” of manufacturing as well as “anti-leaders”. Altogether, 6 crews work for us today, and each of them has such an introduced stand, one of them is electronic.

– How do these innovations influence people?

– As a rule, the majority got through denying stage, in other words they deny the necessity of introducing these instruments and improvements introduced by them. It’s normal, we were cautioned about it during training. However, gradually people get through the process of understanding, and innovations are introduced and got accustomed. Now we experience the process of understanding, and representatives of our company introduce and implement more actively the instruments of lean manufacturing.

– Please, tell us about the principle you use to train your staff?

– For participation in the program, we selected the most active, young and advanced people who should possess enough energy and strengths to master new skills, to introduce in their facilities the instruments of lean manufacturing. These are employees, who will believe in efficiency of this instrument. Taking into consideration the fact that the result won’t be seen immediately, this project needs the most energetic people whose “ignition” wouldn’t vanish after the first two months. By the way, it’s one of the risks we were told about during our training. Some people become familiar with it fast but if they don’t see the result after several months, there is a is likelihood of being disappointed. We were cautioned at once that the results would be no earlier than after 2 years.

– Does “Gazpromneft” possess some methods to encourage organizations taking part in the project?

– We choose the best crew based on monthly results. The winners take money reward. This is not an innovation, such practice exists for plenty of years, and the crews of the Nefteyugansk branch were already the best. The main criteria for choice are performance indicators as well as respect for industrial safety culture. Occupational safety in SSC is always in the first flight.

– Are successes of contracting organizations pointed out in “Gazprom Neft” in some way?

– Certainly, the strive of “Gazprom Neft” to team work, partnership relations have always been on a high note. Conclusions of executed work are drawn monthly, production figures are analyzed, obtained data are brought to the notice of regional representatives of each company. SSC has good results among the contractors of “Gazpromneft-Khantos”. Conferences are convened quarterly, at which representatives of the companies and the chief executives of the contracting organizations draw conclusions, make proposals, discuss indices, highlight successes of each company.

FACTS

In 2016

The “LEANiYA” project started in Gazpromneft-Khantos

5 thousand

of employees and working today in the SSC company, which has 7 divisions in the regions of the RF

– How does self-training take place?

– Lessons are divided into 4 stages and are given once a week. The representatives of SSC, together with the representatives of other contracting organizations, have been taking training in the course of a month. Training was carried out in 2 areas: well construction and drilling. This training is conducted by the specialists, who, in their turn, have taken a course themselves and are already adopting this pilot project in the “Gazpromneft-Khantos” company in their administrations. The main course was held by the deputy chief engineer of “Gazpromneft-Khantos” for productivity enhancement. Training was easy, we could see glowing eyes of our employees. Teachers always listen to the criticism of the contracting organizations and give a substantiated response. Training is conducted in the format of a lecture, and there is a homework assignment. Fulfillment of assignments and attendance of lectures is controlled strictly. The representatives of SSC have fulfilled all requirements, have had a conscientious attitude to fulfillment of a homework assignment and have passed a test on completion of training successfully.

– What other instruments of lean manufacturing does the “Gazprom Neft” company use?

– One of important instruments is a think tank, so to speak. ”Gazprom Neft” has an “Idea” program, according to which each employee, irrespective of his official capacity, can suggest his/her idea on improvement, on increase of the effectiveness and to get a reward for it. There is such program in Siberian Service Company, it is called an “Innovator” and it appeared in SSC several years ago. And now it is growing rapidly.

There is plenty of instruments, but they are introduced incrementally, in stages. The main ones are 5C, WDPP bedsteads, “Idea”. At some enterprises the employees are obliged, are given plans for creation of a certain number of ideas. We don’t have this in our company, neither does “Gazpromneft-Khantos”. Because apart from the number of ideas, it is necessary, first of all, to track their quality.

– How does SSC implement the second stage of the “lean manufacturing” project?

– First of all, we try to avoid losses: the main losses are considered to be unnecessary transportation, idle time, excessive processes, movements, surplus. SSC has always tried to avoid these losses at the place of production, but now we have put special emphasis, identified those losses, which can be considered as the most significant according to their influence of effectiveness. One of the most large-scale excessive processes are idle time, waiting. Here not always everything depends on a certain company, the nature of work is of such kind that it is always necessary to move from one facility to another, from one multiple-well platform to another, which are at different stages of preparation to construction of wells. Also, certainly, at its level, inside its company, the work on reduction of obsolete transportation costs and excessive processes is carried out. And on the whole, everybody is working on productivity enhancement.

– Can you provide examples of significant results on the project?

– Here it is important that the “Gazpromneft-Khantos” company has a result on the whole: it is a result of work of both of SSC, and a merit of all contractors. For the moment, the construction cycle of horizontal wells at SSC has decreased in comparison with 2016 (I take into account the wells, in construction of which SSC takes place). I consider it to be an achievement and a merit of all services and, certainly, of a customer.

– How much time does the whole cycle of well construction take?

– On the whole, the construction cycle takes about 29 days, plus or minus 2 days. This indicator can be considered a good one, just a year ago a well was constructed in 35-36 days, and two years ago – even more so. Here, certainly, there are technological changes of different natures as well, but the instruments of the “Tejpreet”, lean manufacturing, have already started to bear fruit.

– Will the training be continued further as well?

– Training is conducted permanently, nature of training is different, and each session of “drilling on paper” is also some kind of training.

– Tell us about the equipment used by SSC at Gazpromneft-Khantos project, and a technical input of wells construction.

FACTS

More than 1,5 mln m

is an annual volume of prospecting-exploration drilling and production drilling

More than 3200

of carried out maintenance and overhaul repairs of wells per year

– All used by us drill units are fitted with triple-plunger pumps and power top-drives. Use of the modern equipment allows to decrease a share of non-productive time and the number of repairs. We use 3 types of top-drives – Bentec, Canrig и Tesco – at the “Gazpromneft-Khantos” project.

– When did cooperation of SSC and “Gazpromneft-Khantos” start, how many crews are working there?

– Cooperation of SSC and “Gazpromneft-Khantos” is about 10 years. Everything started with two crews, then volumes started to grow, and today there are already 6 constantly working drilling crews.

Experienced drillers work at SSC, some of them have been at this project from the very beginning of our cooperation. There are crews, which have been working at the project for 3-4 years, but they can also already be called skilled, formed and executing their work professionally.

– What is your estimate of the level of the program introduction in SSC now?

– The “lean manufacturing” project has been introduced in the company in a quite active way. Siberian Service Company entered to the “Gazpromneft-Khantos” project with rather high intensity, and considerable changes and improvements are seen at the moment. ●

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BUSINESS-ACCENT

30-STAGE BREAKTHROUGH

Nikolai Vladimirovich Chebykin,
Head of the planning department of geological and technological activities of Gazpromneft-Khantos

IT WAS FOR THE FIRST TIME IN GAZPROM NEFT GROUP OF COMPANIES AND IN WEST SIBERIA THAT GAZPROMNEFT-KHANTOS HAS CARRIED OUT A UNIQUE TECHNOLOGICAL OPERATION ON A 30-STAGE HYDRAULIC FRACTURING AT THE YUZHNO-PRIOBSKOYE FIELD. UNTIL NOW, AN 18-STAGE OPERATION IN A SINGLE HORIZONTAL WELL BORE WAS CONSIDERED TO BE THE MAXIMUM VALUE IN THE COMPANY; IT WAS CARRIED OUT IN MARCH 2016 AS WELL AT THE YUZHNO-PRIOBSKOYE FIELD OF GAZPROMNEFT-KHANTOS

KEYWORDS: *multi-stage hydraulic fracturing, well drilling, oil production, flexible pump-compressor pipe, the Yuzhno-Priobskoye field.*

- Nikolay Vladimirovich, due to what it became possible to carry out a 30-stage hydraulic fracturing at the Yuzhno-Priobskoye field?

- We can talk about the influence of several factors at once. The number of operations of the company was increased thanks to the application of the "ball-free" technology of completion and stimulation of the well. The second factor is the possibility of drilling of a horizontal shaft 1.5 km long. For the first time in the history of development of the Yuzhno-Priobskoye field, this long horizontal section of the well has been drilled. Prior to this, the maximum length of the shaft was 1 km. A new drilling rig with increased lifting capacity was used and a rotary controlled system, which allows making a clear delivery of the instrument in the horizontal shaft. Another important point is the application of a new approach to the hydraulic fracturing itself. To accelerate the preparations for the operation directly, we used a horizontal basin-type tank with a capacity of 600 cubic meters, organized a two-shift operation mode for the teams of hydraulic fracturing and preparation. The coordinated work of contract organizations on hydraulic fracturing and on flexible oil well tubing (FOWT) had its own impact on the process. As a result, up to 6 stages of hydraulic fracturing were performed per day.

- And can multi-stage fracturing be used in any field?

- The deposits are all different, and each of them needs its own approach. The use of multi-stage hydraulic fracturing should be justified technologically and economically. In general, it can be said that the lower the filtration and capacitance properties of the reservoirs - the power and permeability, and the worse the oil reserves are by quality, the more economically feasible is the construction of horizontal wells with the use of multi-stage fracturing.

- Why was the technology used in the 30-stage hydraulic fracturing called "ball-free"?

FACTS

1.6 km
the length of the horizontal borehole section in the Yuzhno-Priobskoye field

600 m³
the volume of the horizontal basin-type capacity used to accelerate the preparation for the multi-stage hydraulic fracturing

6
stages of fracturing were performed for 24 hours

- The peculiarity of the new technology consists in the method of isolating the ports of the hydraulic fracturing unit from each other. Ports are points inside the well where a fracturing is planned. When using the "ball" technology, each new fracture zone is separated from the previous one by a composite or metal ball. The diameter of the balls increases from zone to zone and does not allow for more than 10-12 fracturing operations due to the design features of the well. In addition, the balls should be destroyed after the completion of the fracturing.

Before the multi-stage hydraulic fracturing at the Yuzhno-Priobskoye field, we lowered into the borehole special couplings, which are displaced by means of the flexible tubing. In the tube there is a special tool with a reusable sealing "pillow", which swells and separates the zones with the fracturing which was already performed. Thus, we are no longer limited to the diameter of the balls, we can place couplings as we want, at any distance. This opens new prospects for increasing the number of stages of hydraulic fracturing.

Thanks to the application of the "ball-free" technology in the horizontal section of the well, there appear the opportunities both for maximum acceleration of the process of development and launch of the well into permanent operation, and for geophysical operations and intensification of the inflow during the operation of the horizontal well.

After performing the work, the equipment can be transported to the next location of the hydraulic fracturing. The number of stages of hydraulic fracturing is limited by the length of the well and technical and economic calculations. In a few years, we will be able to re-fracture without any problems. Repeated multi-stage fracturing in horizontal wells with "ball" completion technology involves a number of technological and technical risks and has a low success rate.

- Why exactly 30 stages?

- Together with our colleagues from the Gazprom Neft Scientific and Technical Center in St. Petersburg, we made calculations, including using the hydrodynamic model. It was known that the well would have a horizontal shaft of 1.5 km and for greater efficiency it is necessary to place in it the maximum number of stages with a high payback. The recommendations of the contract organizations, technical and economic calculations confirmed the validity of the decision to conduct the 30-stage hydraulic fracturing.

- What was the complexity of the operation?

- 18 stages of hydraulic fracturing has been considered the maximum value in the company so far. And now - a significant quantitative and qualitative leap. Such technologies have already been used in North America, we were the first who did it in Russia. The work was not easy, because the depth of the well is more than 4.5 km. The most difficult was to establish cooperation between contractors. A hydraulic fracturing team and a team of flexible tubing worked at the well at the same time. Usually they follow one another. In addition, our specialists were on the site, who controlled the process, both in terms of compliance with technology and meeting the requirements for industrial safety and environmental protection, so that all work was carried out in the shortest time and accident-free. And it was a success.

- What are the reasons for obtaining positive results?

- The main thing is the correct planning. We repeatedly calculated everything on simulators, on models, we conducted a drilling and development session “on paper”. The team work of all the production functions and the Scientific and Technical Center brought its results. We, as a subsidiary company, created a working group, which included specialists from various departments. In addition, we would not have succeeded without close cooperation with contractors.

FACTS

4.6 km
borehole depth

14 days
time from the commencement of pilot operations to the start of the well operation

- How much time did the project take?

- The date of commencement of pilot works was May 25, 2016, and on July 7 the well was already in operation. As for the first time and taking into account the performance of 30 stages of hydraulic fracturing, it is very fast.

- How does the project affect the environment?

- During the work performance, the impact on the environment was minimized. Modern technologies of construction and completion of wells allow us to protect the environment from man-made impact. In addition, Gazpromneft-Khantos's control as a customer was very serious. We pursue the goal of "zero" – the no harm to personnel, the environment and property during work performance.

EVENT CALENDAR

July 10–July 13

8th International Industrial Exhibition

INNOPROM-2017

Yekaterinburg

JULY

M		3	10	17	24	31
T		4	11	18	25	
W		5	12	19	26	
T		6	13	20	27	
F		7	14	21	28	
S	1	8	15	22	29	
S	2	9	16	23	30	

July 11 – July 13

International Exhibition of Oil & Gas and Petrochemical Industry

Oil and Gas Asia — OGA 2017

Malaysia, Kuala-Lumpur, Kuala Lumpur Convention Centre

July 11 – July 13

International Exhibition of Oil & Gas Industry

Oil and Gas Africa 2017

Republic of South Africa, Cape Town

July 18–July 20

14th China Xinjiang International Coal Industry Exhibition

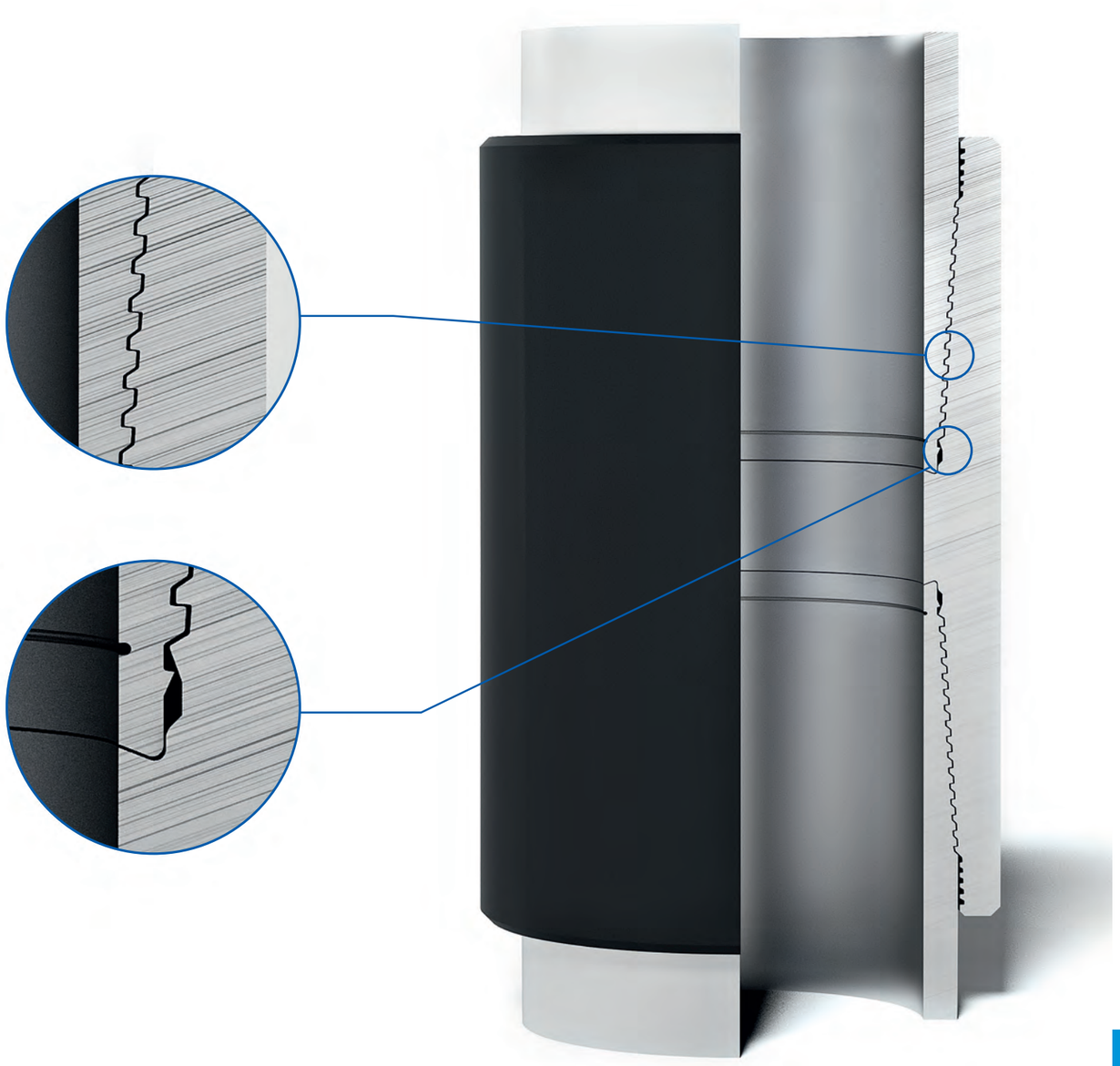
ICME 2017

China, Urumqi,
Xi'an Qujiang International Convention & Exhibition Center (QICEC)

CASING PIPES

From 27-30 June, 2017

We are looking forward to see you at Russia’s largest international exhibition of oil and gas equipment and technologies — MIOGE 2017.
Our stand is A215, Pavilion 3, Hall 13



STRING TMS-OTV-6.35

Application

Casing strings are used to case oil wells and the wells in which there moves the heat transfer medium at a temperature of up to 250 °C.

Advantages of the threaded Joint DOMINANT

- Improving the quality of pipe assembly on the well by means of free entry without rotating the nipple into the collar at a depth of 12 threads;
- Increasing the axial load for extension and compression in the threaded joint F-6,35, virtually to the load which the casing string body withstands;
- Equal distribution of axial load over the threads as a result of gradually increasing the thread depth from the indicating band to the main plane;

Unique design

Sealing of the threaded joint due to interference fit contact at the point of the toroidal seal band of the nipple with the female cone in the collar.

- Facilitating visual control of thread screwing completion by comparing the collar end with the beginning of the wide circular band;
- Increasing reliability of the casing string when lowering it into severely curved wells by optimizing gaps near the threads as well as the toroidal and taper design of threaded joint sealing unit.

STRING TMS-SRV1

Application

These casing strings are used to case oil and gas wells of complicated profile.

Advantages of the threaded Joint DOMINANT

- Threads are cut on the pipe and, in addition, a sealing abutment element is installed which ensures joint sealed interface between the threaded profile and two abutment elements (ridge on the pipe and the bore in the collar) “metal-to-metal”;
- The joint allows considerable increase in the make-up torques and in the bearing capacity of the threaded joint;
- Two types of execution are available: coupling joints and streamline joints;

Unique design

Sealed geometrical interface of the threaded profile and two abutment elements.

- Geometry is sealed on the geometrical dimensions of the thread profile angle interface, on the nipple end and in the bore, i.e. on the collar end “metal-to-metal”. Existence of two turns of the incomplete thread profile on the sealing diametrical surface of the pipe nipple sealing element, which serves as a damper, when the joint operates, is a distinguishing feature of the geometry and a competitive advantage of the Management Company TMC Group LLC.

STRING TMS-SRV2

Application

Casing strings are used to extract high viscosity oil by steam assisted gravity drainage (SAGD).

Advantages of the threaded Joint DOMINANT

- The thread profile is cut on the pipe and, in addition, a sealing abutment element is made which ensures joint geometrical interface of the threaded profile and the sealing unit on two toroidal surfaces “metal-to-metal”;
- There is no gap between the outside surface of the seal on the pipe nipple and in the collar bore in the entire interface of the threaded profile and sealing abutment elements;

Unique design

This joint is characterized by high compression strength, tensile strength, bending strength.

- The joint allows considerable increase in the makeup torques and in the bearing capacity of the threaded joint;
- Torque values are different from those shown in the table of minimum, optimum and maximum micron. For casing strings 245*8,9 mm – micron = 42kN.

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INNOVATIVE TECHNOLOGIES FOR DEVELOPMENT OF HIGH-VISCOSITY OIL RESERVES

DESCRIBES CURRENT STATE AND CHARACTERISTICS OF EXPLORATION AND EXPLOITATION OF UNCONVENTIONAL SOURCES AND OIL RESOURCES, INCLUDING SHALE RESOURCES, HIGH-VISCOSITY AND BITUMEN OIL. THE CHARACTERISTIC OF THE EXISTING (TRADITIONAL) DOWNHOLE TECHNOLOGY TO THE EXPLORATION AND EXPLOITATION OF OIL AND GAS FIELDS BY DRILLING OIL AND GAS WELLS FROM THE EARTH'S SURFACE FROM THE STANDPOINT OF JUSTIFICATION OF THE PROSPECTS AND POSSIBILITIES OF DEVELOPMENT AND EFFICIENT PRODUCTION OF OIL FROM DEPOSITS OF THE BAZHENOV FORMATION ROCKS IN WEST SIBERIA. IT SHOWS THE UNACCEPTABILITY OF DUAL CONSISTENT IN SPACE AND TIME THE DEVELOPMENT AND PRODUCTION OF VARIOUS FORMS AND TYPES OF HYDROCARBONS (DIFFERENT STOCKS AND RESOURCES OF OIL) CONTAINED IN THESE DEPOSITS FOR LARGE-SCALE DEVELOPMENT OF THE BAZHENOV FORMATION AND SIMILAR OIL FIELDS OF THE VOLGA REGION WITH A PURELY TRADITIONAL WELL TECHNOLOGIES. AS AN ALTERNATIVE TECHNOLOGICAL APPROACH OFFERS COAL MINE-DOWNHOLE TECHNOLOGY AND ENERGY TECHNOLOGY SYSTEMS EQUIPMENT, PROVIDING FOR THE OPENING AREAS (MINE FIELDS) DEPOSITS BAZHENOV RETINUE MINE SHAFTS AND THE PREPARATION OF MINING AND MINING BLOCKS (PILLARS) UNDERGROUND MINING AND PREPARATORY WORKINGS WITH THE SUBSEQUENT EXTRACTION OF TARGET PRODUCTS FROM THESE UNITS RESERVOIR INJECTION SYSTEMS-STIMULATING AND DRAINAGE (MINING) WELLS THAT ARE DRILLED MAINLY FROM UNDERGROUND MINES

UDC 622.276.5 + 622.297.5 (072.8)

KEYWORDS: *Bazhenov formation, stocks and oil resources, exploration and exploitation of deposits, technological approaches, mine-downhole technology, energy technology complexes.*

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In recent years, the volume of oil production in the Khanty-Mansiysk Autonomous Okrug, the main oil-producing region of West Siberia, is steadily decreasing. Where should we look for the reason that the success in the development of hard-to-recover hydrocarbon reserves from the Bazhenov formation rocks in West Siberia, despite the occasional "fanfares" and triumphal reports, still remains rather modest?

Effective technologies are a key factor in the development of hard-to-recover reserves (HRR), tax benefits are an important motivation mechanism. But the discussion of benefits, which is very popular today, should not overshadow the need for technology development, otherwise the benefits themselves become senseless. It is needless to say that it's being written and spoken many times today along with representatives of the authorities about these tax benefits for the development of HRR and the need to develop new oil and gas fields. But traditionally this speaking and writing do not come at all to the creation of a national powerful technological basis for the HHR development, as well as of effective subsurface resources management in general. Therefore, so that providing any benefits [1] did not lose its meaning and that the call to action was really meaningful, and was not a mere sound, in order to solve the problem it is extremely important to understand and find adequate answers both to the question "who (or what) is to blame?" and to the question "what to do?".

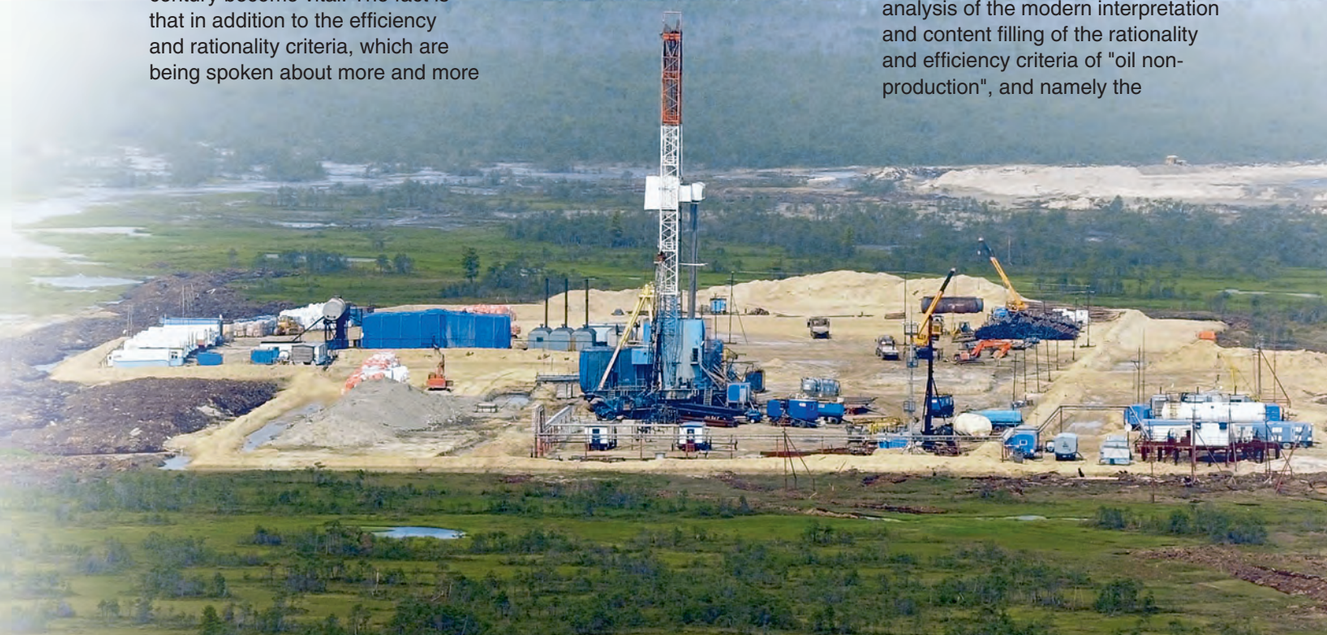
Recently, on the pages of the leading Oil & Gas scientific and technical magazines in Russia ("Oil Industry", "Subsurface Resources Management of the 21st century", "Georesources" and some others), there has been an intensive discussion on normative and methodological documents and criteria regulating Subsurface Resources Management in the sphere of oil & gas production [2]. Unfortunately, we have to state that this discussion, and even the Subsurface Resources Management itself, as some authors are stating (they say "we do not develop fields, we make oil"), has purely oil & gas [3, 4], i.e. to say, a narrow, industry-specific nature.

But in the 21st century, Subsurface Resources Management for Russia can no longer remain narrow, industry-specific or "privatized" by somebody, and the introduction of rationality criteria into use, along with traditional efficiency criteria, which are usually guided by oil and gas business, not only does not guarantee taking of decisions based on social goals and interests, but also enters into a clear contradiction with them, preventing in fact both a professional scientific discussion in this field, and simply conserves many weaknesses and gaps of modern oil & gas production.

Needless to say that not only the innovative character and complexity of the exploration and operation (exploitation) of oil & gas fields, but also the socially-oriented Subsurface Resources Management for Russia in the 21st century become vital. The fact is that in addition to the efficiency and rationality criteria, which are being spoken about more and more often as about something quasi innovative in the exploration and operation of oil & gas fields, we must not forget that these criteria (concepts) themselves have always existed and will take place in the world around us, having at the same time, at each current moment of our life, this or that specific content and filling. And in no case should we ignore that enormous historical experience accumulated by mankind on the whole in the mining business, which is the industrial basis of subsurface resources management. Furthermore, it should also be borne in mind that the development of scientific and technological progress (or in a larger time span – the technological order) depends not only on the goal-setting and the achieved level of excellence, but also has its own internal logics and development tendencies ("To the Future through Experience of the past " – Zakirov S.N. [5]).

For many years now, oil production prospects in Russia have been linked to the need to ensure the rationality and efficiency of the development and commercial exploitation of the Bazhenov formation rocks in West Siberia, as the main oil-and-gas bearing province for the country. A attentive reader, of course, will notice that we have just confused (in comparison with the generally accepted approach today) criteria of efficiency and rationality. But we did it quite on purpose, having in mind those tendencies and priorities that are being established in Russia today, both at the legislative level (Federal laws in the field of subsurface resources management, the Energy Strategy, sectorial General Development Schemes, etc.), and at a corporate policy of the main subsurface resources users – oil and gas producing companies of the country. The problem of the rationality of the development of the Bazhenov deposits, formally speaking, is not even discussed, while remaining, as it seems to us, far from being the first in the list of current priorities, as evidenced, in particular, by the progress neither good nor bad in creation of the "Bazhenov" scientific facility. We can't help speaking without a big share of skepticism about the efficiency of the oil production development from the Bazhenov formation, which possesses the properties of many other oil and gas bearing shale deposits known in the world, and about the creation of truly breakthrough technologies for the exploration and exploitation of this huge storage of hydrocarbon (and not only) raw materials.

Without going into a more detailed analysis of the modern interpretation and content filling of the rationality and efficiency criteria of "oil non-production", and namely the



exploration and operation of oil and gas fields, we should note that today the ecological component of subsurface resources management is becoming more and more significant in this problem. Without effective solutions to specifically the environmental challenges arising from the large-scale operation of the Bazhenov deposits, it is hardly possible to talk about the future rationality and efficiency of oil production in West Siberia.

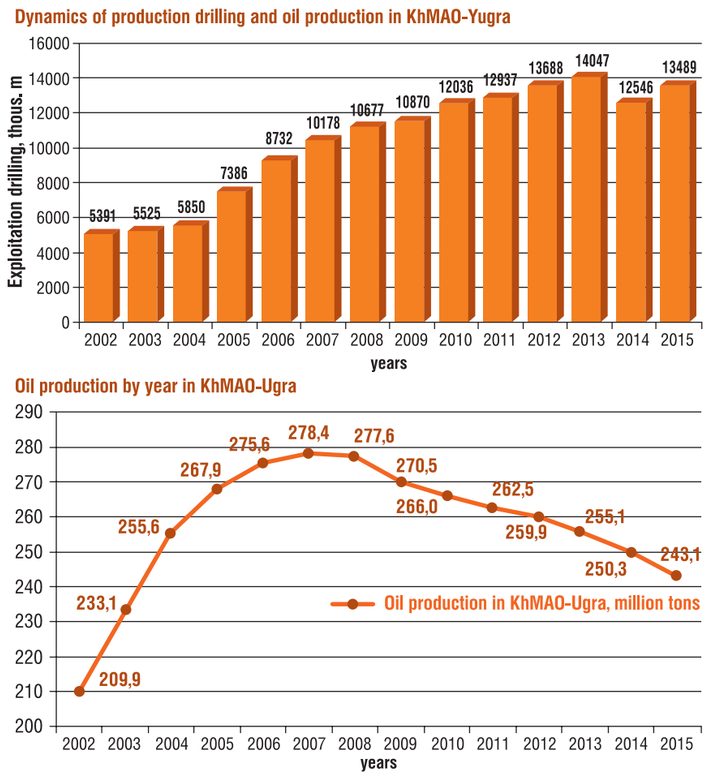
There is a legend that, at the very dawn of the oil era, the famous Colonel Drake at the beginning of the black (oil) fever in Pennsylvania in the middle of the 19th century, in contrast to the underground mining method, which at that time dominated in mining industry (first of all, of course, during the extraction of coal and iron ore) said that "oil should be drilled". And we must clearly recognize the fact that today, i.e., more than 150 years later, the technology of development and production of hydrocarbons by drilling boreholes from the surface of the mother Earth triumphantly marches not only across all continents, but also submerges deeper and deeper from the sea bottom into the oil-and-gas bearing (productive) layers from offshore structures and oil production platforms of all sorts (some behemoth and some rather expensive), down to the placement on the seabed of drilling and production complexes situated under the ice and under water in the Arctic Ocean, which has not yet been reached by this ever present borehole massively

The success of the method (technology) without using mines of development and production of oil and gas by boreholes that are drilled from the surface is so great and impressive that today many and many professionals working in the oil and gas industry do not even imagine that this approach may not be suitable for meeting of new challenges emerging in the oil and gas production. Moreover, it is these purely downhole technologies that made it possible to implement the so-called shale revolution, which became one of the reasons that the world energy market in recent years was literally flooded with the flow of oil and gas from seemingly unthinkable sources and resources, such as the deposits of shale and other solid impermeable rocks.

There was an almost insurmountable stereotype stating that it is this technological method or approach and further improvement of the traditional downhole technology for the exploration and operation of hydrocarbon fields that must be almost the only one and decisive when developing of the Bazhenov formation, to which we still refer many hopes, which are still waited to come true, for the stabilization and development of oil production in West Siberia, which has become a quite successful part of Russia with developed infrastructure, despite the very difficult climatic conditions and features of the region. Therefore quite natural questions arise : So what's the problem? Are the capabilities of the traditional downhole technology of hydrocarbon production comprehensive and universal, and its further improvement and development itself should be the basis for the works on the development of the Bazhenov formation? We do not pretend to any absolute indisputability of our judgments, and in our opinion, therefore, it is obvious that the search for answers to these difficult questions must lie first of all in the plane of (let us say so) of two basic and at the same time indisputable facts or dimensions, and namely: Directly in the essence and peculiarities of the most traditional well oil and gas production technology and, on the other hand, in the Bazhenov formation rocks, as a source and a peculiar storage of hydrocarbons.

At the beginning of the era of hydrocarbons, it was enough to choose the right location for laying

FIGURE 1. Dynamics of production drilling and oil production in KhMAO-Yugra



the oil borehole, and after drilling it with minimum costs to get a fountain of oil in order to think that the job was done or, in modern terms, to say that the field was developed and put into operation. Judging even by a number of television messages from the federal channels in recent times, we have to (and it is not surprising) recognize that precisely this principle today is largely prevalent in the activity of all or almost all subsurface resources users, by the way, almost regardless of their size or economic importance, who operated, are operating or come to operate in West Siberia.

However, the inferiority of such a principle of subsurface resources use in this oil and gas production region in the future is proved by the fact that, as the long-term practice shows, the exploration and operation of oil and gas fields here is extended into many stages and phases, called the trial, pilot production, the first stage, the second stage, early, stable, late, final or some other stage. So according to some data, for example, on the Salym oil field in the Khanty-Mansiysk Autonomous Okrug-Ugra it was in 1967 when the first oil flows were obtained even from deposits of the Bazhenov Formation. Sometimes, under a loud roll of drums, the entire "universe" is informed about the allegedly already existing revolutionary achievements and abilities of traditional downhole technology together with the technology of processing ASP productive layers to revitalize the entire hydrocarbonic West Siberia. At the same time, however, they don't say that for this very ASP technology we will need to import anion active surfactant from America, and to buy polymers from France (if they sell, of course), not to mention other difficulties of this basically traditional technological approach. There are also persistent attempts to "justify" the technology of "multi-stage" purely well exploration and operation (exploitation) of oil and gas fields, including even the highest scientific level, [6], for example, while any attempts to formulate any alternative and really unconventional methods, to put it mildly, are nearly not discussed and dismissed, as they say, "right out of the gate". In the end, this leads to the fact that such an important indicator of the efficiency of oil production and subsurface resources management in fact for the whole of West Siberia as an oil recovery factor (ORF), even in deposits with traditional reservoirs for the upper oil and gas bearing horizon (Cenomanian deposits at a depth of about 1000 m) today is at a level (let us say so) of miserable 20–30%.

Moreover, the traditional downhole technology has a severe impact on the environment during the exploration and exploitation of oil fields in West Siberia, which is a very marshy lowland with a transition to the tundra in the north, because in the course of development of deposits, a huge amount of work is necessary to lay and fill off infield roads, to construct earthfill structures for the construction of wells and cluster pads, as well as other oilfield facilities. It is enough to look, for example, at the "current" situation with the once legendary Samotlor, which has actually entered the final stage of exploitation and the ecological "delights" of traditional exploration and operation of which are especially clearly visible in the pictures "from above" (Figure 2).

In general, as the real oil production practice shows, even in the conventional (traditional) oil fields of the Khanty-Mansiysk Autonomous Okrug-Yugra, which remains the main oil producing region in the country, the traditional downhole technology of oil production, despite the significant growth in the volume of drilling works in the okrug in recent years and application of widely advertised by subsurface resources user companies of hydraulic fracturing, sidetracking and the construction of so-called horizontal wells to improve oil recovery, etc., there is a steady decline in overall oil production in this region.

The large-scale and effective development of the Bazhenov formation deposits, the necessity of which is recognized by almost everyone today, is designed to provide a solution not only to the problem of "oil production", but also has the most important social significance, not only for West Siberia itself, but for the whole economy of the country, and turning this oil and gas province into a giant experimental and industrial site for developing technologies for innovative complex exploration and exploitation of deposits should in fact rather than in word be socially-oriented and fully respond

FIGURE 2. Panoramic photos of the exploration and exploitation of the legendary Samotlor

to the challenges of the subsurface resources management of the 21st century.

A complex of geophysical studies conducted in recent years in the Center of Oil and Gas Technologies at the Lomonosov Moscow State University, . and in a number of other scientific research organizations [7-9], shows that the algorithms and methods of volumetric data for the Bazhenov formation should provide for the possibility of determining of not only the volumes of movable oil V1, the volumes of released oil – V2, but also the volume of so-called oil-generating potential V3. Here, rightfully, it is pointed out that the Bazhenov formation on the whole is such an unconventional facility for the exploration and operation that for it there are virtually no:

- concept of "deposit" with its indispensable attributes – oil-water contact, external and internal circuits, a transition zone, a zone of extreme oil saturation, etc.;
- concept of a collector / non-collector in terms of the boundary values of the porosity and permeability of the productive layer.

Against this background, we propose the following (let us note, it's as it were the only one or self-evident) concept of the exploration and exploitation of the Bazhenov Formation in West Siberia, which is summarized briefly in the following. First, we forecast and allocate zones of the area differential productivity by counting and estimating the oil resource base of the Bazhenov formation for several types of volumes:

- in terms of movable oil volume, including reserves and resources of the first type. It is proposed to refer to the reserves the volume of movable oil, the inflows of which can be obtained as a result of testing or experimental operation without special impact on the productive layer. The resources of the first type are proposed to include volumes of movable oil, additional inflows of which can be obtained from layers of technically stimulated "collectors" of the formation with the implementation of geological and technological activities (GTA);
- in terms of released oil volume (resources of the second type) – are occluded hydrocarbons and free oil sealed thereby;
- in terms of the volume of "synthetic" oil (residual generation potential), which is the volume of oil that can be obtained from the kerogen shale destruction (resources of the third type).

Secondly, there are areas (zones) allocated that are the most and least promising for production drilling with use of existing oil production technologies. The areas with the highest expected productivity are recommended for the development first, and zones with the least productivity are recommended for the development after the creation and improvement of technologies for the production of bound hydrocarbon compounds and oil from closed pores. For the zones with a high residual generation potential of organic substances and a large volume of physically bound hydrocarbon compounds, new methods of obtaining oil must be developed.

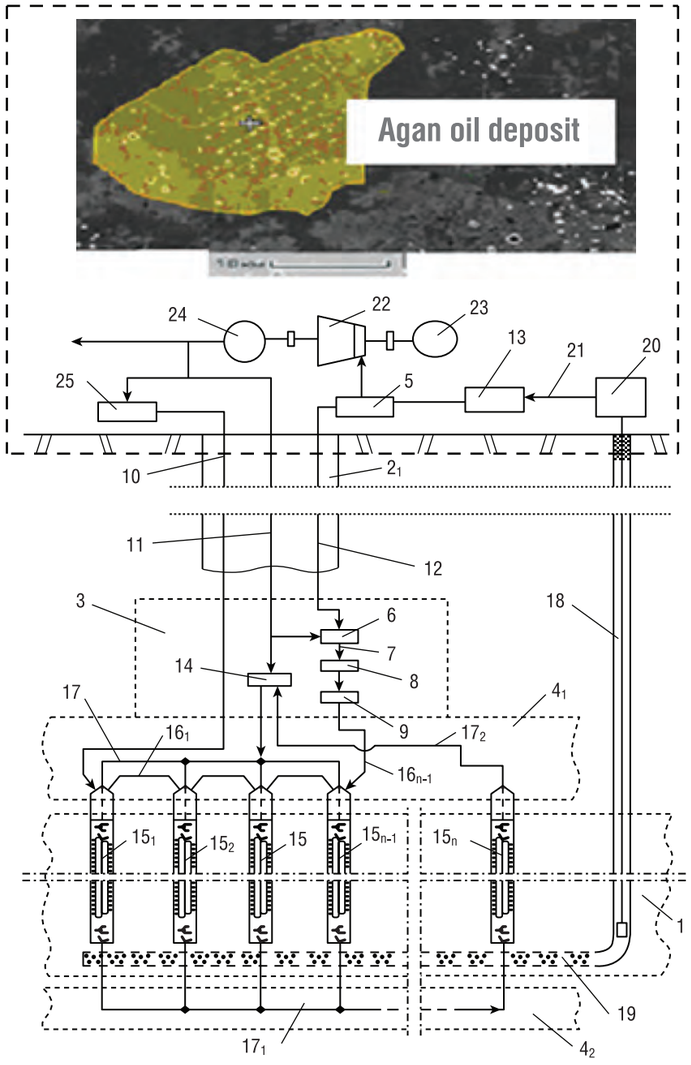
However, the adoption of this concept of exploration and exploitation of hydrocarbons of the Bazhenov formation in West Siberia, and many other deposits and sources of unconventional hydrocarbons in other regions of the Russian Federation, not only faces great difficulties of purely economic nature, but (more importantly) will in fact conserve with the negative effect the technological disadvantages which are inherent in traditional (existing) technologies of exploration and exploitation of hydrocarbon deposits and in integrated development and use of mineral resources in general.

In fact, as we see, we propose a method or a technological approach to the exploration and operation of the Bazhenov formation, which not so long ago we called "imperialistic or predatory" way of exploiting mineral deposits, which involves searching for and taking off the most "delicious" pieces of the pie in the form of so-called reserves (of movable oil) and the orientation to the fact that, perhaps someone and sometime in the future will produce from this very formation not less than 70% of the remaining hydrocarbons in the form of resources and generation potential. Because of the much greater depth of the Bazhenov horizon, the features and complexity of the void space of the productive layer, the increased clay content and (as a result) high hydrophobicity, and the presence of a number of other complicating factors and the distinctive features of the rocks of this formation, this is hardly possible in principle. Let us take, for example, the same hydraulic fracturing as some panacea or one of the "blue chips" of the shale revolution, which even today someone calls a "bubble which is just about to collapse". On the one hand, as stated in [7], in the investigated regions the geochemical parameters in the sediments of the Bazhenov formation are more or less evenly distributed, which is connected with "mono-facial relatively deep-water sedimentation conditions in the Bazhenov time". This in itself makes very doubtful attempts to search for industrial clusters of light movable oil. On the other hand, attempts to artificially increase (by hydraulic fracturing) the porosity and permeability will be no less illusive. The fact is that the porous space of the productive layer of the formation, as shown in the mentioned papers, contains: "open, connecting pores filled with movable oil; closed pores filled with free oil; occluded hydrocarbon compounds on the surface of pores, water occluded on the surface of clay minerals and hydrophilic capillaries", and in general the rocks of Bazhenov deposits have an increased content of kerogen. In addition, the productive layer itself has not only a relatively small capacity, but it has also a complicated structure. In these conditions, the possibility to create highly efficient injection-stimulating and drainage systems in a deep-lying productive layer by drilling downholes from the surface of the earth, and simply the performance of hydraulic fracturing and the increase in the well coverage ratio become very, very illusive.

At the same time, as our studies and developments show [10–13], and so does the entire mining development history, today there is every reason to say that there are possibilities to use other approaches to the exploration and exploitation of the deposits of the Bazhenov formation, and not just alternative to the traditional ones described above – purely downhole approach, but also approaches that integrate the world experience and the opportunities of all the mining technologies that have been mastered and operated in the mining, including, of course, modern (traditional) downhole methods of exploration and operation of hydrocarbon deposits.

We are talking about the so-called mine-downhole technologies and approaches to the exploration and exploitation of layer deposits and mineral deposits that provide an innovative level and not in words, but in practice of an integrated approach to the involvement in the development of hard-to-recover oil and gas reserves and resources, among which of course, there are deposits of the Bazhenov Formation in West Siberia and many deposits of high-viscosity, bitumen and so-called "immature" oil in the Volga region. The basic conceptual and methodological provision (system-technological approach) of such an innovative approach is the following principle: Opening and preparation for the development of productive layers is carried out with the help of mine shafts and underground mining development, and extraction of target products from productive layers of oil and gas bearing deposits is carried out by appropriately prepared extraction blocks – pillars with the help of the whole arsenal of modern downhole methods and technologies for providing oil recovery by drilling of stimulating and production downholes (and/or their systems) from underground mines.

FIGURE 3. Process flow chart of innovative mine-downhole "secondary" development of the Agan oil field in West Siberia [17]



In general, the basis for the proposed scientific methodological and truly innovative approach [14–17] is the need and the real possibility of creating highly productive and fully controlled drainage systems through mine opening of the productive layer and preparation of extraction blocks (sections) of the layer for the subsequent downhole production of hydrocarbons. The most important components of this approach are:

- development and use of energy-efficient, resource-saving and safe methods and technologies for causing an impact on productive layers;
- ensuring the full utilization and effective use of oil associated gases for the processes of hydrocarbon extraction from productive layers and production of electric power for

the energy supply of the created underground (mine-downhole) energy technology complexes, as well as the fullest and most comprehensive use of all components (parts) of downhole production;

- ensuring environmental friendliness, safety and reduction of the vulnerability of technology complexes and production in the exploration and exploitation of oil and gas reserves and resources in difficult conditions, regardless of their genetic origin, migration stages and paths, degree of mobility, bounding and maturity of hydrocarbons, which will determine for how long strategically the hydrocarbon energy industry will be able to retain its positions in the modern world;
- full orientation to the maximum to the most developed technologies and equipment of domestic production.

Strategically, it should also be recognized that it is mine-downhole technologies and underground energy technology complexes that, in principle, can effectively solve such a problem, which is crucial for many already seemingly fully developed oil fields with traditional oil (Figure 3), containing structurally not only significant volumes of residual and non-recoverable hydrocarbons by existing methods, but also productive layers with heavy and high viscosity oil, which in itself, in addition to the problem of development of Bazhenov formation, is also extremely important for the economy of West Siberia and the Volga region, and for the entire economy of the country. ●

Литература

1. *Federal Law "The Tax Code of the Russian Federation (part two)" dated 05.08.2000 No. 117 (as amended on 03.07.2016) (as amended and supplemented, effective from 01.10.2016).*
2. *Zakirov S.N., Zakirov E.S., Indrupsky I.M. On regulatory documents in the oil and gas subsurface resources management. – Oil Industry. – 2016, No. 10, p. 6–9.*
3. *Zakirov S.N. Hardly-recoverable oil reserves and the rationality criteria. – Georesources. – 2014, No. 4(59), p. 16–19.*
4. *Zakirov S.N. Subsurface resources management and morality are not divisible concepts. – Subsurface resources management of the XXI century. – 2010, No. 2, p. 73–76.*
5. *Zakirov S.N. To the Future through the Experience of the past. – Geology, geophysics and development of oil and gas fields. – 2002, No. 5, p. 64–66.*
6. *The method of development of the oil deposit in the sediments of the Bazhenov formation. Patent of the Russian Federation No. 2513963 dated 08.10.2012 – Patent holder – Federal State Budgetary Institution of Science Institute of Oil and Gas Problems of the Russian Academy of Sciences (IOGP RAS). Authors: Dmitrievsky A.N., Zakirov S.N., Zakirov E.S., Indrupsky I.M., Zakirov I.S., Anikeev D.P., Ibatullin R.R., Yakubson K.I.*
7. *Kostenko O.V. Blocker character of the distribution of high-molecular compounds of bitumen in the pore system of the Bazhenov Formation (West Siberian Basin). – Oil and gas geology. Theory and practice. – 2014. – V.9 – No. 1, p. 2–15.*
8. *Bilibin S.I., Dyakoova T.F., Isakova T.G., Yukanova E.A., Kalmykov G.A., Valova L.V., Ganichev D.I. Algorithms for determining the volumetric data of the deposits of the Bazhenov formation according to the Salym group of deposits. – Scientific and technical bulletin of NK Rosneft. – 2015, No. 2, p. 9–17.*
9. *Bilibin S.I., Valova L.V., Dyakonova T.F., Isakova T.G., Yukanova E.A., Polyakova Yu.V., Kalmykov G.A. Algorithms for determining the volumetric data and a methodology for estimating the movable reserves of V1 and resources V2 and V3 of the Bazhenov formation of the Salym group of deposits. – Geophysics. – 2015, No. 3, p. 37–50.*
10. *Afanasyev V.Ya., Ilyusha A.V., Linnik Yu.N., Linnik V.Yu. And Sherstkin V.V. Innovative mining and downhole technologies for the exploration and operation of shale oil reserves in West Siberia and the Volga region. – Electronic magazine "Technologies of hydrocarbon production and use". No. 1(5), 2015. – www.tp-ning.ru*
11. *Afanasyev V.Ya., Ilyusha A.V., Linnik Yu.N., Linnik V.Yu. And Sherstkin V.V. Innovative mining and downhole technologies for the exploration and operation of shale oil reserves in West Siberia and the Volga region. – Scientific and practical magazine "Coiled tubing time". – No. 3 (053), September 2015.*
12. *Ilyusha A.V., Afanasyev V.Ya., Linnik V.Yu., Sherstkin V.V., Korchak A.V., Rakhutin M.G., Kaverin A.A. Physical and technical basics and features of breakthrough mine-borehole technologies for recovering of hard-to-recover oil and increasing of oil recovery efficiency. – Electronic magazine "Technologies of hydrocarbon production and use". – No. 1(6), 2016. – www.tp-ning.ru*
13. *Ilyusha A.V., Afanasyev V.Ya., Linnik V.Yu., Sherstkin V.V., Korchak A.V., Rakhutin M.G., Kaverin A.A. Physical and technical basics and features of breakthrough mine-borehole technologies for recovering of hard-to-recover oil and increasing of oil recovery efficiency. – Scientific and practical magazine "Coiled tubing time". – No. 1 (059), March 2017.*
14. *Method of development of shale oil and gas bearing deposits and technological equipment complex for its implementation. – Patent of the Russian Federation No. 2547847 dated 20.02.2014. The patent holder is FSFEI HPE "State University of Management" (SUM). / Authors: Ilyusha A.V., Afanasyev V.Y., Votinov A.V., Godin V.V., Udut V.N., Zakharov V.N. Linnik Yu.N., Linnik V.Yu., Ambartsumyan G.L., Sherstkin V.V.*
15. *Method of mine-downhole production of shale oil and technological equipment complex for its implementation. – Patent of the Russian Federation No. 2574434 dated 23.12.2014. The patent holder is FSFEI HPE "State University of Management" (SUM). / Authors: Ilyusha A.V., Afanasyev V.Ya., Godin V.V., Zakharov V.N., Linnik V.Yu., Ambartsumyan G.L., Vorontsov N.V., Sherstkin V.V.*
16. *Method of mine-downhole production of hard-to-recover (bitumen) oil and technological equipment complex for its implementation. – Patent of the Russian Federation No. 2579061 dated 27.02.2015. The patent holder is FSFEI HPE "State University of Management" (SUM). / Authors: Ilyusha A.V., Afanasyev V.Ya., Godin V.V., Zakharov V.N., Linnik V.Yu., Ambartsumyan G.L., Vorontsov N.V., Sherstkin V.V.*
17. *Method of mine-downhole production of hard-to-recover oil and technological equipment complex for its implementation. – Patent of the Russian Federation No. 2593614 dated 14.05.2015. The patent holder is FSFEI HPE "State University of Management" (SUM). / Authors: Ilyusha A.V., Afanasyev V.Ya., Godin V.V., Zakharov V.N., Linnik V.Yu., Ambartsumyan G.L., Korchak A.V., Sherstkin V.V.*

ESTIMATION OF COMPLEX SPATIAL STRUCTURES OF PETROCHEMICAL EQUIPMENT FOR SEISMIC LOAD USING DIRECT DYNAMIC ANALYSIS

THE SIMPLIFIED LINEAR-SPECTRAL METHOD LIES IN THE BASIS OF THE STANDARD DESIGN OF PETROCHEMICAL EQUIPMENT FOR SEISMIC LOAD. ALTHOUGH THE SIMPLEST RESTRAINED BAR DIAGRAM WITH DISTRIBUTED MASSES IS USED IN THE ESTIMATION, THE METHOD REQUIRES TO DETERMINE THE VALUES OF NATURAL FREQUENCIES AND MODES OF OSCILLATION OF THE STRUCTURE, WHICH IS A DIFFICULT MATHEMATICAL PROBLEM. WHAT METHODS OF ESTIMATION OF COMPLEX SPATIAL STRUCTURES ARE USED BY MODERN COMPANIES?

UDC 665.6

KEYWORDS: *spatial structures, petrochemical equipment, the method of direct dynamic analysis, block system, heat exchanger.*

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The company HIMMASH-APPARAT CO., LTD is a team of like-minded people, whose joint work through the system of horizontal links allows to solve complex engineering problems. As a rule, by exercising the competence of the company in design, manufacture and supply of equipment, each participant of the process has the opportunity to realize his extensive knowledge on practical experience in the form of a specific product or installation.

The simplified linear-spectral method (LSM) lies in the basis of the regulatory design of petrochemical equipment for seismic load (LSM) – a method used to determine the seismic load using the response spectrum (SO,OSO, PSO). Although the simplest restrained bar diagram with distributed masses is used in the estimation, the method requires to determine the values of natural frequencies and modes of oscillation of the structure, which is a difficult mathematical problem.

The most accurate method is the method of direct dynamic analysis (MDA), which involves the numerical integration of the equations of motion of the system (the mathematical model of the object) with the seismic load specified by the accelerograms.

In the paper the calculations of the double heat exchangers are considered. They were carried out both within the limits of the standard approach (LSM), and within the limits of accurate approach (MDA), with use of a finite-element method.

In accordance with SNiP II-7-81*, according to the method, the estimated seismic load S_{ik} in the selected direction, applied to the point k and corresponding to the i-th tone of natural oscillations is determined by the formula:

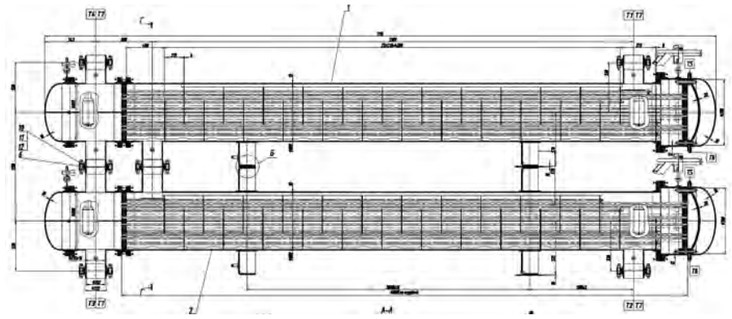
$$S_{ik} = K_1 S_{0ik}$$

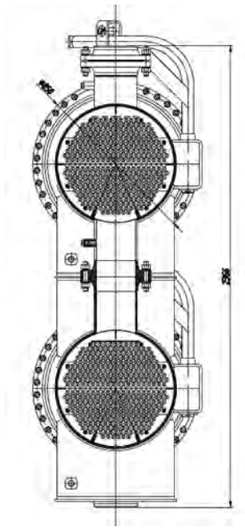
where: $K_1 = 0.25$ is the coefficient taking into account the permissible damage to buildings, S_{0ik} – is the value of the seismic load for the i-th tone of the natural oscillations, determined under the assumption of elastic deformation of the structures using the formula:

$$S_{oik} = Q_k A_c \beta_i K_w \eta_{ik},$$

β_i and K_w *are coefficients from SniP II-7-81*[1];* η_{ik} is a coefficient that depends on the shape of the deformation of the building or structure with its natural oscillations

FIG. 1. Drawing of a double heat exchanger





according to the i-th tone and the load location. η_{ik} – Matrix of modal masses:

$$\eta_{ik} = \frac{x_k \sum_{j=1}^{n} Q_j x_j}{\sum_{j=1}^{n} Q_j x_j^2},$$

$Q_j = Q_k$ – weight of the apparatus acting on the support, referred to the point k, which is determined with taking into consideration of design loads on the structure; x_k and x_j – distances from the points k and j to the upper cut of the foundations.

Calculation of the design on the basis of numerical modeling of the dynamic process of seismic stability by specifying the motion of the foundation supports according to the 8-point accelerogram

Estimated seismic impact at a random point of the estimated diagram is as follows:

$$S_{ik} = \frac{Q_k}{g} \eta_{ik} W_i(t)$$

Function, which is set in the form of full-scale (or synthesized) accelerograms.

$$W_i(t) = -\frac{2\pi}{T_i} \int_0^t \ddot{\Delta}(\tau) e^{-\frac{\gamma\pi}{T_i}} \sin\frac{2\pi}{T_i}(t-\tau)\, d\tau$$

In the estimation we used a synthesized 8-point accelerogram, provided by CNIISK:

FIG. 3. 8-point accelerogram

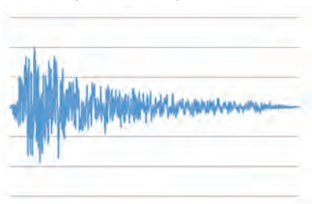
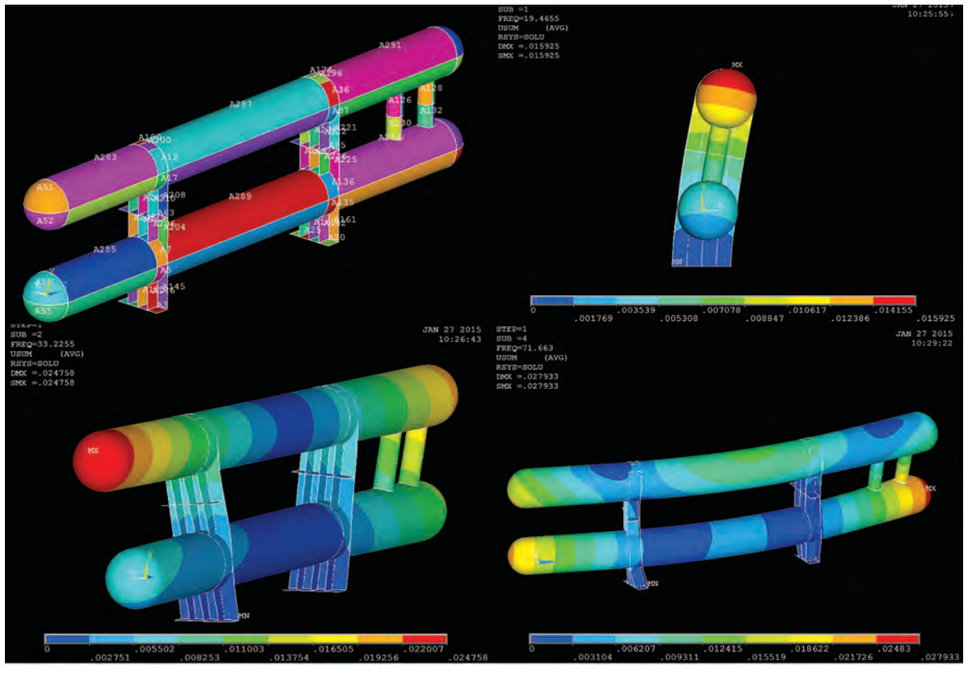


FIG. 2. Calculated design and oscillation modes



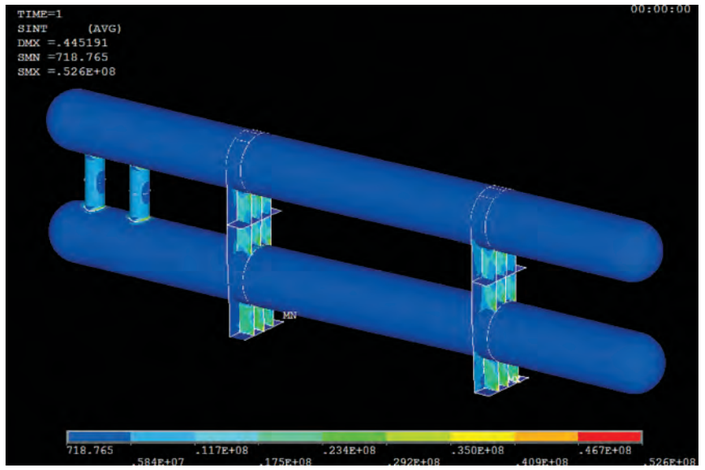
On the basis of an 8-point accelerogram, in the boundary conditions the motion of the foundation parts of the supports was set both in the horizontal direction along the axis of the heat exchanger and in the direction perpendicular thereto. In Fig. 4. stress fields in the structure are obtained.

The maximum voltage level reaches 52 MPa, which is less than the permissible voltage of 140 MPa.

Calculations by two methods – the approximate method – LCM and the accurate – dynamic method on the accelerogram – led to slightly different results.

At the beginning of the exposure, the solution by a dynamic method gives a maximum stress level of 52 MPa, which is less than the allowable voltage of 140 MPa, but exceeds the value obtained in the LCM of 12 MPa. I.e. the method of direct integration gives the higher values of the stresses in the structure.

FIG. 4. Stress fields after 1 second of exposure



As the above calculation shows, the double heat exchanger meets the strength requirements for seismic load with an intensity of 8 points.

HIMMASH-APPARAT CO., LTD has the necessary experience and possibilities of estimation, manufacture and delivery of complex equipment, the developed devices and block systems are successfully operated in industrial plants of many oil refining and chemical plants in Russia.

The design capacities of the enterprise allow the development of the main sections of the design and working documentation of newly constructed facilities and complexes, documentation for technical re-equipment, design documentation.

Own scientific and engineering base allows to solve the problems on the development of new effective design of apparatuses using mathematical modeling methods.

On the issues of development and ordering of equipment, you can contact by e-mail: **info@him-apparat.ru** and tel. **+7(495) 2-680-680** (multi-line). ●

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VENEZUELA'S SECRET PLOT TO SELL BANNED SYRIAN OIL IN THE US MARKET

Bloomberg

Ben Bartenstein

Syria and Venezuela plotted in recent years to evade international sanctions on Syria through a secret deal to transport its crude oil through Russia to the Caribbean. This

plan presupposed the sale of Syrian oil at a large discount to Venezuela through a Russian "gasket company" that would send oil to Aruba for processing and distribution at gas stations in the US and other countries. The scheme, which hasn't been executed, indicates the extent to which the two pariah nations are willing to go to evade international rules and antagonize global powers.

RUSSIA-SAUDI COLLABORATION MUST CONTINUE, SAYS ROSNEFT

FT FINANCIAL TIMES

Guy Chazan

Collaboration between the two largest world's oil producers, Russia and Saudi Arabia, must continue after the OPEC restrictions on production are over, in order to make the transition to a normal oil market, writes the Financial Times, citing the director of Rosneft. When speaking in Berlin, I. Sechin said that the two oil producers must discuss how to implement the "smooth transition" so that

"the market would not suffer." According to him, the supply of large volumes of oil to the market can lead to such volatility, which will strike the consumers. Sechin, a long-time ally of President Vladimir Putin, was traditionally skeptical about OPEC and argued that Russia should adhere to its own strategy and protect its market share. But over the past year, he changed his mind. ●

UNITING FOR COMMON GOALS

SWISS CONCERN PHOENIX MECANO AG OFFICIALLY OPENED PHOENIX MECANO LLC IN RUSSIA. THIS EVENT MARKED UNITING OF REPRESENTATION OFFICES OF COMPANIES ROSE SYSTEMTECHNIK, THE LEADING WORLD PRODUCER OF EXPLOSION-PROOF EQUIPMENT, AND BOPLA ENCLOSURE SYSTEMS, THE MANUFACTURER OF HULL SYSTEMS FOR ELECTRONICS AND INSTRUMENTATION

KEYWORDS: *explosion-proof equipment, hull systems, electronics, oil and gas, instrumentation.*

Alexey Potrebchuk,
Head of the commercial department,
Phoenix Mecano LLC

On April 5, 2017, the solemn opening of Phoenix Mecano LLC, which was founded by the Swiss concern PHOENIX MECANO AG took place. This event marked uniting of the representation office of the company ROSE Systemtechnik, the world's leading manufacturer of explosion-proof equipment, which this year celebrates the 10th anniversary of successful operation in the markets of Russia, CIS countries and former Soviet republics, with a very young representative office of the company “BOPLA Enclosure Systems, the manufacturer of hull systems for electronics and instrumentation.

Phoenix Mecano AG, Switzerland (Phoenix Mecano AG) is an international group of companies, the world leader in manufacturing hulls and electronic components, the competitive advantage of which is based on specialized knowledge and experience, as well as on the use of modern production equipment and advanced technologies.

While opening in Russia Phoenix Mecano LLC, we think primarily about the quality of our relations with the partners and customers and strive to meet the current needs of the Russian market not only in the quality of the supplied equipment meeting the highest international standards, but also thanks to convenient and reliable service, the implementation of non-standard tasks, development of customized solutions, as well as an efficient logistics system and high speed of order processing.

Active support and further development of relations with partners of the companies ROSE Systemtechnik” and BOPLA Enclosure Systems as one of the priority tasks of the company Phoenix Mecano includes:

- representation of interests of companies ROSE Systemtechnik and BOPLA Enclosure Systems in the markets of Russia and CIS countries, promotion of existing products of companies and launching new products and developments of plants;
- opening of new production capacities and expansion of warehouse in Russia with the possibility of automated data access on the availability of equipment;
- provision of special working conditions to distributors and other loyal partners of the company.

On behalf of the companies ROSE Systemtechnik and BOPLA Enclosure Systems we express our sincere and deep gratitude to our partners for fruitful cooperation and their contribution to our joint activities and we hope that in the future our joint work will reach an even higher level and will be marked by a number of new joint achievements and victories, and our mutual relations will fully meet our mutual interests.

ROSE и BOPLA

20 years of the presence of ROSE and BOPLA products in the markets of Russia and CIS countries;

More than **1,000** professional employees all around the world;

More than **15** plants around the world;

More than **15,000** nomenclature positions;

More than **1,000** projects successfully implemented in Russia and CIS countries over the past 10 years

The company ROSE Systemtechnik was founded in Germany in 1969, it is a part of the Swiss concern Phoenix Mecano AG and since 2017 has been manufacturing and assembling finished products in the Russian Federation under the name of Phoenix Mecano LLC in addition to the already existing 15 plants of the company.

One of the main directions of the company's production is the manufacture of explosion-proof hulls. Explosion-proof (Ex e, Ex ia, Ex d) terminal boxes, button remote panels, control posts and cabinets made of aluminum, polyester and stainless steel have been in operation for many decades throughout the world, meeting the highest quality requirements and proving their reliability when used in hazardous areas, aggressive chemical environments, arctic conditions (up to minus 60°C) and at tropical temperatures (up to +135°C).

The range of standard general industrial enclosures of the company ROSE Systemtechnik includes:

- enclosures for industrial gauges;
- enclosures for electronic components and instruments;
- enclosures for fire fighting equipment;
- enclosures for data recorders, measuring instruments and automation tasks;
- enclosures for compact and built-in control devices, instrument mounting systems and mobile stands;
- stainless steel hulls (Commander control systems, etc.);
- electromechanical components (cable entries, membrane keypads, terminals, etc.).

All products are accompanied by mandatory certificates of conformity (ATEX, GOST R, Certificate of compliance with requirements of the Customs Union Technical Regulations 012/2011, Approval of the Russian Maritime Register of Shipping). In 2011 and 2015 equipment manufactured by “ROSE Systemtechnik” has successfully passed all the necessary tests for compliance with the Federal standards of industrial safety and operating conditions at the facilities of JSC GAZPROM.

For today the company ROSE Systemtechnik” implemented projects following the orders of the largest oil and gas and petrochemical industries in Russia, in particular, Yamal SPG (PJSC Novatek), arrangement of the Kharyaga oil field (Total S.A.), reconstruction of the Ufa Refinery (PJSC ANK Bashneft), reconstruction of Kuibyshevsky and Novokuybyshevsky Refinery (PJSC Oil Company Rosneft), JSC Achinsk Oil Refinery VNK (PJSC Oil Company Rosneft), Kurgankhimmash LLC,

TAF project (JSC Ammony), JSC Gazpromneft-Omsk Refinery, LLC RN-Tuapse Refinery (PJSC Oil Company Rosneft), the Sakhalin-2 project (PJSC Gazprom) and many others.

The company BOPLA Enclosure Systems, founded in Germany in 1970 and being part of the Swiss concern Phoenix Mecano AG, specializes in the development and production of high-quality hull products for electronics and instrumentation. The company delivers standard products, as well as carries out the development and implementation of customized solutions for high-tech equipment for various areas of production.

Directions of production of the company BOPLA Enclosure Systems are as follows:

- enclosures for manual control devices;
- wall hulls for meters, data recorders and other purposes;
- desktop hulls for laboratory equipment;
- 19-inch constructs and a wide range of components for them (telecommunication equipment, equipment for railway);
- hulls for the support bar designed for the production of various kinds of controllers;
- standard enclosures made of aluminum, polyester, polycarbonate, ABS-plastic, polystyrene and polyamide;
- electromechanical components (cable entries, membrane keypads, etc.).

The products of the company BOPLA Enclosure Systems are operated all over the world, satisfying the highest international standards and proving their reliability when used in aggressive chemical environments and at the widest temperature range. Applications range from sterile medical laboratories to oil refineries and mining equipment.

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BUSINESS-ACCENT

URALMASH OGE HOLDING:

WE HAVE LONG BEEN READY FOR EXPLORATION OF EASTERN SIBERIA

Yuri Anatolievich Karpov,
General Director of
Uralmash OGE Holding LLC

URALMASH OGE HOLDING IS A LEADING RUSSIAN PRODUCER OF DRILLING RIGS FOR EXPLOITATION AND DEEP EXPLORATION DRILLING WHOSE MAIN TASK IS TO MEET THE NEEDS OF THE RUSSIAN OIL AND GAS INDUSTRY IN DRILLING EQUIPMENT TAKING INTO ACCOUNT THE MOST STRINGENT REQUIREMENTS TO QUALITY, DELIVERY DATES AND MAINTENANCE SERVICE. WITH ACTIVE ASSISTANCE OF THE STRATEGIC PARTNER OF THE HOLDING – GAZPROMBANK, THE COMPANY IS IMPLEMENTING A LARGE-SCALE PROGRAM OF MODERNIZATION OF PRODUCTION FACILITIES AND ENGINEERING. THE GENERAL DIRECTOR OF THE HOLDING YURI KARPOV TELLS ABOUT THE CURRENT DEVELOPMENT AND FUTURE PROSPECTS

KEYWORDS: *drilling equipment, drilling rigs, drilling, import substitution, metal, components.*

– Yuri Anatolievich, how was your company being established?

Uralmash Oil and Gas Equipment Holding was established in November 2010. It combined design and production facilities for the production of drilling equipment of Machine Building Corporation Uralmash, CJSC and Uralmash-Drilling Equipment, CJSC (URBO). At the same time, Uralmash-Techservice, CJSC and the separate division Uralmash-Engineering, LLC previously being part of the OMZ Group (United Heavy Machinery Plants), were included in the Holding. In 2013, Neftemash Plant, OJSC, BKU Plant, OJSC (Plant of Block-Complete Devices) and Neftegazengineering, LLC were integrated into the structure of UOGEH.

– Is there a link between the Holding and the heavy machinery corporation Uralmash?

– Uralmash OGE Holding is a completely independent economic entity not related to MK Uralmash, Uralmashzavod, PJSC or OMZ Group. The common shareholder Gazprombank is the only thing that unites us today. Moreover, we closely cooperate with these associations as part of production cooperation. For example, OMZ Group supplies steel castings and metal billets to us, and we cooperate with Uralmashzavod PJSC on drilling pumps and metal machining.

Meanwhile, “Uralmash” became part of our holding’s name not by chance. Historically there were two main enterprises producing drilling equipment in the Soviet Union: Uralmashzavod and Volgograd Drilling Equipment Plant (VZBT). In due time, Uralmashzavod had allocated its manufacture of drilling equipment into a separate structure - URBO. For a long time, URBO has remained a subdivision of Uralmashzavod, but then the company was purchased by the oil service company Integra. When Uralmashzavod fell under Gazprombank's control, the new shareholder decided to revive the production of drilling equipment. Therefore, in 2010, URBO was purchased from Integra and combined with those “drilling“ design units that remained at Uralmashzavod based on a specially created holding. "Uralmash" was left in the name of the holding because this production association had been the main one in our country to produce drilling rigs and supply them both to the internal market and for export since 1945. Understandably, in those markets where we work today, this brand is still perfectly recognizable. Accordingly, Gazprombank decided to consolidate and develop its "drilling" business based on Uralmash OGE Holding, LLC.

By the way, our holding has also integrated some assets of the above mentioned VZBT that has gone into liquidation, at least in its previous capacity.

– What is Uralmash OGE Holding like today, and what helps it maintain leadership at the drilling equipment market?

– We are a leading company in Russia for the production of drilling equipment. We produce drilling rigs and almost the entire range of components to them. Currently, about 3 thousand people work in our holding. The structure of Uralmash OGE Holding includes three production sites. The first one is the URBO plant in Yekaterinburg where a little more than one thousand people work. It produces about 7 thousand tons of metal a year. The enterprise produces high-tech equipment - drilling pumps and winches, top drives, hoist systems and rotors. That is, all that drives the rigs into action.

FACTS

50

drilling devices of different class per year is that indicator, which is planned to be achieved by the Holding’s power capacity in pursuance with production strategies

4 billion

rubles is an amount of implemented investment program

Since 2008

the average depth of new wells has increased by 10%

To date, Gazprombank has invested most of its investments into this plant. Here, powerful metalworking complexes have already been built based on imported - Japanese, South Korean and German – equipment. However, URBO modernization and development keeps up.

The second site is located in Tyumen – it is the BKU Plant, which Uralmash OGE Holding acquired in 2012. Today, about one thousand people work here as well. The plant specializes mainly in the production of welded metal. It performs welding of drilling rigs, circulation systems, stairs, platforms, and so on. So far, the enterprise produces 14 thousand tons of metal a year. But this year, we expect to complete its modernization, after which the production capacity will reach 22 thousand tons of metal a year.

The third site is located in Otradnoye of Samara region - this is the Neftemash Plant, which Uralmash OGE Holding acquired in 2012. The company employs about 400 people. It produces a little more than 3 thousand tons of metal annually. At Neftemash, modernizationis also under way, after which the production capacity shall reach 5 thousand tons a year. It, like BKU, mainly produces welded metal and circulation systems. Moreover, the productions of mechanisms such as screw conveyors and high-pressure cranes operate. The only thing we do not do at Neftemash is we do not weld drilling rigs. This is done only at URBO and at BKU. In addition to the three listed production sites, we have the service company Uralmash-Techservice where about 250 people work. This is our one-hundred-percent "subsidiary", which provides full service support for drilling rigs, both of our production and any other. It also repairs top drives, both domestic and imported ones - Varco, Tesco, Bentec and others.

Today, most customers request us not only to ship a drilling rig but to bring it to the drilling point, mount it, start it up and deliver it on turnkey basis. Therefore, our logistics service is engaged in shipment and delivery of drilling rigs, and Uralmash-Techservice receives, assembles, starts and services them.

This enterprise is engaged in repair of drilling equipment on our Yekaterinburg industrial site. We also possess one of the most powerful "drilling" design bureaus not only in Russia, but also in the world. Comparing Uralmash OGE Holding, let's say, with the Chinese oil equipment company Honghua Group Limited or American National Oilwell Varco, we employ approximately the same number of designers. There are around 350 people in our holding.

FACTS

About
22 %
is a growth of volumes of the market of nodes and STA (spare parts, tools and accessories) for drilling equipment since 2012

85 %
is a share of own production of Uralmash OGE Holding LLC at the present moment

Two design divisions function in the structure of Uralmash OGE Holding, LLC – in a Yekaterinburg branch and in the Neftegazengineering branch in Volgograd. The Yekaterinburg branch employs the former team of "drilling" designers of Uralmash. In the Volgograd branch – the team of recently liquidated VZBT. By the way, let me remind you that in Soviet times, Uralmash was engaged in heavy drilling rigs – of 200 tons to 700 tons class, and VZBT dealt with light installations. Accordingly, even today, our designers in Volgograd mainly design mobile drilling rigs, and in Yekaterinburg - heavier machines.

– How wide is the product and service range of Uralmash OGE Holding?

– Our performance capabilities allow us to design and produce land-based drilling rigs of all types, a wide range of block-complete oil and gas equipment, as well as to provide a full range of services. In particular, we make mobile units of 160 tons to 200 tons class, both on semitrailers and self-propelled ones. We supplied seven of such machines to Gazprom Drilling, LLC in 2013. We also produce cluster machines of 160 tons to 450 tons class, which move in the field from a well to a well on the rails drilling out cluster sites. The unique drilling rig "Yekaterina" belongs to this type of rigs; Gazprom ordered development and production of it by our enterprise in 2007 (not yet part of Uralmash OGE Holding then). We produced 11 such vehicles in a year then, nine of which were shipped to Bovanenkovo, two - to Urengoy. Today, they work in various parts of Russia including Chayanda in Yakutia.

– What is their uniqueness?

– The structure of these drilling rigs includes a cementing complex, which ensures well cementing while drilling. Our unique rigs also include the Arctic drilling rig - we made four of them for NOVATEK, PJSC and one - for the Integra Group. It is a block-modular installation whose working premises are completely hidden from wind, precipitation and frost and are heated from the inside with hot air. People can work on it in any weather condition wearing light clothes. Now, these rigs are used in Yamal at the South Tambey field and in Eastern Siberia at the Kuyumbinskoye field. In addition, we produce fixed machines of 200 tons to 700 tons class. Thus, we produce almost the entire range of land drilling rigs.

– How many ready-to-use drilling rigs can the Holding produce per year? And what is the total production capacity?

–Nowadays, our holding is able to provide about 40 drilling rigs annually in production because a drilling rig production cycle is about 9 months on average. Today, we produce about 30 ready-made machines a year, and in production, there are about forty of them each year.

– Who are the main customers?

– Taking last six years preceding 2015, Gazprom Drilling, LLC was our key customer, which had been part of Gazprom until 2011. And in 2015-2016, Rosneft, which we signed contracts for the supply of a total of 28 drilling rigs with, took its place in the order portfolio of Uralmash OGE Holding. Now, these orders have been fulfilled, and all the rigs shipped by us are in operation. Let me remind you that in the structure of Rosneft there is a specialized company RN-Drilling, LLC, which we mainly interact with.

The second and third positions after RN-Drilling, LLC is occupied by Surgutneftegaz and ERIELL. We supplied 11 drilling rigs to Surgutneftegaz just the year before last. All of them are in operation today.

– Are export work streams developing?

– We are actively engaged in foreign projects, but, unfortunately, it has not reached the supplies yet. For example, we had a project in Syria, as long ago as before the war. We practically created a joint company - we were going even to organize localization of our production in Homs. But the war began, and it became impossible.

We interacted very actively with Venezuela. For our part, we had it all worked out and prepared, but as soon as it came to financing, the process stopped. And in general, it is understandable why - the economic situation in this country is extremely difficult and it is only getting worse lately.

FACTS

3 thous
employees are working in the structure of Uralmash OGE Holding LLC

We have signed an Iranian contract for the supply of 12 fixed 450-ton class cars, but again, unfortunately, our Iranian partners would not solve the financing issue. Though, the design work for this order has long been completed by our designers.

So, we are actively heading the foreign direction, and we hope that we will be able to successfully enter the export markets soon.

– What regions do the supplies of Uralmash OGE Holding equipment mainly go to?

– So far, our main supply direction is Western Siberia. In particular, it includes the regions of Nefteyugansk and Nizhnevartovsk where Rosneft operates. Speaking about the shipments for Gazprom

projects, we have shipped two machines for oil-service company ERIELL near Urengoy this year. We expected there would be large drilling equipment orders as part of exploration of Eastern Siberia by Gazprom but, unfortunately, we do not see any big activity in this direction so far. Nevertheless, if it occurs, we have long been ready for it.

– Who are the main competitors of your Holding among the Russian and foreign companies?

– We do not have any serious competitors among domestic companies today. Of course, in the past 4 years, new manufacturers have entered the Russian market of complete drilling rigs, which were previously specialized in the production of separate units of drilling equipment. These are PG “Generation” (Bulanash Machine-Building Plant, JSC), USPK, CJSC (Ural-Siberian Industrial Company) and Kliver, LLC. On the other hand, our largest direct competitors - VZBT and GK "Kungur" (OJSC "Kungur Machine-Building Plant") went bankrupt in 2014–2015.

The Western manufacturers of drilling rigs, Bentec, Drillmec and others, primarily Americans, Germans and Italians, have occupied no more than 13% of the Russian market in the past 4 years. The Romanians who used to be one of the main foreign suppliers of drilling equipment to the USSR and Russia appear to have left the market of land installations. At least, I do not see them anywhere on tenders, in which we participate. Apparently, because the Romanian company Upetrom is currently focused on the development of offshore equipment.

Our main competitors in the Russian market are, as before, the Chinese manufacturers of drilling rigs, such as, for example, HongHua, HaiHua, RG Petro-Machinery and DFXK Petroleum Machinery.

– How big is the share of imported components in the products of the Holding? Are there any plans regarding import substitution?

– In monetary terms, the share of imported components in our products is around 25% now. This is mainly European, American and Chinese equipment. But not at all because we cannot do something in Russia. In fact, we produce drilling rigs in accordance with the technical requirements of the customer who often wants to have definite components of specific production in their rig. For example, cleaning systems, electric motors, drilling control systems, centrifugal pumps for pumping drilling mud. Therefore, there are aspects that do not depend on us here.

FACTS

9 months

this is an average complete production cycle of a drilling device

24 thous. tons

of metal constructions is generally produced by the industrial sites of Uralmash OGE Holding LLC

In spite of this, we are quite actively engaged in import substitution jointly with a number of domestic enterprises. And, I think, we will be able to produce a completely Russian car in 1.5-2 years. Thus, production of a domestic cleaning system has been launched at Russian plants - we have tested it, and now we will make procurements and install it on our basic drilling rigs.

Domestic electric motors of the main drives of drilling rigs were developed at Electroprom plant in Lysva and Snezhinsk Plant of Special Electric Machines. We have accepted the equipment of the first enterprise for testing, and drillers have tested the second one at Rosneft.

Until recently, we had to purchase the drilling winch control systems operated with joystick from the driller's cabin only by import from German Bentec. Today, similar domestic systems are developed and prepared for production by Start NPP named after A.I. Yaskin, Scientific and Production Association of Automatics named after academician N.A. Semikhatov and the Novosibirsk company "RosEngineering". We are currently conducting their industrial tests.

Alongside the creation of imported equipment analogs, we are actively engaged in the development and implementation of innovations. For example, the manufacture of a driller's cabin has been very costly for us until now. The thing is, it is located in the gas contamination zone at the drilling site, thus, all equipment in it is explosion-proof. As a rule, it is the most expensive. Just like, for example, an explosion-proof household computer will cost a sequence higher than a usual one. But we have found a way to avoid the need to use explosion-proof equipment in the driller's cabin. Boost air charging is arranged into the cabin, which would simply prevent the gas from entering it when leaving the cabin. As a result, the equipment may not be explosion-proof here.

– Do you embrace innovations?

– Of course. Now, for example, we are developing new generation drilling pumps. We have a very extensive research and development program. For instance, we have signed a protocol on cooperation with Gazprom Neft, within which we are engaged in the development of an upper drive for offshore drilling rigs, an automated wrench for unscrewing and screwing up of drilling pipes and of a new drilling pump as well. We have signed the relevant protocols with Gazpromneft-Sakhalin LLC, and established the working groups. So, we are actively working in this direction.

– How profound is the Holding’s cooperation with other Russian enterprises?

– The degree of cooperation with domestic enterprises declines with the development of our holding. While in 2011 the share of our own production was about 25%, it is about 85% today. Of course, sometimes we place large orders for cooperation. After all, there are different cases. For example, we can win several large contracts at once with the same delivery dates, but the production cycle of a drilling rig is nine months whether you want it or not. At the same time, it is senseless to increase our own production capacities dramatically, so that they do not become redundant.

However, there are areas of cooperation that we are interested to support and develop. Let's say, the same electricity, and the "brains of the rig" CTD (complete thyristor devices) and LCD (low-voltage complete devices) - this is traditionally our cooperation. All this is done by Russian companies.

By the way, most recently, we signed an agreement with German Siemens and Electroprom on cooperation in creating machinery for offshore drilling sites with the localization of Siemens production in St. Petersburg. This equipment may be used in land installations as well. We will give assignments to them, and they will develop and produce the equipment we need.

– What direction will your company develop in future?

– Our business strategy is obtaining the biggest possible market share.

FACTS

2

design offices operate in the structure of Uralmash OGE Holding LLC

Our production strategy is increasing the capacity of our facilities to the level of 50 drilling rigs of various classes per year. For this purpose, an investment program of about 4 billion rubles is being implemented. To date, we have already explored about 2.5 billion. I think that we will complete this process next year. This is extremely important, because you can not do what is done in the world without high-tech and high-precision machining equipment. For example, we were buying American, German and Canadian top drives, which could not be made by anyone here. Now, we have launched their production, and successfully supply them to the market. We are going to expand the line - today we are

into 320 tons class, and our goal is to master the drives of the classes above and below.

In the longer term, our strategy involves access to marine technology and offshore drilling market. For this purpose, a special design office has already been established in our holding. Conceptually, we are already ready for what will be required of us in this regards, which is confirmed, in particular, by Gazprom Fleet, LLC. If something will be needed additionally, then, most likely, this will be some occasional investments. For example, acquirement of a machine for processing a particular part.

– How, in your opinion, will the market situation develop? What are the prospects?

– Drilling, which we are engaged in, is very sensitive to world oil prices. When the price falls - the investment programs of our customers are cut back as well. And they, of course, primarily reduce the drilling volumes. Accordingly, purchases of drilling equipment fall. Therefore, making any predictions is a thankless task. But we can analyze the situation.

Experts predict that the decline in oil production in 2017 agreed with OPEC and other hydrocarbon producing countries will not have an impact on drilling volumes in Russia. Given the gradual decline in oil production in the first half of this year from 11.2 million to 10.9 million barrels per day, the total volume of oil production in 2017 will remain at the level of 2016 - about 546 million tons.

For example, in 2015, oil production in our country increased by 1.3%, and drilling by 10%, in 2016, the growth was 2% and 12%, respectively. Thus, Rosneft increased its hydrocarbon production by 4%, drilling by 35% in 2016. In turn, Surgutneftegaz increased its production by 0.2%, and drilling - by 7%.

Since 2018, the developers of Russian fields, where residual oil reserves exceed 150 million tons, and the degree of watering exceeds 90%, will receive tax benefits suggesting reduction in the mineral extraction tax (MET) by half. An obligatory condition for obtaining the benefits is the confirmed fact of drilling increase by three times. Accordingly, the companies developing the fields that meet these conditions will seek to increase the amount of footage.

If we forecast taking into account the rig fleet in Russia and its wear, our prospects are also quite good. Just a little more than a thousand drilling rigs are working in our country now. About 70% of them are physically and morally obsolete. Undoubtedly, their reconstruction and modernization is under way, but modern drilling standards and technologies dictate their complete replacement. It effects the speed and efficiency of penetration, the efficiency of mobilization of drilling equipment, and accordingly, the timing of well construction.

Suffice to say that today, we observe a trend of an increase in the average depth of new wells since 2008 by 10%, as well as a three-fold increase in the volume of horizontal drilling thenforth in Russia. This suggests a growing need to use new, heavier mobile drilling rigs with the carrying capacity of 200-250 tons, as well as fixed and cluster rigs with the carrying capacity of 250-400 tons.

Of course, not everyone can afford upgrading of the drilling fleet. Smaller players are forced to deal with repairs and modernization, since they simply do not have enough money to buy new equipment. Thus, since 2013 the volume of the Russian market of drilling rigs for production and deep exploration drilling has decreased by 40%, to the level of 2009-2011. On the other hand, there is an increase in the market volume of components and SPA (spare parts, tools and accessories) to drilling equipment - since 2012, the growth has been about 22%.

Today, only large companies can afford buying new drilling rigs, primarily such as Rosneft and Surgutneftegaz, which have their own drilling units. For example, Surgutneftegaz always, as soon as a crisis occurs, buys new drilling rigs. The drillers who work independently now feel more difficulties.

Meanwhile, the main prospects for the development of our holding are mainly due to the large-scale approach of domestic oil and gas companies to Eastern Siberia and the continental shelf of Russia. Therefore, planning our development, we are largely focused on the future needs of the Gazprom Group. ●

FACTS

In 2016

The "LEANiYA" project started in Gazpromneft-Khantos

5 thousand

of employees and working today in the SSC company, which has 7 divisions in the regions of the RF

WHAT Neftegaz.RU WROTE ABOUT 10 YEARS AGO…

Prime Minister of Norway is probing the sea for Norwegian companies

On June 7, 2007, the Prime Minister of Norway E.Stoltenberg arrived in Moscow as part of a five-day official visit to Russia. "The main attention will be paid to the issues of cooperation in the energy sector, the development of our relations in the Far North in the Barents Sea area and further deepening of them," the Norwegian Prime Minister said.

• Comment
Neftegaz.RU

Today, most European companies have scrapped to their projects in Russia, but Russian companies are showing an active interest in European oil and gas fields. In particular, to the Norwegian fields. So, Rosneft considers the Norwegian shelf as highly prospective for its participation in its development and plans to continue participating in new license rounds for the blocks on the Norwegian shelf for geological exploration (GE). Rosneft entered the Norwegian shelf in June 2013, having signed an agreement with Statoil and obtained a 20% stake in PL713 license, which includes 4 blocks on the Barents Sea shelf. In August 2014, Rosneft and Statoil began exploration on the Pingvin license block PL713, then the first exploratory borehole was drilled and a gas deposit with reserves of 7.8 bn m3 was discovered.

IEA predicts Russia's "end of oil" since 2010

On June 13, 2007, the International Energy Agency published a report according to which oil production in Russia will decrease and cease in 3 years.

Experts of the agency substantiate this conclusion by the fact that by 2010 the Russian Federation will reach a peak in oil production growth, which is due to the uncertainty of foreign investors in the energy sector of the Russian economy. At the same time since 2012 a decrease in oil production may begin, the IEA says. Experts say that Russian companies will not have enough funds of their own to greatly increase the oil production base.

• Comment
Neftegaz.RU

Today Russia not only does not increase production, but on the contrary, it reduces it. Throughout May of 2017, within the framework of the agreement with the OPEC countries, Russia provides a reduction in oil production by 300 thousand barrels per day. Russia achieved the level of 300 thousand barrels per day at the end of April 2017. "In May, we have been holding minus 300 thousand barrels over 22 days. In previous years, the production was constantly growing. So, in 2014, the growth in oil production in Russia was 0.6% compared to 2013. And in 2012, Russia overtook even Saudi Arabia for oil production, once again becoming the world's largest oil-producing country.

Gazprom sells gas from undeveloped Kovykta

After having bought TNK-BP's share in the Kovykta field in 2007, Gazprom has not yet begun to recover gas, but has already begun to think about where to sell this gas. The most profitable options are two. The development of the Kovykta field can be started not within the long term and will be carried out at an intensive pace, said A. Medvedev. Possible markets for gas from the Kovykta field are China and Korea.

• Comment
Neftegaz.RU

In 2014, Gazprom and CNPC signed an agreement on the supply of Russian gas to China along the eastern route. It is assumed that natural gas can be delivered from Russia to China for 30 years in the amount of 38 bcm per year via the Sila Sibiri-1 MGL. MGL will connect the Kovykta and Chayandinskoye fields with the Amur gas processing station, and from there gas will be supplied to China. But the authorities of the Irkutsk region are not yet able to agree with Gazprom on the gasification of the Irkutsk region by accelerating the commissioning of the Kovykta gas condensate field, despite the fact that gas is supplied only to 8.1% of the region. ●

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BUSINESS-ACCENT

THE EQUIPMENT OF NATIONAL IMPORTANCE

DRILLING RIGS FOR OFFSHORE DRILLING WILL BE CREATED IN RUSSIA

THE CREATION OF MODERN RUSSIAN DRILLING RIGS FOR OFFSHORE OPERATIONS IS ONE OF THE KEY DIRECTIONS OF THE DEVELOPMENT OF THE COUNTRY'S FUEL AND ENERGY COMPLEX, AND THE PRODUCTION OF SUCH EQUIPMENT IN RUSSIA IS THE MOST IMPORTANT NATIONAL TASK. IN MARCH 2017, AN AGREEMENT WAS SIGNED IN MOSCOW, WHICH EXPERTS, WITHOUT EXAGGERATION, CALL A LANDMARK IN THE DEVELOPMENT OF OFFSHORE OIL AND GAS PRODUCTION PROGRAMS. THE COMPANIES THAT ARE THE LEADERS IN THEIR AREAS - URALMASH NGO HOLDING, SIEMENS AND ELEKTROPROM - DOCUMENTED A PARTNERSHIP IN THE SPHERE OF DRILLING RIGS FOR OFFSHORE DRILLING, INCLUDING THE AREAS WITH EXTREMELY SEVERE CLIMATIC AND OPERATIONAL CONDITIONS

Keywords: *drilling equipment, drilling rigs, agreement, cooperation, shelf, climatic risks ofoffshore drilling.*

The head of Siemens LLC (the parent company of Siemens AG in Russia, Belarus and Central Asia), Dietrich M ller, being the host of the place of signing the agreement, said: "This is the beginning of a great and fruitful work. I am sure that a team that unites three such partners can create high-quality drilling equipment for not only Russia, but also, I hope, for export deliveries. It goes without saying that this equipment will be produced at the highest technological level".

It is to be recalled that that Siemens AG (Berlin and Munich) is the world's leading technology group company, which operates in more than 200 countries and specializes in such areas as electrification, automation and digitalization. Siemens is one of the world's largest suppliers of energy-efficient and resource-saving technologies. The enterprise is one of the leading manufacturers of combined-cycle plants for efficient energy production, a provider of solutions for its transmission, a pioneer in the field of infrastructure solutions, automation technologies and software for the industry.

However, in the new partnership, Uralmash NGO Holding is to play the central production and technological role. It acts not only as the creator of the final equipment (its workshops are going to be the place where the appearance of each drilling rig will be formed with the inclusions of elements created by the partners). In addition to that, it is planned that Uralmash will supply the products to buyers, both Russian and foreign ones: the signing also outlined the export prospects of the equipment being created in the partnership. By the way, it was the head of Siemens who declared about the export.

Moreover, the inventions and technologies of Uralmash NGO Holding are the fundamental basis for future models of offshore drilling rigs. Having absorbed the best engineering and production experience of Soviet drilling equipment schools, the holding has created the largest engineering center in Russia and one of the world's leading engineering centers, which successfully develops and develops new elements of drilling equipment. Among the novelties from the holding, for example, is the top drive system, which was fully developed in Russia - it is currently manufactured and successfully operates under the most severe conditions. This example is more than indicative, since the top drive is the most complex and expensive element of a modern drilling rig.

It is important to note that Uralmash NGO Holding has been successfully developing import substitution in the field of drilling equipment since its foundation, and in 7 years, it has managed to achieve very high results in this sphere. Thanks to the efforts of the holding, the undisputed national leader in the development and creation of modern drilling rigs, it happened that not only the negative trends that threatened the loss of the domestic drilling equipment market could be stopped, but the situation was reversed.

Today, the structure of the domestic market of drilling equipment is cited as an example of a reasonable policy of strengthening the national industrial safety. At the same time, the share of Russian equipment is growing steadily, primarily due to the efforts made by Uralmash NGO Holding to develop and produce high-quality drilling equipment (considering that the quality is an absolute market condition for development).

Moreover, absolutely natural in this way was the signing of an agreement that consolidated the

FACTS

The developments and technologies of Uralmash NGO Holding are the fundamental basis for future models of offshore drilling rigs

67 billion

the volume of investments in the Russian electric power industry in 2016

In March

2017

Uralmash NGO Holding, Siemens and Electroprom signed an agreement on partnership for the creation of offshore drilling rigs

intention of the three leading companies to make special efforts to create offshore drilling rigs. The director general of Uralmash NGO Holding Yuri Karpov, the director general of Elektroprom Boris Abramov and the president of Siemens in Russia Dietrich
Möller signed the agreement.

It is important to note that the engineering company Elektroprom has long been specialized in the development and production of automated electric drives for various industries in Russia, including for ground and offshore drilling rigs. In recent years, the company has developed, manufactured and delivered a complex of electric drives with the automated control systems of the support-lifting device and an additional charge system for diesel-electric stations of the “Arkticheskaya” self-lifting drilling rig, as well as a set of electric drives of the main mechanisms of the drilling complex of the“Obskaya-1” floating drilling rig.

At the first stage, the partners agreed to prepare a plan for the development of drilling rigs with the manufacturing at Russian production facilities, and with the full localization of the production, if necessary, including special elements of mechanical and electrical equipment used at offshore drilling rigs. It is assumed that the production sites of all the partners will be involved.

The participants of the agreement expect that the joint project will be successful. It is expected that the equipment will be supplied primarily to Russian mining companies. Among the potential consumers, Yuri Karpov at the signing ceremony called Rosneft, Gazprom, and Surgutneftegaz.

FACTS

9 tons

The lifting capacity of drilling rigs produced by Uralmash NGO Holding

The creation of modern Russian drilling rigs is one of the key directions of the country’s fuel and energy complex development

“The agreement signed is a new step in the cooperation between our companies. This work is planned as the development of joint long-term positive experience in the creation of modern ground-based drilling rigs for the Arctic conditions of Russia. One of the joint significant projects was the project to equip the unique “Arktika” drilling rigs with electric drives - these drilling rigs are used to drill the Yuzhno-Tambeyskoye gas condensate field for NOVATEK. These plants have proved to be highly effective and reliable in the difficult climatic conditions of the Arctic during their work”, Yuri Karpov said.

The director general of Elektroprom, Boris Abramov, also noted the importance of the efforts combined: “In Russia, there are production complexes that, in cooperation with the world’s leading manufacturers, can create a drilling platform. Today we unite our efforts in Russia to create such a technology center, and I am sure that we will cope with this task”.

“The cooperation with such leading companies in the field of oil and gas equipment as Uralmash NGO Holding and Elektroprom opens new opportunities for us. I am confident that together with our Russian partners we will be able to launch the production of modern drilling equipment for projects implemented in difficult climatic conditions. The planned joint work will be our common contribution to the Russian engineering industry, the development of which is one of the main priorities of the country’s economy”, Dietrich M ller said.

He also declared: “The localization of the production of offshore drilling rigs is another technological challenge for us, so to speak, because we are talking about

the creation of equipment for the work in very difficult climatic conditions. We hope that together with our reliable partners - Uralmash NGO Holding and Elektroprivod, we will solve all the problems. The signing of this partnership agreement is really an important strategic step for Siemens. We also associate a certain working load of our Siemens Elektroprivod plant in St. Petersburg with this agreement. We are hoping for a large number of orders from Russian customers, in particular from Rosneft, Gazprom, Surgutneftegaz, NOVATEK”.

Yuri Karpov supported his colleague: “Our very close cooperation with Siemens and Elektroprom has been lasting for many years. We know each other well, we have produced a large number of drilling rigs jointly, we have great confidence in each other. The signed agreement confirms that we will continue to cooperate and develop the production of more and more perfect drilling equipment for our customers. I do not have even a bit of doubt that we will succeed. We will make good quality equipment for the development of offshore deposits”.

Behind these words of the head of the leading national producer of drilling equipment is a great way of investment, development, and modernization of production and technological lines at the holding’s enterprises.

FACTS

In 1976

Uralmashzavod produced the first semisubmersible drilling rig (“Uralmash-6500 PEM”)

It is important to recall that the holding already has a successful experience of innovative developments in cooperation with Siemens and Elektroprom. For example, in partnership with these companies, Uralmash NGO Holding created a new model of the unique “Arktika” drilling rig, which successfully operates at the Yuzhno-Tambeyskoye field.

In the new project, the holding and its partners face with another important innovation task to create a national drilling complex for offshore operations. Each of the partners has a lot of own developments and technologies that they contribute to the new cooperation, thus creating the necessary block of basic technologies and expertise.

GEOLOGICAL AND ECONOMIC EVALUATION OF OIL AND GAS RESOURCES

as a basis for increasing the efficiency of geological exploration

THE CONDITION OF THE HYDROCARBON RESOURCE BASE OF RUSSIA IS GIVEN, THE STRATEGIC DIRECTIONS OF OIL AND GAS RESOURCES EXPLORATION ARE CONSIDERED, THE METHODOLOGICAL FUNDAMENTALS OF THE ECONOMIC-GEOLOGICAL EVALUATION OF OIL AND GAS RESOURCES ARE PRESENTED, POSSIBLE RISKS ARE SHOWN AND THE DIRECTIONS FOR IMPROVING OF THE ECONOMIC-GEOLOGICAL EVALUATION AND INCREASING THE EFFICIENCY OF GEOLOGICAL EXPLORATION ARE JUSTIFIED

KEY WORDS: *oil, gas, economic-geological evaluation, exploration, reserves, resources, deposits, resource base, strategy development, cost, risk, efficiency, profitability.*

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The current stage of development of the world oil industry is characterized by the emergence of new efficient methods and technologies for increasing oil recovery in existing fields, increasing their resource base, and, most importantly, by introducing huge accumulations of shale oil and gas into industrial turnover.

The combined impact of these factors has led to a sharp increase in the extraction potential of the hydrocarbon resource base and, as a result, to an excess of oil supply in the world energy markets.

Oil actually lost the status of a scarce strategic resource and is now seen as a valuable commodity, the profitability of which depends on the level of market prices.

This condition is decisive in assessing the efficiency of geological exploration, the costs of which can be justified only in the case of identifying oil and gas fields which are investment-attractive for the development.

Compliance with this condition is very relevant for Russia, regeneration and exploration of the hydrocarbon resource base of which is characterized by deterioration of its structure and qualitative parameters of the detected fields. They discover, as a rule, small deposits, located in the industrialized regions, or medium and even large deposits, but in remote areas and in inaccessible water areas. The profitability of the development of such deposits is relatively low and does not always allow justifying the investment risks associated with their prospecting and exploration.

TABLE 1. Allocation of unclaimed recoverable oil and gas reserves in Russia[1]

Status	Oil, million tons		Gas, billion cubic meters	
	$A+B+C_1$	C_2	$A+B+C_1$	C_2
Unallocated fund	552	438	2000	2213
Prepared for industrial development	971	422	11789	2760
Undeveloped and conserved	1668	2546	6719	3454
TOTAL in the RF	**3191**	**3456**	**19908**	**8427**

[1] According to VNIGRI's evaluation

Low investment attractiveness is one of the reasons for the formation of a huge amount of unclaimed reserves, which exceeds 6.6 billion tons of oil, and 28.3 trillion m³ of gas (table 1).

Most of the unclaimed oil reserves account for the undeveloped and conserved reserves of the exploited deposits, totaling more than 4 billion tons. Almost one and a half billion tons of reserves are idle while waiting for commissioning. About one billion tons of oil is in the unallocated subsoil reserve fund.

A detailed analysis of the reasons for the down time of a large part of unclaimed oil reserves was not carried out. We can assume that, most likely, it is caused by low profitability of the development. At the same time, these reserves make up a quarter of the country's explored oil resource base. Excluding them from active industrial turnover will significantly reduce the oil supply to the oil industry.

The overwhelming part of the volume of unclaimed gas reserves comes from well-known deposits prepared for industrial development.

Acceleration of their bringing into development depends primarily on the energy market environment and the possibility of attracting huge amounts of investment for the creation of transport and industrial infrastructure. In addition, a number of the major unclaimed fields contain multicomponent gases, which require preliminary conditioning and separation of fatty fractions, and separation of helium for the East Siberian fields. In fact, to ensure the rational operation of idle gas fields, it is necessary to create a new large gas processing industry.

In these conditions, the tasks of geologists include primarily prospecting and exploration of new competitive, highly efficient oil fields and the identification of industrially significant, highly profitable gas fields in areas with developed gas production system and close to operating or designed gas main pipelines.

For today it is possible to outline six basic directions of regeneration of hydrocarbon resource base in Russia (table 2).

The resource potential of some of these directions is comparatively the same, but the effectiveness of prospecting and exploration of deposits in them will vary significantly.

For example, the preparation of reserves in the old oil-producing regions that are at the final stages of operation will certainly be better than, say, in East Siberia. But at the same time, the costs of industrial development of newly discovered

TABLE 2. Strategic directions of development of hydrocarbon resource base of Russia

Направления освоения УВ базы	The volume of recovered resources[1]		Conditions for implementation
	Oil, billion tons	Gas, trillion m³	
Identification and exploration of small and medium-sized, low-rate, deep-sunk deposits in old oil producing regions	~ 12	~ 40	Implementation of new technologies, tax incentives
Identification and exploration of large deposits in new areas with poor infrastructure	~ 28	~ 53	Allocation of major investments in facility development, industrial and transport infrastructure
Identification and exploration of large and unique deposits on the Arctic shelf	~ 9	~ 95	Creation of technologies for the development of deposits under ice and under water and allocation of the largest investments in the facility development, industrial and transport infrastructure
Involvement in the development of unclaimed reserves of open fields	~ 6.6	~ 28.3	Increase of investment attractiveness of unclaimed reserves due to new technologies
Increase in oil recovery of developed deposits	~ 12–15	–	Involvement of new technologies for oil recovery
Involvement in development of non-traditional hydrocarbon resources (Bazhenov formation)	~ 10	~ 8	Involving of new technologies, tax incentives

[1] According to VNIGRI experts' estimates

deposits are fairly lower. A similar situation will develop in the course of geological exploration on the Arctic shelf. The costs of preparing reserves on the large and unique oil and gas fields projected here can be relatively low, but huge investments (up to $ 1 trillion by expert estimates) will be required to create above-water and underwater producing complexes, tanker and auxiliary fleets.

In general, the Arctic shelf with its giant prognostic hydrocarbon resource base is one of the basic regions. However, the opportunities for its cost-effective exploration and development should be confirmed through a geological and economic evaluation (GEE).

The methodology of geological and economic evaluation of oil and gas resources in Russia has basically developed and undergone practical testing in the course of the repeatedly conducted estimates of the forecasting hydrocarbon base of the territories and water areas of the country.

It is a combination of geological, technological and economic methods that allow quantitative and qualitative assessment of the amount of hydrocarbon resources, the technical capabilities of their development, the costs of preparing and developing of reserves and possible revenue.

Geological and economic evaluation of resources in accordance with the requirements of the Classification of reserves and resources of oil and combustible gases should be carried out separately by groups of different geological exploration degree.

The purpose of the GEE is to substantiate the possible industrial importance and investment attractiveness of various groups of oil and gas resources projected in dissimilar mining and geological, geographic and economic conditions of development.

The efficiency of regeneration of the country's hydrocarbon resource base should be ensured by the preparation of new oil and gas reserves that are profitable to develop. A prerequisite for identifying such reserves is the allocation of promising oil and gas territories and water areas and facilities, geological and economic evaluation of the resource potential of which corresponds to the accepted economic criteria.

The last geological and economic evaluation of the Russian Federation's resources which was completed in 2014 allowed to determine the volume of profitable resources in various oil and gas provinces and regions of the country, the need for capital investments in their search, exploration and development, and revenue from involvement in industrial turnover.

However, it did not find wide application for the reason that it did not have a close connection with the existing subsoil use practice.

Among the GEE facilities (oil and gas bearing provinces, regions, complexes and local structures) there were no basic subsoil use facilities – licensed areas. Moreover, we did not take into account the differences in the exploration degree and reliability of the various resource groups, the geological and economic evaluation of which is necessary in accordance with the requirements of a new classification of reserves and resources of oil and combustible gases.

In order to strengthen the role of GEE as an important tool for making management decisions at the early stages of geological exploration, it should be made more differentiated. As part of the evaluation facilities, along with oil and geological facilities, it is necessary to identify subsoil use facilities – licensed sites with resources of category D0, Dл, and where they are absent – prospective sites with resources of cat. D1 (in areas with proven industrial oil and gas potential) and cat. D2 in areas where the industrial oil and gas potential has not yet been proven. Such detailing of the evaluation facilities corresponds to the Classification of Reserves and Resources of Oil and Combustible Gases, introduced in 2016, according to which their geological and economic evaluation should be carried out separately for groups of different geological exploration degree [1].

Sequence of geological and economic evaluation of resources and tasks to be solved

Geological and economic evaluation of oil and gas resources consists of two blocks – geological and economic (Figure 1).

In the geological block, a quantitative evaluation of resources is carried out.

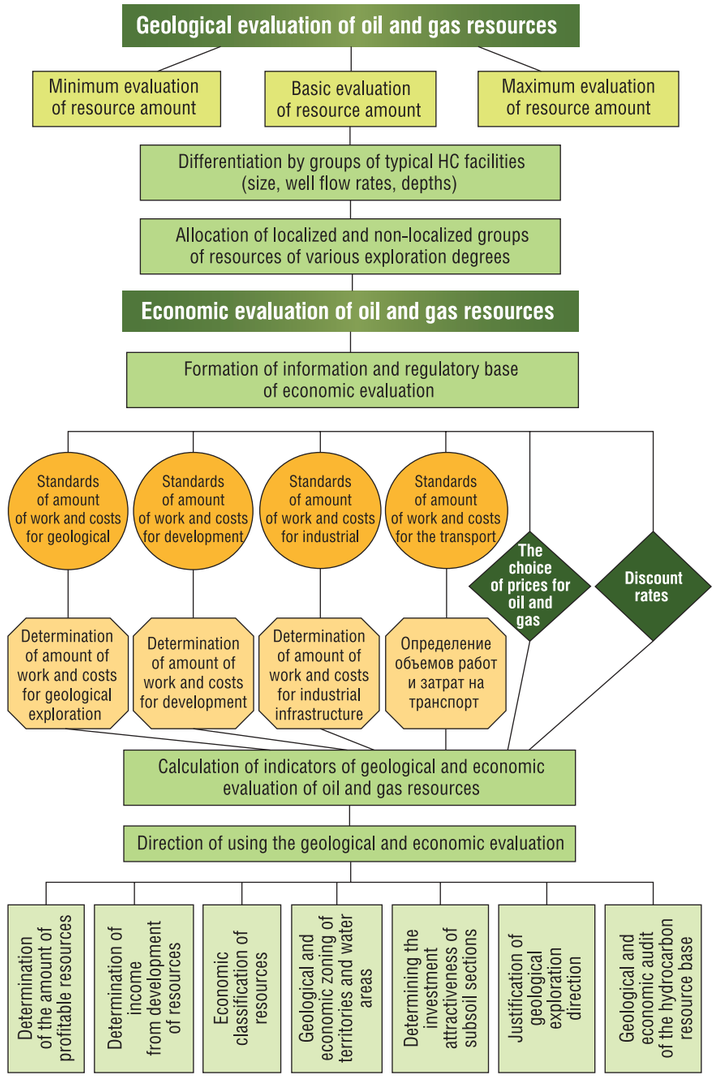
Approximation of GEE of resources to solving practical problems of subsoil use requires improvement of methods of their quantitative evaluation. Given the probabilistic character of exploration results associated with the possible non-confirmation of the oil and gas potential of the exploration and prospecting of deposits and the amount of their resource potential, it is necessary to refuse from the current deterministic evaluation of hydrocarbon resources and switch to an interval-probabilistic evaluation.

Calculations of resource amount for all types of oil and gas facilities should be carried out using the methodology of probabilistic evaluation according to the minimum (confirmability of 10%), maximum (confirmability of 90%) and the most probable (confirmability of 50%) options. The most probable (basic variant) is accepted as the main one for further geological and economic calculations.

The allocation of the current volume of forecasting resources for the purposes of the GEE is done by excluding the amount of extracted, identified and explored reserves from the amount of the initial volume of initial geological resources. The amount of remaining resources is divided into localized and non-localized. The localized resources include the resources of the structures identified and prepared for drilling, as well as undrilled deposits of explored and developed deposits.

Non-localized resources are distributed by prospective sites

FIG.1. Schematic diagram of geological and economic evaluation of oil and gas resources



in accordance with the accepted volumetric data.

To differentiate the initial total resources (ITR) of oil and gas by classes of different sizes, the methodological recommendations of 1988 [4] can be used, according to which differentiation is performed for each complex within the boundaries of oil and gas bearing area. In each class, the number of forecasting deposits is estimated. We exclude from the total number of deposits subject to evaluation the deposits already discovered, which are registered in the State Register of Mineral Reserves. The remaining amount of resources is divided into two groups.

The first group includes localized resources of identified and prepared structures. The economic evaluation of this group of resources is based on the mining and geological and geographic and economic characteristics of specific local facilities.

The second group consists of non-localized resources, the volume of which is determined after deducting from the total amount of the ITR of the resources of the already discovered deposits and the localized resources of the structures identified and prepared for drilling. It is necessary to exclude from the total amount of localized and non-localized resources technically inaccessible deposits that cannot be explored or involved in development due to various restrictions. The distribution obtained of localized and non-localized resources in terms of mining and geological parameters characterizes the resource potential of the evaluated territory, which can be explored and developed under existing or forecasting technological and economic conditions.

The allocation of technically inaccessible resource groups is based on modern technical capabilities and technologies for prospecting and developing of oil and gas fields in complex mining, geological and natural climatic conditions.

The basic amount of technically inaccessible resources refers to the deep-sea zones of the Arctic shelf, within the boundaries of which oil and gas reserves can be identified and explored, but there are no technical means for their development.

In each oil-and-gas bearing area there are regional exploration floors, including one or more oil and gas bearing complexes, the exploration of which is carried out by a single well system. For each individual facility, there is identified its belonging to a regional exploration floor and the possible association of single facilities into a multi-pay field.

If a single facility is part of a forecasting multi-pay field, its evaluation should take into account the possibility of combining exploration and development costs, costs for field development and the construction of oil and gas pipelines.

By the phase composition of hydrocarbons, the base evaluation facilities are divided into oil and gas facilities. The resources of dissolved gas are evaluated based on geological oil resources and gas saturation data. The condensate

resources are determined by the potential content of the condensate in gas.

The initial mining and geological characteristics for the localized evaluation facilities are taken on the basis of the results of geological exploration for their identification and preparation for exploratory drilling.

For non-localized resources, the mining and geological characteristics of single standard facilities are determined using the analogy or expert evaluation method.

Technical and economic calculations should be carried out for localized resources for licensed and prospective sites, for non-localized resources – for prospective sites, which, if possible, should be allocated within the boundaries of the design sites used in the quantitative evaluation of resources.

The characteristics of each site should contain data on the possible number of productive structures, the depth of occurrence of productive horizons, and the possible production flow rates of wells.

In the economic block, in order to conduct an economic evaluation of resources, the initial information and regulatory base are preliminarily formed, including the standards for costs for geological exploration, development of deposits and transporting of oil and gas to consumers. On the basis of these standards, the corresponding volumes of work and costs for the preparation and development of reserves and the criteria parameters of the GEE are calculated: Net discounted income, profitability index, internal rate of return.

These indicators of the GEE characterize the ultimate efficiency of the results of geological exploration and can be used for taking of operational and strategic management decisions on the justification of areas and the selection of exploration and prospecting deposits.

The results of GEE of resources can be used to solve a wide range of operational and strategic tasks of oil exploration. These include: Determination of the volume of profitable oil and gas resources, determination of the possible income that can be obtained from their development, assessment of the investment attractiveness of licensed and promising subsoil sites, economic classification of resources, and others.

Structure of the system of geological and economic evaluation of oil and gas resources

The structure of the geological and economic evaluation of oil and gas resources within the boundaries of oil and gas bearing area is shown in Fig. 2. It consists of the following blocks:

- GEE of prepared resources of local facilities (LF) of licensed sites (LS) with developed fields (resources of category D_0);
- GEE of localized resources of local facilities of licensed sites with explored deposits (resources of cat. $D_п$);
- GEE of perspective resources of local facilities of licensed sites without identified deposits (resources of category D_1);
- GEE of non-localized forecasting resources (cat. D_2).

The total resource potential of oil and gas bearing areas (OGA), regions (OGR) and provinces (OGP) is determined with taking into account the likely characteristics of different groups and resource categories.

Geological and economic evaluation of localized resources is carried out for each accounted oil and gas facility.

For non-localized resources, a geological and economic evaluation is carried out for each selected standard single facility and then is covering all the facilities in this group.

As the integral object of the geological and economic evaluation

FIG. 2. The structure of the facilities of geological and economic evaluation of oil (gas) resources for the oil and gas region (area)

$LS_д$	LF No.	Amount of resources cat. D_0
	1	
	2	
	…	
	n	

LS_p	LF No.	Amount of resources cat. $D_п$
	1	
	2	
	…	
	n	

$LS_п$	LF No.	Amount of resources cat. D_1
	1	
	2	
	…	
	n	

OGR (OGA)	
Categories of resources	Amount of resources, million tons (billion cubic meters)
D_0	
$D_п$	
D_1	
D_2	
Total	

$PS_Н$	FLF No.	Amount of resources cat. D_1
	1	
	2	
	…	
	n	

$PS_В$	FLF No.	Amount of resources cat. D_2
	1	
	2	
	…	
	n	

Legend:

LF – local facilities on the site;

$LS_д$ – a licensed site with a deposit being developed;

LS_p – a licensed site with an explored deposit;

$LS_п$ – licensed site with structures prepared for exploratory drilling;

FLF – forecasting local facilities;

$PS_Н$ is a prospective site in the area with proven oil and gas potential;

$PS_В$ – is a prospective site in an area with probable oil and gas potential

we take the summarized resources of the deposits forecast, identified and prepared for drilling, which can be taken into account in the evaluated licensed or prospective sites, oil and gas bearing entity of oil and geological and administrative division in evaluation of oil (gas) resources for the oil and gas region (area) according to the results of the quantitative evaluation of resources and the requirements for the classification of reserves and resources of oil and combustible gases.

As single local facilities for the GEE the following should be considered:

а) in areas with proven industrial oil and gas potential:

- deposits prepared for drilling;
- deposits discovered in the results of prospecting geological and geophysical studies;
- deposits forecast by the results of regional geological, geophysical, geochemical exploration;

б) in areas with unproved industrial oil and gas potential:

- deposits forecast on the basis of available data of geological, geophysical, geochemical studies, and by analogy with the areas where oil and gas deposits are located.

Technical and economic calculations should be carried out for resources prepared for exploratory drilling (cat. D_0) and localized resources (cat. $D_п$) for licensed sites, for non-localized resources – for prospective oil and gas bearing sites that can be allocated for inclusion in the program for the preparation of new licensed sites.

In order to provide technical and economic calculations for perspective sites, it is required to clarify the methodology for quantitative geological evaluation of hydrocarbon resources in such a way that it provides the possibility of forecasting of data for each site on the expected number of productive structures, depth of occurrence of productive horizons, possible well flow rates, etc.

The characteristics of each site should contain data on the possible number of productive structures, the depth of occurrence of productive horizons, and the possible production flow rates of wells. According to the Methodological recommendations on the application of the classification of oil and combustible gas reserves and resources, the evaluation and accounting of oil and gas resources of various categories is carried out separately [2]. Accordingly, geological and economic evaluation of resources should be carried out separately.

For today, there is no any generally accepted methodology for solving this problem. In most cases, the resource potential of prospective sites is assessed on the basis of expert assessments, the reliability of which depends on the qualifications of the experts. Taking into account the importance of this problem for assessing the investment attractiveness of allocated subsoil sites, it is necessary to justify general methodological approaches that allow to formalize the process of geological evaluation of the resource potential of newly allocated oil and gas prospects and to develop recommendations containing proposals on the criteria for selecting such sites, their location and size.

As such recommendations, the following provisions are proposed:

- Prospective sites for licensing are allocated in the territory of the undistributed subsoil fund, taking into account the condition of licensing in the OGR;
- when allocating prospective oil and gas bearing sites within the OGR, their equivalence in terms of geological significance should be ensured;
- Between the contours of prospective and licensed sites there should not be any unevaluated territory;
- Each allocated site should, if possible, be located within one-type structural-facial zone and be homogeneous in terms of the general geological structure and oil and gas conditions;
- The contours of the sites with sufficient exploration degree of the area should be made in the middle between deposits or prospective local facilities, and in cases where their position is unknown – at a distance from the central part of the site divisible by the distance between local facilities characteristic of a given area (zone);
- As a rule, at least 3–5 local structures should be within each site. In terms of identifying 1–2 deposits, this requirement determines the optimal site area in the amount of 200–300 km² for well-explored areas, as for poorly explored territories and water areas this area can be increased to 500–1000 km².

Geological and economic evaluation of hydrocarbon resources of licensed sites and prospective oil and gas bearing sites is based on different geological information base.

In the first case, information on the volume of resources, the number of local facilities of evaluation and their mining and geological characteristics are taken on the basis of license agreements and adopted geological exploration programs.

In the second case, probabilistic methods for estimating geological indicators are used to forecast the quantitative and qualitative characteristics of undistributed resources.

Forecasting the mining and geological characteristics of prospective sites (PS) is currently an unsolved problem requiring special consideration. One of the possible variants of its solution is the use of the analogy method given in the Methodological Guidelines for the Quantitative Estimation of the Forecast Resources of Oil, Gas and Condensate of the Russian Federation [3].

This method consists in that the quantitative and qualitative characteristics of the resources of the reference sites are transferred to the prospective (design) site,

and as a result, the amount of resources, the depth of productive horizons and a number of other parameters necessary for geological and economic calculations can be determined on the basis of the design site.

The basic calculated formula for any geological method in the analogy method is as follows:

$$\frac{\rho_р}{\rho_э} = K_{ан} = \frac{X_{1р} \cdot X_{2р} \cdot ... \cdot X_{np}}{X_{1э} \cdot X_{2э} \cdot ... \cdot X_{nэ}},$$

where: $\rho_р$ – density of resources in the design site,

$\rho_э$ is the density of the reserves in the reference site,

X_{np} – varying parameters in the design site,

$X_{nэ}$ – varying parameters on the reference site.

However, it must be taken into account that this method should be used for sites having a certain geological commonality or compliance. The legality of its application for determining the characteristics of prospective sites should be confirmed by special studies.

Accounting for price volatility and risks in geological and economic evaluation of oil and gas resources

The unfavorable situation in the oil markets that has developed in recent years leads to strong volatility in oil and gas prices. Reduction of these prices reduces the value of the industrially significant resource base of hydrocarbons and the inflow of investments into geological exploration.

Russia has a negative experience of the impact of low oil prices on the hydrocarbon resource base. For example, in 1998, when they fell to 7–8 dollars per barrel. The oil companies said they had no resource base and had to conserve thousands of wells due to unprofitable operation.

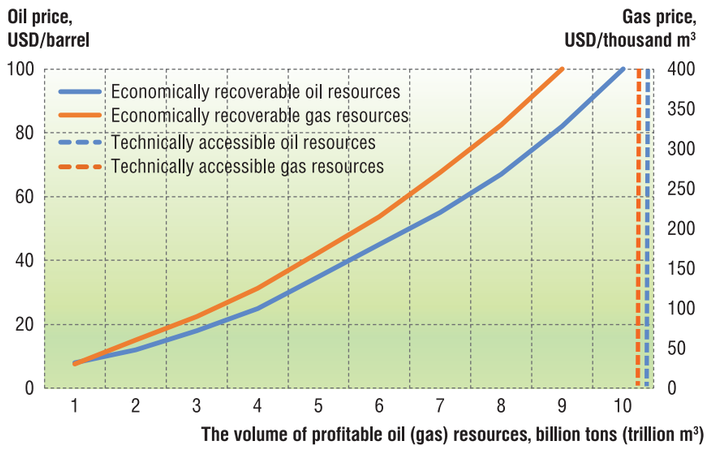
In this regard, it is reasonable to take into account the influence of the price factor on the value of the forecast hydrocarbon base to estimate the profitability of its development at various price levels, from the lowest possible to the maximum.

The graph-analytical model of the condition of the hydrocarbon resource base, proposed for solving this problem and widely used in the US, allows us to clearly trace the dependence of the cost-effective volumes of oil and gas resources on the price level (Fig. 3). At their maximum value, the volume of profitable resources is close to the amount of resources that can be extracted from the subsoil with existing technical capabilities. In case of price reduction, the volume of profitable recoverable resources will be significantly lower than the amount of technically available resources.

The use of this model allows us to quickly determine the volume of profitable oil and gas resources in the price range – from the minimum to the maximum possible. The model can be constructed for facilities of different levels, including the local HC facility, the licensed site, the OGA, the OGR, the OGP, and the country as a whole.

The most important condition for making effective management decisions on prospecting and exploration of deposits is the consideration of the probabilistic nature of information, risks and uncertainty.

РИС. 3. Graphical model of calculating the cost-effective part of the forecast resource base depending on the prices for oil and gas



The following types of investment risks are the most significant for the development of hydrocarbon deposits:

- ***Geological risk*** – is due to the possibility of unsuccessful prospecting or unconfirmed assessment of recoverable oil (gas) reserves, is minimized in the process of additional exploration and pilot operation;
- ***Technological risk*** – is associated with the mismatch of the technical parameters to the actual conditions of development of deposits and the possibility of emergence of emergency situations for this reason;
- ***Economic risk*** – associated with the instability of economic legislation, investment conditions and inflation, fluctuations in market conditions, prices, exchange rates, uncertainty of terms of sale and transport of hydrocarbons, etc.;
- ***Political risk*** – arises in connection with the uncertainty of the political situation (the possibility of adverse socio-political changes in the country or region, the imposition of trade sanctions, the closure of borders, etc.).

The economic and political types of risks, based on the possibilities of influence in the oil and gas production sector, are mostly uncontrollable or objective, since they are determined by external factors. Objective risks cannot be regulated, but can be forecast. Accounting for their impact is possible at the level of expert assessments and long-term forecasts.

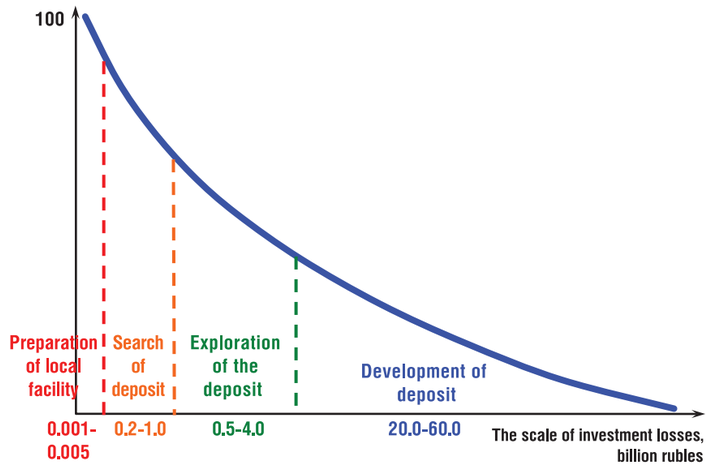
Managed or subjective risks should include the geological, technological types of risks and part of the economic risk associated with the geographical location of the region, natural and climatic conditions and the development of industrial and transport infrastructure. Subjective risks, in particular, the risk of non-confirmation of reserves, in contrast to objective ones, can be directly regulated, although not fully, by the participants of the investment project (for example, by increasing the costs of prospecting and exploration of deposits).

At different stages of the process of exploration and developing of HC resources, the influence of managed risks on the efficiency of management decisions is not the same.

Uncertainty of work performance conditions is not specified. As exploration and prospecting progress, additional information is received on the parameters of the forecast deposits, and the previously existing uncertainty is reducing.

A schematic diagram of the ratio of managed risks and the scale of investment losses at different stages of the process of exploration and development of hydrocarbon resources is shown in Fig. 4.

FIG. 4. A schematic diagram of the ratio of risks and the scale of investment losses at different stages of the process of exploration and development of hydrocarbon resources



The greatest degree of risk is characteristic for the initial stages of exploration. At the same time, since the volumes of geophysical and drilling operations are limited, the scale of possible losses at these stages is small. As the flow of geological and other information increases in the subsequent stages of work, the share of risk is reduced, but the increasing volumes of work and the associated investment may increase the scale of losses.

So, at the stage of search of a deposit, these losses can reach 1.0 billion rubles, at the exploration stage – 4.0 billion rubles. The most significant volumes of risky investments in calculation, for example, for a relatively large offshore oil or gas deposit, may reach 25–85 billion rubles, although the value of the geological risk at this stage is minimal.

In the calculations of the geological and economic evaluation, the following methodological approaches can be used to account for investment risks:

- Method of introducing a risk premium to the base discount rate;
- Method of stability testing (project sensitivity analysis);
- Method of analysis of scenario approaches;
- Method of simulation;
- Real options method.

When choosing methods for accounting for investment risks, it is necessary to take into account that the degree of their influence decreases with the increase of exploration degree of oil and gas facilities. However, at the later stages, the volume of risk investments increases.

Recommendations on the choice of the method of accounting for the impact of investment risks at various stages of development of oil and gas projects are presented in Table 3.

The most simple and convenient for calculations is the method of accounting for investment risks by introducing a risk premium to the base discount rate. This method is recommended to be used in the economic evaluation of the resources of licensed areas, projects for prospecting, exploration and development.

When using this method, risk accounting is provided by introducing in the calculation of the net present value (NPV) of the risk premium to the base discount rate. The estimated value of this rate

TABLE 3. Methods of accounting for the impact of investment risks on the economic evaluation of oil and gas facilities

Project implementation stage	Methods of accounting for investment risks				
	The introduction of a risk premium to the base discount rate	Verification of the sustainability of economic evaluation	Analysis of scenario approaches	Simulation modeling	Real Options
1. Economic evaluation of the HC LS	+	-	-	+	+
2. Economic evaluation of the deposit prospecting program	+	+	+	+	-
3. Economic evaluation of the deposit exploration program	+	+	+	+	-
4. Economic evaluation of the project of industrial development of the deposit	-	+	+	-	+
5. Economic evaluation of the residual reserves of the deposit	-	+	-	-	+

increases for a certain, differentiated premium for geological and geographic-economic risks.

In the early stages of geological exploration, the profitability of the preparation of hydrocarbon resources is heavily influenced by investment risks associated with the deployment of HC resources in hard-to-reach, industrially undeveloped areas, and also with a low exploration degree.

The impact of geological and geographical factors increases investment risks and in order to cover these risks it is necessary to increase the level of profitability of development of oil and gas facilities.

The investment attractiveness of the hydrocarbon resource base is determined by the level of profitability of their development.

In practical GEE calculations of oil and gas facilities, the level of return on investment is set through the discount rate. The size of the discount rate is one of the regulators of the estimation of the industrial importance of the resource base. Its scales increase or decrease, depending on the decrease or increase in the chosen value of the discount rate.

The possible profitability of developing the forecasting hydrocarbon facilities, taking into account the receipt of additional income necessary to cover investment risks, is recommended to calculate by the formula:

$$R_{д} = \sum_{t=t_n}^{T} (Z_t - S_{ПРt} - S_{дt} - S_{Tt} - S_{ИНt}) * * (1 + Eб - Ep)^{-t}$$

where: $R_{д}$ – absolute value of the monetary estimate;

Z_t – value of products produced in the t-th year (oil, gas, condensate);

$S_{ПРt}$ – amount of the forthcoming exploration costs in the t-th year;

$S_{дt}$ – sum of the forthcoming costs in the t-th year for the extraction of oil (gas), environmental protection;

S_{Tt} – amount of expenses for inter-field and main transport forthcoming in the t-th year;

$S_{ИНt}$ – amount of costs for creation of an industrial infrastructure in the t-th year;

Еб – Basic discount rate;

Ep – Risk premium;

T – The estimated period of cost-effective development of the resources of the evaluation of local facility, years.

The discounting rate is chosen with taking into account the risks in the early stages of geological exploration.

As a method of accounting for investment risks in the geological and economic evaluation of oil, gas and condensate resources, it is recommended to use the method of introducing a risk premium to the base discount rate in the calculation of the NPV.

The estimated value of this rate increases for a certain, differentiated premium for geological and geographic-economic risks. As the base discount rate, depending on the problem to be solved, we should consider the average rate of return on capital accepted in this industry, the long-term deposit rate, the foreign bank's credit rate, the Central Bank of Russia's refinancing rate, with taking into account the margin of commercial banks.

In practical calculations it is recommended to use the base discount rate equal to 10%.

The approximate values of the risk premiums to the discount rate, depending on the exploration degree and the economic-geographical location of the forecast resources of the valuation facilities, are given in Table 4.

Concluding the discussion of methodological and practical problems of geological and economic evaluation of oil and gas resources as a basis for increasing the efficiency of geological exploration, the following

TABLE 4. Risk premiums to the base discount rate

Degree of risk	The premium for geographic and economic risk, %		Premium for geological risk, %		Total risk premium, %	Final discount rate, %
	Territories, water areas	Premium	Exploration of development facilities	Premium		
Low	The old developed regions (the Ural-Volga region, the Northern Caucasus, West Siberia, the Kaliningrad region, the Komi Republic, Sakhalin), the shelf of the Baltic Sea	0	Prepared resources cat. D_0	4-5	4-5	14-15
			Localized resources cat. $D_п$	6-8	6-8	16-18
			Perspective resources cat. D_1	9-10	9-10	19-20
			Forecasting resources cat. D_2	11-12	11-12	21-22
Mid	New regions bordering with the developed regions (Nenets AO), the shelf of the Caspian Sea	1-2	Prepared resources cat. D_0	4-5	5-7	15-17
			Localized resources cat. $D_п$	6-8	7-10	17-20
			Perspective resources cat. D_1	9-10	10-12	20-22
			Forecasting resources cat. D_2	11-12	12-14	22-24
High	New regions without developed infrastructure (East Siberia, Chukotka Autonomous District), the shelf of the Okhotsk and Bering seas	3-4	Prepared resources cat. D_0	4-5	7-9	17-19
			Localized resources cat. $D_п$	6-8	9-12	19-22
			Perspective resources cat. D_1	9-10	12-14	22-24
			Forecasting resources cat. D_2	11-12	14-16	24-26
Very high	Arctic water areas	5-7	Prepared resources cat. D_0	4-5	9-12	19-22
			Localized resources cat. $D_п$	6-8	11-15	21-25
			Perspective resources cat. D_1	9-10	14-17	24-27
			Forecasting resources cat. D_2	11-12	16-19	26-29

conclusions and recommendations can be made:

1. The current stage of development and regeneration of the hydrocarbon resource base occurs in unfavorable market conditions caused by a significant excess of oil supply in world markets over demand and, as a consequence, a drop in world prices for oil and gas.

2. Thanks to the success in the development of non-traditional sources of hydrocarbon resources, the resource base of the oil and gas producing industry has significantly increased and its production potential has increased. Oil lost the status of a strategic resource and is seen as a commodity, the profitability of which depends on the level of current market prices. Under these conditions, exploration costs will be justified only if such oil and gas deposits are discovered, the development of which will ensure an acceptable level of profitability for oil companies.

3. To comply with this condition, it is necessary to conduct geological and economic evaluation of resources already at the early stages of geological exploration, which can provide the selection of the most economically viable directions and facilities for prospecting and exploration of deposits and the rejection of facilities technically inaccessible and obviously unprofitable to be developed.

4. For Russia, taking into account the degree of geological exploration of the main oil and gas producing regions, the geological and economic evaluation of resources should be carried out not only in oil and gas provinces and regions, but also on existing and promising subsoil use sites – licensed areas and prospective oil and gas bearing areas.

5. To increase the reliability of geological and economic evaluation of investment risks, it is necessary to abandon the deterministic geological assessment of reserves and resources and move to interval-probabilistic.

References

1. *Classification of reserves and resources of oil and combustible gases. Approved by the Order of the Ministry of Natural Resources of Russia from 01.11.2003 № 477.*
2. *Methodical recommendations on the application of classification of reserves and resources of oil and combustible gases. Approved by the Order of the Ministry of Natural Resources of Russia from 01.02.2016. No. 3-p.*
3. *Methodological guidelines for the quantitative assessment of the forecasting oil, gas and condensate resources of the Russian Federation, Moscow, 2014 (draft).*
4. *Methodical recommendations for the application of the "Temporary Methodology for the Economic Evaluation of Forecast and Prospective Oil Resources". – L., VNIGRI, 1988.*
5. *Methodical recommendations for geological and economic evaluation of oil, gas and condensate resources. – Novosibirsk, Moscow, 2015.*
6. *Nazarov V.I. The concept of a methodology for geological and economic evaluation of oil and gas resources // Neftegazovaya Geologiya. Theory and practice. – 2017. – T.12. – №1. – http://www.ngtp.ru/rub/3/12_2017.pdf.*

EFFICIENCY OF SOCIAL TECHNOLOGIES

SSC: TARGET IS CONTINUITY

UDC 331

AT THE MOMENT IS CONTRACTING WITH THREE DRILLING COMPANIES SIMULTANEOUSLY WITH ONE OF THEM BEING SIBERIAN SERVICE COMPANY JSC. WHY LEADING OIL AND GAS PRODUCING ENTERPRISES CHOOSE ON SIBERIAN SERVICE COMPANY (SSC)?

KEYWORDS: *drilling contractors, Gazpromneft-Khantos, Siberian Service Company, personnel, scientific-technical conference.*

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It is common knowledge: any company's success is based on the company's high professional staff. For the management of SSC JSK – leading Russian oil service company successfully operating on the market since 2000 – this is a top priority and therefore the company strives to create extremely comfortable conditions for effective work.

Human resources is a key factor in oil and gas producing industry. In well drilling works preliminary operations take up to 60% of the whole process time. That is why the efficiency of final results depend on the speed and the quality of preliminary operations. Only high experienced professionals can manage heavy workloads and meet the requirements of the customers at the same time.

When working in industrial hazardous areas, sometimes even in extreme conditions, social support of the personnel is considered to be of strategic importance which determines the development of the entire company. However, the teams of Siberian Service Company are among the best ones in Russia! The collectives have been repeatedly awarded with prizes and certificates of honors by the customers.

FACTS

60 %

of time is taken by the preparatory process in drilling

For instance, in late 2016 well coordinated and professional operation of the employees of Directional Drilling & Telemetry branch of SSC-Technology were acknowledged: thanks to the professionalism demonstrated by the contractors which performed operations at the wells of Ombinskoye field of the Nefteyugansky region as well as due to perfect equipment functioning, several records of commercial speed and daily drilling were broken

It's impossible not to mention the fact that SSC JSC has been drilling wells at one of the largest oil field of Gazpromneft-Khantos - Priobskoye field – for 11 years. On average, the drilling team drills one directional well for 10 to 12 days which fact can also be obvious cause for pride. However, record 8 days have been fixed in the history of the company.

At the moment Siberian Service Company JSC actively develop slant-hole directional drilling. This technology requires radically new knowledge, skill, and experience. However, even now it can be seen that the professionals of SSC JSC successfully manage this task.

SSC JSC grows new generation of drillers to assist the company's veterans. The company provides young specialists with all facilities so that they will develop successfully. Education programs, social and material benefits, professional competitions are carried out to ensure enhancing their skills" continuously. Practical training starts even before the specialists have been employed in the company and includes practical work at the company's branches, internships. SSC JSC actively employs graduates from the best specialized education institutions of Moscow, St. Petersburg, the Urals, Ufa, Tomsk, Tyumen and other cities. The best graduates from Nefteyugansky Industrial College also work on probation at the company.

The status of young specialists is assigned to newcomers for five years. The status ensures the rights to enjoy certain benefits and guarantees. An experienced professional is attached to every young specialist to adapt him/her to working conditions, train him/her the best way to use knowledge, experience, and skills gain during

This June one of drilling teams of Nefteyugansky branch working together with contracted organizations of Gazpromneft-Khantos completed drilling of horizontal well with factual term of construction works equal to 28.21 days while planned term amounted to 32.5 days. This is a very good figure

the course of education. An individual development plan is designed for each young specialist.

Siberian Service Company JSC holds scientific and technical conferences regularly. The conferences serve as venues where young specialist from all company's branches can present their innovative solutions. The initiatives and proposals of the young specialists related to improvement of production and management activities of the company's branches are always met with great interest by the company's management.

Director of Tomsk branch Andrey Koshelev: "Young specialists is our future. The scientific and technical conference is held with the expectation that young specialists will invent some solutions applicable in our industry of drilling and construction of wells. The most promising projects will be realized for the benefit of the company"

Director of Yamal branch Yevgeny Guzeyev: "Our management is always supports conferences. This is one of our good traditions in Siberian Service Company: obligatory annual event where young specialists can present their ideas in the form of research papers. No doubt, both the company and the young specialists benefit from the event. While the company has opportunity to implement the ideas into production, the young specialists possess chances to demonstrate their abilities. The conference may serve as the impetus for their further professional development in SSC JSK"

IThe examples of the most successful projects in this year: "Equipment Modernization during Carrying out Tests" (Tomsk branch), "Development and Application of Epoxy Polymer Compositions as Modern Way of Finding Solutions to Interlayer Crossflows when Building Oil and Gas Wells" (Yamal branch).

A number of corporate education programs to support effective development of the future professionals have been designed in the company. Both experienced professionals and young specialists witness the importance of the programs.

ФАКТЫ

Since

2000

SSC SKC has been working on oil service market

For instance, in 2016 BIRC together with SSC JSC developed specialized education course for young specialists to improve key qualities: forming team targets when working in teams, development of abilities to coordinate actions in the process of solving problems, leadership in teams.

From the very moment of its foundation Siberian Service Company JSC pursue the policy of continuity: purposeful activities aimed at personnel development is a necessary condition for successful operation now and in the future. Respect, fairness, social partnership, continuity of experience and traditions present values SSC JSK bases its work on to offer high quality services performed by experienced professionals using advance equipment and up-to-date techniques. ●

Nowadays Siberian Service Company JSC is a leading company in its segment on domestic market. Market share of SSC JSC amounts to approximately 7% of annual drilling works performed in Russia. That means more than 4.5 thousand workplaces in several regions of Russia

HARDWARE-SOFTWARE COMPLEX FOR ELECTRICAL EXPLORATION

1.5 Devices, systems and means of automation

1.5.2 Control and measuring instruments

1.5.2.8 Geophysical equipment

The hardware and software complex for carrying out electrical exploration with use of resistance method, method of natural field, induced polarization, pipeline diagnostics, electrochemical protection studies, etc. This is a hardware-software complex that allows conducting electrical exploration with use of several methods.

Features:

- Communication between the generator and the measuring device on the radio channel (starting at the beginning and at the end of generation, setting up of the generator's frequency and current)
- Light kit weight – about 1.1 kg
- Long battery life (up to 5–7 days)
- Dust-moisture-shock-proof according to IP-65 protection class
- Screen heating (for operation at low temperatures)
- Conversion of dU to Rk
- Saving of results in the memory of the device, with the possibility of further transmission to the PC via USB-interface in the format of "ZOND" software
- Accounting of the methodology of fieldwork – reeling – unwinding, numbering of survey stakes, of the sizes of the intake lines and long-line currents, etc.
- Drawing of probing graphs on the screen of the measuring device, both during measurements and for archival data. ●

SPECIFICATIONS	
Generator:	
Output voltage up to	200V
Output current range	0.5–100 мА
Frequency range	0–2500 Hz
Generation started manually or via radio channel from a measuring device Stabilization error	 1%
Protection degree	IP65
Operating temperature range	from -30 to +50°C
Dimensions	160 * 80 * 55 mm
Weight	0.6 kg
Measuring device:	
Frequency range	0–2500 Hz
Measuring range	-5 - + 5V
ADC resolution	24 bit
Memory capacity	2MB
Communication interface with PC	USB
Synchronization with the generator	Radio channel 433MHz
Protection degree	IP65
Operating temperature range	from -30 to +50°C
Dimensions	180 * 130 * 35 mm
Weight	0.55kg

INFORMATION MONITORING OF WELL DRILLING AND GEOLOGICAL EXPLORATION

WHEN DRILLING IT IS NECESSARY TO CONSTANTLY MONITOR THE IMPLEMENTATION OF DESIGN SOLUTIONS, AND IN SOME CASES, THEIR PROMPT ADJUSTMENT. AFTER ALL, IT IS POSSIBLE TO OBTAIN HIGH-QUALITY GEOLOGICAL INFORMATION AND MINIMIZE ACCIDENTS WHILE DRILLING WELLS ONLY WHEN ALL DESIGN SOLUTIONS ARE IMPLEMENTED. ACCESS TO DRILLING MATERIALS AT ANALOGUE FACILITIES CAN IMPROVE THE EFFECTIVENESS OF PREVENTING COMPLICATIONS AND ACCIDENTS. ALL THIS MAKES THE METHODS OF PROCESSING AND STORING OF THE OBTAINED INFORMATION EXTREMELY IMPORTANT FOR CONDUCTING DRILLING OPERATIONS. HOW IS INFORMATION MONITORING CARRIED OUT IN MODERN ENTERPRISES TODAY?

KEYWORDS: *the exploration, drilling, information monitoring, drilling, oil production.*

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UDC 550.8

The implementation of all design solutions allows to obtain high-quality geological and field information and to minimize accidents during well drilling. Therefore, when drilling it is necessary to constantly monitor the implementation of design solutions, and in some cases, their prompt adjustment. Possibility of access to drilling materials at analogue facilities can improve the effectiveness of preventing complications and accidents. All this makes the methods of processing and storing of the obtained information important for conducting drilling operations.

In this regard, it is relevant to use the information environment both for drilling monitoring and for systematizing of the actual material for geological study of subsoil resources, determining of the priority directions for further geological exploration of oil and gas, as well as for using it to calculate the reserves, to create pilot projects, and for the development. Such a system will ensure the convenience and efficiency of using the entire amount of information. One of the most important tasks is the maintenance of geological information in the actual state.

FIGURE 1. Planning, organization and control of geological exploration, input data and results of implementation

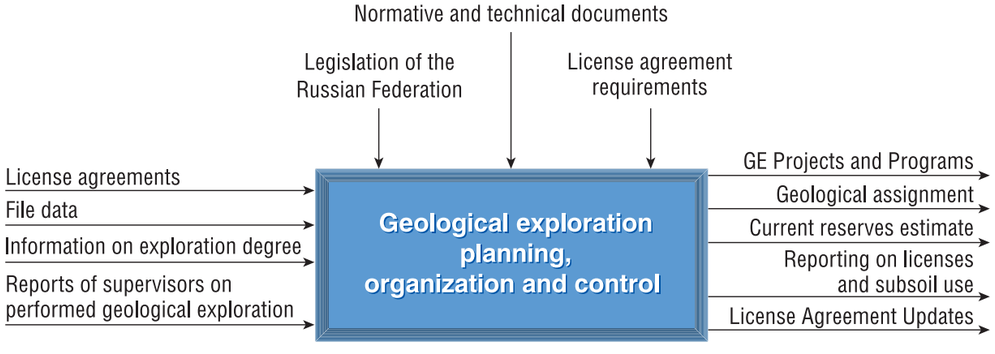
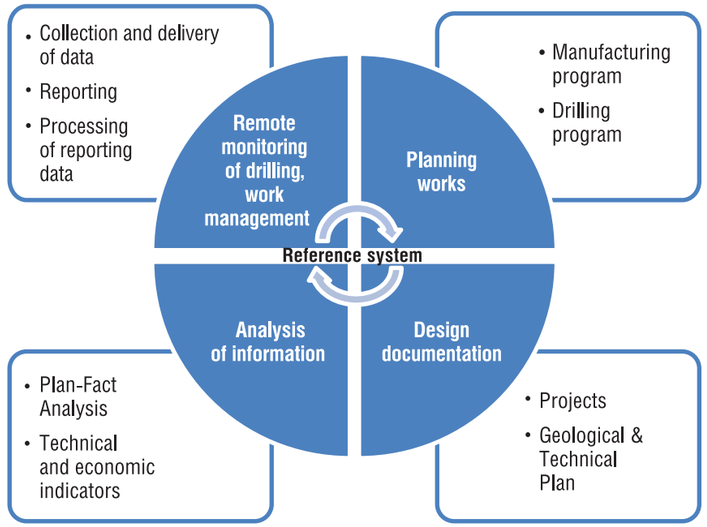


FIGURE 2. Operational diagram of the system



In SibGeoProekt LLC, a computer technology for monitoring of geological exploration has been developed, which allows to unite in one information environment design solutions and their current implementation, taking into account the accumulated experience of geological exploration in the area of interest. The exploration monitoring technology is a way of tracking the progress of operations, their control and regulation. A set of parameters was determined that allow the most accurate and complete tracking of the tasks and objectives of geological exploration (Figure 1).

The system consists of modules that are logically interconnected and complementary in terms of information. The system allows obtaining information in real-time mode from a monitoring facility, generating and processing daily and analytical reporting.

A tool has been developed that allows analyzing the indicators both by year and by depth. The ability of the system to use the accumulated information on the study of the territory allows to improve the quality of work on the design of new wells. Aggregation consists in transferring the time/depth/operation values from the discrete values to the integral values of the duration and interval of the operation, which allows you to quickly analyze and control the processes of carrying out various technological operations both on a separate well and on the scale of the entire deposit.

A distinctive feature of the developed information system is the ability not only to monitor the current parameters of well drilling, but to conduct their comparative analysis with design parameters, and, if necessary, with the data obtained when drilling analogue wells.

The interface used is developed in analogy with supervisory reporting, which makes it possible to use this system without additional training for company employees.

The collection of electronic forms of daily reports on drilling and testing of wells is carried out in automatic mode via communication channels to the company's server in real-time mode. You can generate a summary on daily reports on drilling and testing, in a tabular form for the selected period, as well as to make up a time balance chart.

With the help of the developed system, the drilling and testing process can be analyzed in different sections: For technical and economic indicators, chisel, core, sludge, perforations.

The module of keeping GTP is independent, to work with which it is enough to install Microsoft Office Access, that allows to use it without additional expenses.

Information coming from daily reports on the intervals of perforation of the formation, test intervals in the open shaft, well design is visually displayed in comparison with the design parameters.

The developed system provides on-line access to all the accumulated information on geological exploration, keeping of electronic design documents for drilling, on-line monitoring of the performance of physical volumes of work, compliance with deadlines and technological parameters, automation of the formation of regulated and analytical reporting (Figure 3).

FIGURE 3. Analytical block of the information system

The system allows to collect, structure and generalize the results of drilling of exploration wells, to conduct a comprehensive analysis of ongoing work. It is a prompt delivery of information from drilling sites to the subsoil user level that makes it possible to make quick and correct decisions on the performance of work.

INCREASE IN OIL RECOVERY FACTOR IN TERMS OF NEW ACHIEVEMENTS OF THE ACADEMIC SCIENCE

RUSSIA HAS A RICH RAW MATERIAL BASE OF LIQUID HYDROCARBONS: RECOVERABLE RESERVES OF A + B + C1 + C2 CATEGORIES OF OIL ACCORDING TO THE RUSSIAN CLASSIFICATION EXCEED 29 BILLION TONS, CONDENSATE RESERVES – 3.5 BILLION TONS. HOWEVER, ACCORDING TO THE ESTIMATION OF SPE CLASSIFICATION OF RESERVES ADOPTED ABROAD AND TAKING INTO ACCOUNT THE ECONOMIC COMPONENT OF OPERATION, THE PROVEN RESERVES OF LIQUID HYDROCARBONS IN RUSSIA DO NOT EXCEED APPROXIMATELY 11 BILLION TONS. ACCORDING TO THESE CALCULATIONS, RUSSIA RANKS EIGHTH IN THE WORLD RANKING OF OIL PRODUCING COUNTRIES AFTER VENEZUELA, SAUDI ARABIA AND CANADA, IRAN, IRAQ, KUWAIT AND THE UNITED ARAB EMIRATES. WHAT ARE THE PROSPECTS FOR INCREASING OF THE RAW MATERIAL BASE AND WHAT THE RUSSIAN ACADEMIC SCIENCE OFFERS FOR THIS?

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Keywords: *the increase in oil recovery, natural resources, new developments, oil & gas, oil recovery factor.*

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According to the Ministry of Natural Resources and Ecology of the Russian Federa-tion, the prospects for increasing the raw material base of traditional oil in Russia are very significant – the most reliable resources of category C3 exceed 12.5 billion tons, and the fore-cast resources of lower reliability (categories D1 + D2) are estimated at more than 47 billion tons. The basis of the Russian raw material base of liquid hydrocarbons is the West Siberian oil and gas basin, which accumulates two thirds of reserves, half of the forecast and 40% of prospective oil reserves. The basin oil has good qualitative characteristics, it is mostly light and medium in density, small and medium-sulfur oil. But the oil recovery factor in the basin varies in a wide range. Low-permeability reservoirs contain more than half of the basin's reserves, accumulating high-quality oil.

Stabilization and growth of the Russian economy are largely determined by the effi-cient and sustainable operation of the oil industry, which along with the gas industry can meet not only domestic needs but also needs of the external market.

Today's achievements of the oil industry in Russia were largely the result of the use of capacities formed during the Soviet era. However, over 60 years of industrial development of oil fields, their main operational facilities are in the late stage of development, which is char-acterized by high depletion of oil deposits and significant water cut of the borehole. There is a clear negative trend: The depletion of traditional oil reserves and the slowing of the growth rate of its production.

Two dozen Russian oil fields are unique (with reserves of more than 300 million tons). They provide a third of the national oil production. At the same time, many of them (Samotlor, Romashkinskoe, Mamontovskoe, Fedorovskoe, etc.) are in the late stages of their development. They are depleted and heavily watered. Several more giant deposits have reached a stable development maximum.

At the same time, according to the RF Ministry of Energy, 2/3 of the explored reserves are hard to recover, including 13% of high-viscosity oil, 36% of low-permeability reservoirs, 14% of sub-gas zones (oil rims), 4% of small thickness of the layers. It turns out that in mod-ern conditions only a third of Russian oil reserves are suitable for cost-effective development.

Almost half of the undeveloped oil reserves are in small and medium-sized deposits, they are more than 1,000. Many of them are remote from the infrastructure, expensive and difficult to develop, so the prospects for such deposits are very ambiguous.

Factors restraining the increase in the oil recovery factor

Completeness of oil recovery is measured by parameters characterizing the impact on the layer at the micro- and macro scale. The integral characteristic of the efficiency of oil production is the oil recovery factor (ORF). The level of oil recovery is considered to be the main criterion for a rational field development system. The higher the ORF, the more the field development system meets the criteria of rationality. The basics of the rational field development, formed during the Soviet era, ensured the achievement of ORF close to 50% already in the 1960s, while at present it hardly reaches 33%.

The tendency towards a decrease in ORF is due to both geological and technological factors (an increase in the share of hard-to-recover reserves, high water cut, man-induced changes in the layer, etc.). In addition to these reasons, a significant factor is the poor use of new knowledge gained in recent decades.

Existing diverse methods of active influence on the layer are unified from the hydro-dynamic point of view and are based on the theory of multiphase multicomponent filtration, equipped with modern information and software products (mainly of foreign origin). An im-portant part of these methods is the classical theory of fluid filtration in an isotropic medium, which is based on the Darcy law and the hypothesis of capillary pressure and relative phase permeabilities (RPP) as universal equilibrium functions of local saturation. It should be noted that the RPPs make a significant contribution to the oil and gas recovery factor, and the cor-rect determination thereof is of fundamentally important.

Thus, over the past 40-60 years, there has been no ideological advancement in the the-ory of hydrocarbon field development. At the same time, in recent decades new scientific re-sults have appeared that show that the main assumptions of the classical theory are not ful-filled in many practically important cases, and the results themselves are far from being used in real projects. First of all, this applies to the deposits with falling production, with a high degree of water cut, to hard-to-recover reserves in low-permeability, heterogeneous, aniso-tropic reservoirs, to high-viscosity heavy oil, layers changed due to man's activity, deep de-posits etc.

Will the science be welcome to increase ORF?

We will note only some of the new scientific results and technologies obtained by the staff of the RAS institutes, which should be taken into account when planning the ex-ploration and exploitation of deposits.

- Research of man-induced changes in the properties, structure, organization of the pore space and composition of formation fluids, the formation of occluded fluid phases not only in the borehole zones, but also in the interwell spaces, (IOGP RAS).
- A computer program has been developed to manage the created database and to calcu-late the physico-mechanical properties of reservoir rocks of oil fields according to seismic ex-ploration and GIS data (Institute of Physics of the Earth RAS, IPE RAS).
- A domestic simulator for modeling hydraulic fracturing of a layer was developed in an expanded formulation, taking into account the effects of reorientation of the formation stress fields (Institute of Applied Mathematics RAS – IAM RAS).
- A software package was developed for modeling the processes of heat and mass trans-fer and non-isothermal multicomponent filtration, taking into account the kinetics of liquid hydrocarbon oxidation in productive reservoir layers (Institute of Control Sciences of RAS – ICS RAS).
- They gave a scientific substantiation and recommendations on the practical application of the technology of directed relief of the formation to increase the productivity of the wells. A numerical model of the change in the filtration-capacitance properties of the nearfield was developed with using this technology (Institute of Problems in Mechanics of RAS – IPMech RAS).
- Scientific substantiation of methodological approaches to the localization of oil re-serves of marginal and underlying oil rims in oil and gas condensate fields under the long-term development in the gas condensate cap depletion regime (IOGP RAS, CEMI RAS).
- They gave the substantiation of new technologies for the application of the method of volumetric interpretation of gravitational fields during the operation of oil and gas condensate fields (IPE RAS, IOGP RAS).

- Technologies were developed for monitoring of geomechanical and thermodynamic processes in the development of oil and gas condensate fields (IOGP RAS, IPMech RAS, ICS RAS).
- Methods for controlling the properties of clays in the process of exploitation of oil de-posits were developed on the basis of research of the insulating and capacitive properties of clays and their changes during lithogenesis (Institute of Geoecology of RAS).
- They developed recommendations for identifying promising oil and gas facilities in deep-lying pre-Jurassic formations of deposits in the north of West Siberia on the basis of a complex of geological and geophysical research methods, fundamental studies of endogenous energy processes, fluid dynamics and degassing (IOGP RAS).
- Theoretically and experimentally, there were substantiated new ideas about the nature of the dependence between the absolute and phase permeabilities in the processes of two-phase expulsion of fluids. It is proved that the relative phase permeability (RPP) in anisotropic media depends not only on the saturation, but also on the expulsion direction. In field explora-tion planning practice, the absolute permeability anisotropy is taken into account only indi-rectly by setting its vertical component 10-2-10-3 times smaller than the measured permeability values along the axis of symmetry of the core sample. The RPPs are always specified as scalar functions of saturation for a given reservoir rock and filterable liquids. A similar result of the dependence on the flow direction was established experimentally for capillary pressure. This drastically changes our understanding of capillary effects and their connection with the chang-ing wettability of the solid matrix material in the process of oil recovery. The obtained results are important both for increasing the reliability and completeness of the initial information for the hydrodynamic

models, and for arranging of horizontal wells and estimating of reserves (IOGP RAS).

- A modern method for the comprehensive research of an anisotropic core material (terrigenous and carbonaceous) has been developed, which makes it possible to determine the absolute permeability, RPP, capillary pressure, elastic constants of the rock sample for various types of anisotropy (IOGP RAS, IPMekh RAS).
- The scientific fundamentals of new integrated technologies have been developed to ensure the effective development of hydrocarbon deposits with hard-to-recover reserves based on new physical and mathematical models and adequate numerical algorithms for studying of the mechanisms for managing the field's energy and for calculating of multiphase filtration flows (IAM RAS, IOGP RAS).
- They created a new generation of polymer-gel reagents with predetermined prop-erties and such technologies on their basis that allow to control fluid flows and increase the oil recovery of layers with a high degree of water cut (IOGP RAS).
- They have scientifically substantiated and prepared for implementation the tech-nology of minimizing of sand recovery to the oil wells in fields with falling production based on the creation of a polymer-gel rock-forming filter in the borehole zones, which retains me-chanical impurities with preservation of conductivity for oil (IOGP RAS).
- They gave a scientific substantiation of the technology of water shut-off of wells with the help of coiled tubing without lifting equipment based on the mathematical model (IOGP RAS).
- A new physico-chemical effect of the decomposition of gas hydrates by injecting of carbon dioxide has been discovered, which can be the basis of the technology for developing gas hydrate deposits (IOGP RAS).
- The features of the phase behavior of multicomponent hydrocarbon mixtures in the vi-cinity of critical points have been experimentally established; the results can be used to de-termine the type of deposit and the regime and technology selected for the development of oil and gas fields (IOGP RAS).

A special strategic emphasis should be made on the development of the Arctic shelf. Reserves of the Arctic shelf and transit opportunities of the Northern Sea Route are recog-nized as key strategic resources, the exploration of which is a task of national importance.

The creation of new technologies before the active development of Arctic deposits is fundamentally important. An important direction may be the use of underwater modules for the development of offshore deposits on the continental shelf. It should be noted that the in-dustrial exploitation of unique underwater compressor stations on the shelves of the Norwe-gian and Northern Seas began in 2015. The development of this direction in Russia will pro-vide significant economic and environmental advantages over existing technologies (con-struction of capital-intensive above-water offshore structures with personnel accommodation, power installations and other equipment).

It is necessary to implement the project of “selective” geological and geophysical field studies before the drilling of offshore boreholes.

There will appear a necessity for new solutions and technologies for physico-chemical monitoring of water areas, where oil and gas extraction takes place, hydroacoustic monitoring of the shelf, and technologies for mobile monitoring of the condition of underwater pipeline. The task of scientists should also be the development of a system for monitoring of emergen-cy situations (in particular, oil spills) and assessing environmental threats. Neither Russia nor anybody in the world has a technology to eliminate spills in arctic conditions.

In the context of a significantly more complicated structure of hydrocarbon reserves and the geological conditions of their occurrence, one of the main multi-parameter scientific priorities in the field of oil and gas problems is the development of innovative technologies for increasing of ORFs based on the use of new knowledge in various fields of science. And the theory of hydrocarbon field development planning is becoming multi-disciplinary, based on modern methods of geophysical research, underground hydromechanics and formation physics, on physical chemistry, mechanics of heterogeneous media, multiphase multicompo-nent filtration theory, thermodynamics and the theory of phase transformations, fluid and gas dynamics, theory of elasticity and plasticity, on the exploration of hydrocarbon systems in near- and above-critical conditions.

The current stage of development of oil and gas science is going through a turning point. It is caused by the unprecedented spread of computerization and informatization of the entire infrastructure related to the search, exploration and development of oil and gas fields, the implementation of the achievements of fundamental scientific research into the techniques and technology of oil and gas production, transport and refining, which makes it possible to move to an innovative stage in the development of oil and gas industry in Russia. ●

RISK MANAGEMENT OF SOIL AND WATER POLLUTION DURING OIL PRODUCTION AND TRANSPORT

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THE ANALYSIS, SYSTEMATIZATION AND GENERALIZATION OF INFORMATION CONCERNING A PROBLEM OF SOIL AND WATER PROTECTION AGAINST OIL POLLUTION ARE CARRIED OUT. EXAMPLES OF THE MOST CONSIDERABLE EMERGENCY OIL FLOODS TO SOIL AND SURFACE WATERS DURING ITS PRODUCTION AND TRANSPORT ARE PRESENTED. THE MEASURES FOR A REMEDIATION OF THE SURFACE WATERS POLLUTED BY OIL ARE DESCRIBED. THE SPECIAL ATTENTION IS PAID TO A REMEDIATION OF SOIL POLLUTED BY OIL AS A SOURCE OF ITS ENTERING IN GROUND WATERS, BY MIGRATION ON A SOIL PROFILE. THE ESSENCE OF THIS REMEDIATION CONSISTS IN SOIL CLEANING BY MEANS BIOCOMPOST FOR THE ACCELERATED MICROBIOLOGICAL DEGRADATION OF OIL HYDROCARBONS. RESEARCHES SHOWED THAT ENTERING VARIOUS DOSES OF BIOCOMPOST (50 AND 100 G/KG) INTO THE SOIL REDUCE TIME OF ALMOST FULL DEGRADATION OF OIL HYDROCARBONS AT CONCENTRATION IN 50 G/KG BY 1.8–4.8 TIMES, AT CONCENTRATION OF 100 G/KG – 1.7–4.0 TIMES

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KEYWORDS: *oil, pollution, soil, surface waters, ground waters, protection, remediation, biocompost, oil hydrocarbons degradation.*

It is known that the most serious pollution of soil, surface and underground waters by such fossil fuel as oil happens at its emergency flood. At the same time oil, coming in particularly to various water objects (lakes, rivers and seas), forms the film floating on water, the dissolved or emulsified forms, and its heavy fractions settle on a bottom and are adsorbed by bottom sediments as a source of secondary pollution of water mass [1]. The last occurs at a stirring up of surface layers of bottom sediments at wind influence, sharp increase in speed of a stream, dredging, i.e. withdrawal of bottom sediments during the dredging works. Oil in the water environment makes direct or indirect negative impact on the organisms (hydrobionts) living in its. So, at a flood of 1 t of oil can be formed the film capable to cover up to 12 km^2 of a water mirror that leads to violation of the vital exchange processes between an atmosphere and a hydrosphere, to temperature increase of a surface layer of water, deterioration in gas exchange and eventually, to death of hydrobionts [2].

Meanwhile, the main source of intake of oil in underground waters is the soil, which becomes polluted at the accidents arising by search and investigation, production and transportation of oil. Besides, in the course of drilling and operation of wells tightness of the underground water-bearing horizons is disturbed, their hydrodynamic and hydrochemical mode changes and as a result oil gets to these horizons or which are already used by the population for the drinking purposes, or subject to use in the long term [3]. Migration of oil from a soil in underground waters comes on pores of the horizons (on emptiness, cracks and cavities) composing a soil profile. Oil is besieged in zones of a capillary border and seasonal raising of underground waters, and also spreads on their surface. Furthermore, time achievement time by an oil stream of a mirror of underground waters is considerably reduced in the conditions of the so-called physically disturbed soil i.e. deprived of a vegetable cover and the top organogenic layer and presented by the underlying mineral horizons which have come to a day surface, and, therefore, the oil which is not protected from migration on a soil profile. Similar physical violation of the soil usually happens when constructing facilities on production and transportation of oil, in particular, on boring platforms and on routes of the roads and pipelines laid at the device of wells. In the absence of the top, most biologically active layer of soil, soil self-cleaning from oil, usually carried out by various hydrocarbons-oxidizing microorganisms (bacteria, yeast and fungi) is practically not observed [4]. Therefore, high risk of migration of oil into underground waters on a soil profile arises.

The purpose of this work is the analysis, systematization and generalization of information concerning a problem of protection of soil, surface and underground waters against pollution by oil. The logic of the specified problem demanded a statement of this information in the following sequence:

1) Examples of risky emergency oil spills in soil and surface waters;
2) Remediation of surface waters polluted by oil;
3) Risk of oil migration in underground waters from polluted soil on its profile;
4) Remediation of polluted soil as source of oil entering in underground waters.

Examples of Risky Emergency Oil Spills in Soil and Surface Waters

Concrete examples of quite recent pollution of soils and surface waters by emergency oil spills are given below. So, by data [5], the pollution of water of the Irtysh river (the Tyumen region) by oil made 57 maximum permissible concentration (MPC). In the Orenburg region in one case an oil spill from an oil-gathering collector was found that led to pollution of the soil site, and also a water surface (500 m^2) up to 46 MPC of the brook flow into tributary of the Samara river (the Volga river basin), and in other case of the depressurization of the pipeline led to oil spill and pollution of the brook flow into the Kindelka river (the Urals river basin) up to 23 MPC [6]. Meanwhile in the Komi Republic as the result of depreservation of ownerless wells there was an emission of oil and pollution of the Izhma river (the Pechora river basin) up to 82 MPC. In the Sakhalin region there was an oil flood on the soil surface (550 m^2) of 2.8 t from an oil collector [7]. In inflow of the Amur river – the Bureya river (the Amur region) an oil slick 25 km long has been noted, and the content of oil in water was more than 100 MPC [8]. In the Samara region an unauthorized (criminal) insert in the pipeline was resulted by oil spill on soil surface (600 m^2), and in the Sakhalin region pollution of water of the Okhinka river by oil in content of more than 100 MPC has been registered [9, 10].

As it is well known the quantity of similar emergency floods cannot be planned, and it is impossible to avoid them almost completely and therefore naturally a problem of a remediation in particular of the surface waters polluted by oil is arising.

Remediation of Surface Waters Polluted by Oil

To number of basic measures for a remediation of the surface waters polluted by oil the following is carried:

1) Installation the booms (floating) obstacles having various modifications (fixed buoyancy, inflatable, tidal and emerging) made of the special fabric having the high durability and resistance to oil impact and employees for restriction of distribution of its film on a water surface and promoting its concentrated collection and also use of the sorbents (peat bertinate, i.e. the dehydrated peat, aerosil – pyrogenic silicon dioxide and butadienestyrene rubber) simplifying and accelerating the procedure of mechanical removal of oil from a water mirror [11].

2) Application for water purification of the hydrocarbons-oxidizing microorganisms preparations representing dried up by lyophilization (at a low temperature and in vacuum) biomass of active strains, mainly the bacteria using oil hydrocarbons as the only source of carbon and energy, and also as material for synthesis of structural components of a cell [4]. Nitrogen-phosphorus compounds for stimulation of growth of number of microorganisms, and also the neutral sorbent having buoyancy for keeping of bacteria on a surface of a hydrocarbonic film are the important part of these preparations. The mentioned preparations usually apply at the water pollution level by oil which is not allowing to use water objects for the economic-drinking purposes, i.e. corresponding to an oil film on a water surface up to 1 mm thick.

Risk of Oil Migration in Underground Waters From Polluted Soil on its Profile

According to [12], the share of underground waters in water supply of the population of the Russian Federation is quite considerable and makes 46%. And in this regard the importance is attached to protection of underground waters against pollution by oil in areas of its production and transportation, as there is a risk of migration of oil into underground waters from the polluted soil on its profile.

The real intake of oil from the polluted soil in underground waters is demonstrated by a number of the works performed in the conditions of in situ. So, in the experiment on the podzol illuvial-humus soil (the Middle

Ob river) it has been established that the oil brought in soil surface at the dose of 22 l/m^2 in 1 year was frontally filtered up to the depth of 50 cm, that reaching a underground waters mirror causing their pollution [13].

On observations [14], in the conditions of the earth barn intended for burial of spilled oil in a profile of the silty-gley soil (zone of humid subtropics) emergence of the powerful intra soil flow of oil moving to the place of unloading of underground waters was noted. At the same time the upper bound of oil flow was traced at a depth of 50–60 cm, and lower bound was closed with a underground waters mirror.

In other work [15], the content of oil around an earth barn with a total area of 3000 m^2 (the Krasnodar region) used for collection of the oil spreading around a well was determined. It was as a result established that oil pollution of a soil profile extended up to the depth of 120–130 cm.

Meanwhile, at intake of oil in underground waters, tastes of drinking water spoil already at content >0.1 mg/l. This value represents MPC in water, in particular, of the multisulphurous oil established on the so-called organoleptic limiting harm indicator characterizing change of a smell and taste of water in the presence of this substance. However water becomes soiled not only by oil, but also by the cancerogenic substance benz(α)pyrene ($C_{20}H_{12}$) which quantity depending on the oil field can fluctuate within 240–8050 mkg/kg that is fraught with grave consequences for the person health [16]. So, in researches [17], direct correlation between pollution of drinking water by benz(α)pyrene of an oil origin and incidence of gullet cancer in local population in the basin of the Urals River was established.

Remediation of Polluted Soil as Source of Oil Entering in Underground Waters

Remediation of the polluted soil as a source of oil entering in underground waters includes soil cleaning by biological means containing hydrocarbons-oxidizing microorganisms. At the same time it is reasonable to carry out an efficiency evaluation of use of biological means originally in the conditions of in vitro that allows to model action of various factors (dose of substance, soil temperature and humidity) on degradation of oil hydrocarbons and to quickly obtain necessary information for an evidence-based remediation in the conditions of in situ.

So, in our works [18–20] efficiency of cleaning with simultaneously physically disturbed and oil polluted soil by means of biocompost representing the fermented peat-manure mixture enriched with hydrocarbons-oxidizing microorganisms in number of 10^6 cell/g and also nutrients was estimated. Such quantity of microorganisms is considered sufficient for self-reproduction of their population as one of conditions of effective cleaning of polluted oil soil [4]. Physically disturbed soil representing the naked sandy loam lower illuvial horizon of the gray forest soil 50–90 cm thick served as an object of a research (Fig. 1). Here the illuvial horizon is understood as the soil layer which is transition from the overlying horizons to parent rook. It should be noted that coloring of this soil is the most available, and first of all, the evident morphological feature characterizing its physical disturbance. Here for comparison of oil and biocompost colorings are presented. Meanwhile pollution of the soil was imitated by processing of its separate samples by oil in doses of 50 and 100 g/kg in which then brought biocompost in doses of 50 and 100 g/kg.

It should be noted that the peat which is a base part of biocompost slows down migration of oil in underground waters that is connected with its high sorption capacity reaching 10 g of oil on 1 g of dry peat and accelerates oil degradation process as number the hydrocarbons-oxidizing microorganisms in peat by 4–5 times exceeds a similar indicator for the soil [21].

Researches on degradation of oil hydrocarbons under the influence of biocompost have shown that when entering its various doses (50 and 100 g/kg) into the soil time of almost full degradation of hydrocarbons at concentration of oil in 50 g/kg is reduced rather control option by 1.8–4.8 times, and at concentration of 100 g/kg – 1.7–4.0 times (Table 1).

Here calculation of time of almost full degradation of hydrocarbons, i.e. for 99% (T_{99}) was carried out on results of the analysis of content of hydrocarbons in dynamics, using exponential dependence: $y = e^{-kt}$, where y – the residual content of hydrocarbons for the period of t carried to initial y_0; e – basis of a natural logarithm; k – constant of speed of degradation of hydrocarbons. The corresponding formula for calculation looks as: $T_{99} = ln\ 100/k$, where $k = ln(y_0/y)/t$.

FIG. 1. Coloring of the natural soil (1), physically disturbed soil (2), oil (3) and biocompost (4)


1


2


3


4

TABLE 1. Time of practically full degradation (T_{99}) of oil hydrocarbons in a simultaneously physically disturbed and oil polluted soil under biocompost action

Variant	T_{99}, day	Variant	T_{99}, day
Oil, 50 g/kg, control	**329**	Oil, 100 g/kg, control	**1150**
Oil, 50 g/kg + biocompost, 50 g/kg	**184**	Oil, 100 g/kg + biocompost, 50 g/kg	**658**
Oil, 50 g/kg + biocompost, 100 g/kg	**69**	Oil, 100 g/kg + biocompost, 100 g/kg	**288**

The contents of oil hydrocarbons noted in the course of the experiment a decrease under the influence of biocompost confirm the microbiological nature of degradation of these substances. The mechanism of observed process consists, first of all, in absorption of hydrocarbons by means of a hydrophobization of the cell wall of microorganisms realized through biosynthesis of specific compounds – lipophil glicol-, peptide- and peptideglicollipids [4]. In case of a direct contact of bacteria with a hydrocarbon film the latter penetrate into the cell by passive diffusion – gradual penetration into the cell wall – and reach enzymes on membranes, which are carrying out hydrocarbons degradation. Along with molecular-diffuse penetration of hydrocarbons through the surface of the cell wall, they can penetrate through special ultra-microscopic pores as well. Such channels filled with electron-dense (granular) substances were first found in yeasts. It is known that oxidation of oil hydrocarbons occur by majority of microorganisms happens to the help of so-called adaptive enzymes. The end products of oxidation of hydrocarbons are carbonic acid and water, however as intermediate products alcohols, organic acids and ester are found.

Conclusion

Thus, protection of soil, surface and underground waters against pollution by oil as the substance containing cancerogenic benz(α)pyrene, consists in their remediation. So, for effective remediation of the surface waters polluted as a result of emergency oil spills the boom obstacles serving for restriction of distribution of its film on a water surface and promoting the concentrated oil collection. Other means for this purpose are the sorbents simplifying and accelerating the procedure of mechanical removal of oil from a water surface and also preparations of hydrocarbons-oxidizing microorganisms for cardinal water purification of in situ are used. Remediation of the polluted soil as main source of intake of oil in underground waters can be carried out only by its degradation by hydrocarbons-oxidizing microorganisms preparations that the risk of pollution of these waters by this substance will be avoided. ●

References

1. *L.I. Sverlova, N.V. Voronina. Pollution of Environment and Ecological Pathology of the Human. Khabarovsk: OOP KKGS Publishing House, 2001. – 216 p.*
2. *T.A. Alekseeva, L.M. Masaeva. Problems of protection of the water environment against pollution by oil and oil products // Environment Protection in an Oil and Gas Complex. – 2008. – No. 5. – P. 21–24.*
3. *Z.I. Zholdakova, N.I. Belyaeva. Danger of water objects pollution at oil production // Hygiene and Sanitation. – 2015. – No. 1(94). – P. 28–31.*
4. *E.S. Dmitrevskaya, T.A. Krasilnikova, O.A. Markova. About pollution of environment and a radiation situation in the territory of the Russian Federation in March, 2016 // Meteorology and Hydrology. – 2016. – No. 6. – P. 103–110.*
5. *E.S. Dmitrevskaya, T.A. Krasilnikova, O.A. Markova. About pollution of environment and a radiation situation in the territory of the Russian Federation in April, 2016 // Meteorology and Hydrology. – 2016. – No. 7. – P. 103–111.*
6. *E.S. Dmitrevskaya, T.A. Krasilnikova, O.A. Markova. About pollution of environment and a radiation situation in the territory of the Russian Federation in May, 2016 // Meteorology and Hydrology. – 2016. – No. 8. – P. 100–106.*
7. *E.S. Dmitrevskaya, T.A. Krasilnikova, O.A. Markova. About pollution of environment and a radiation situation in the territory of the Russian Federation in August, 2016 // Meteorology and Hydrology. – 2016. – No. 11. – P. 96–103.*
8. *E.S. Dmitrevskaya, T.A. Krasilnikova, O.A. Markova. About pollution of environment and a radiation situation in the territory of the Russian Federation in October, 2016 // Meteorology and Hydrology. – 2017. – No. 1. – P. 124–131.*
9. *E.S. Dmitrevskaya, T.A. Krasilnikova, O.A. Markova. About pollution of environment and a radiation situation in the territory of the Russian Federation in January, 2016 // Meteorology and Hydrology. – 2017. – No. 4. – P. 124-129.*
10. *I.Iu. Kulikova, I.S. Dserzhinskaya. Modern technologies of cleaning of soil territories and water areas of oil pollution // Environment Protection in an Oil and Gas Complex. – 2008. – No. 5. – P. 72–75.*
11. *T.V. Koronelly. The principles and methods of an intensification of biological degradation of hydrocarbons in environment (review) // Applied Biochemistry and Microbiology. – 1996. – No. 6(32). – P. 579–585.*
12. *L.I. Elpiner. Modern medico-ecological doctrines about underground waters // Hygiene and Sanitation. – 2015. – No. 6. – P. 39–46.*
13. *I.G. Kalachnikova, T.A. Maslivets, A.A. Oborin, A.I. Ogloblina, Iu.I. Pikovsky. Transformation of oil in podsolic soils of Middle Ob river // Migration of the Polluting Substances in Soils and Adjacent Environments. Leningrad: Gidrometeoizdat Publishing House, 1985. – P. 74–80.*
14. *Iu.I. Pikovsky, V.A. Veselovsky, V.S. Vshivtsev, L.S. Ernestova, L.A. Biya. Geochemical and ecological studying of oil streams in a zone of humid subtropics // Migration of the Polluting Substances in Soils and Adjacent Environments. Leningrad: Gidrometeoizdat Publishing House, 1985. – P. 64–69.*
15. *A.P. Maksimenko, V.A. Gersh. Assessment of pollutants of the soil – sludge depots // AgroXXI. – 2006. – No. 7-9. – P. 47–48.*
16. *G.S. Serkovskaya. Content of benz-α-pyrene in samples of commodity oils // Chemistry and Technology of Fuels and Oils. – 2011. – No. 3. – P. 56.*
17. *T.M. Belyakova, T.M. Dianova, N.Ya. Trefilova. Geoecological studying of landscapes of a river basin the Urals in connection with population morbidity by cancer // Problems of Biogeochemistry and Geochemical Ecology. – 2006. – No. 1. – P. 183–191.*
18. *V.A. Markelov, O.P. Andreev, D.N. Kobylkin, A.K. Arabsky, O.B. Arno, P.G. Tsybulsky, V.N. Bashkin, A.S. Kazak, R.V. Galiulin. Gas Industry Sustainable Development. Moscow: LLC «Publishing House Nedra», 2013. – 211 p.*
19. *R.V. Galiulin, R.A. Galiulina. Remediation of polar ecosystems polluted by gas condensate and oil hydrocarbons by biological preparations // The Open Ecology Journal. – 2015. – V. 8 (Suppl 1-M5). – P. 40–43.*
20. *R.V. Galiulin, V.N. Bashkin. Biogeochemical approaches for managing geoenvironmental risk of hydrocarbons pollution in disturbed soils // In: Biogeochemical Technologies for Managing Pollution in Polar Ecosystems. Environmental Pollution. Springer International Publishing Switzerland, 2017. – V. 26. – P. 185–192.*
21. *T.P. Alekseeva, T.I. Burmistrova, N.N. Tereshchenko, L.D. Stakhina, I.I. Panova. Prospects of peat use for cleaning of the petropolluted soils // Biotechnology. – 2000. – No. 1. – P. 58–64.*

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Speakers of the Russian
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A. Ivantsov, V. Zavershinsky

K. Nizhegorodov

Participants
of NDExpo-2017

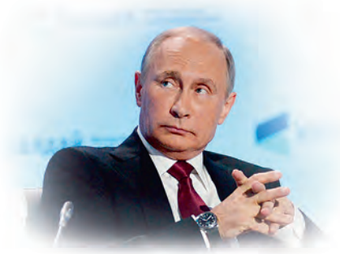
M. Dubinina

"The oilman will never lay his head on the road or on the rails. Miners are a special page in the fuel and energy sector"

V. Kalyuzhny

"There where there are Muslims, there is oil; the converse is wrong"

Ch. Issawi



"For the last two years, oil production in Russia has increased by 400 thousand barrels"

A. Novak

"How will our economy react to the reduction in oil production? We took this step consciously, we have a fairly high production limit"

V. Putin

"They say that low inflation now is, in many respects, the result of higher oil prices and the strengthening of the ruble"

E. Nabiullina

"The oil sector should be privatized in the next 7–8 years"

A.Kudrin

"The issue of dividends of state-owned companies and the public sector, reduction of the state sector through privatization is a matter of competition, which is critical now"

A. Siluanov

"As the main fuel sources, oil and gas will go to the background"

G. Gref

"There are serious restrictions for potential growth, and we need to work with them. Two such basic elements are investment support and development of human capital"

M. Oreshkin

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