EVOLUTION OF OIL AND GAS TECHNOLOGY

RUSSIAN FUEL AND ENERGY SECTOR: DIGITISING

OFFSHORE INTEGRATED LNG TERMINAL

BUSINESS MAGAZINE

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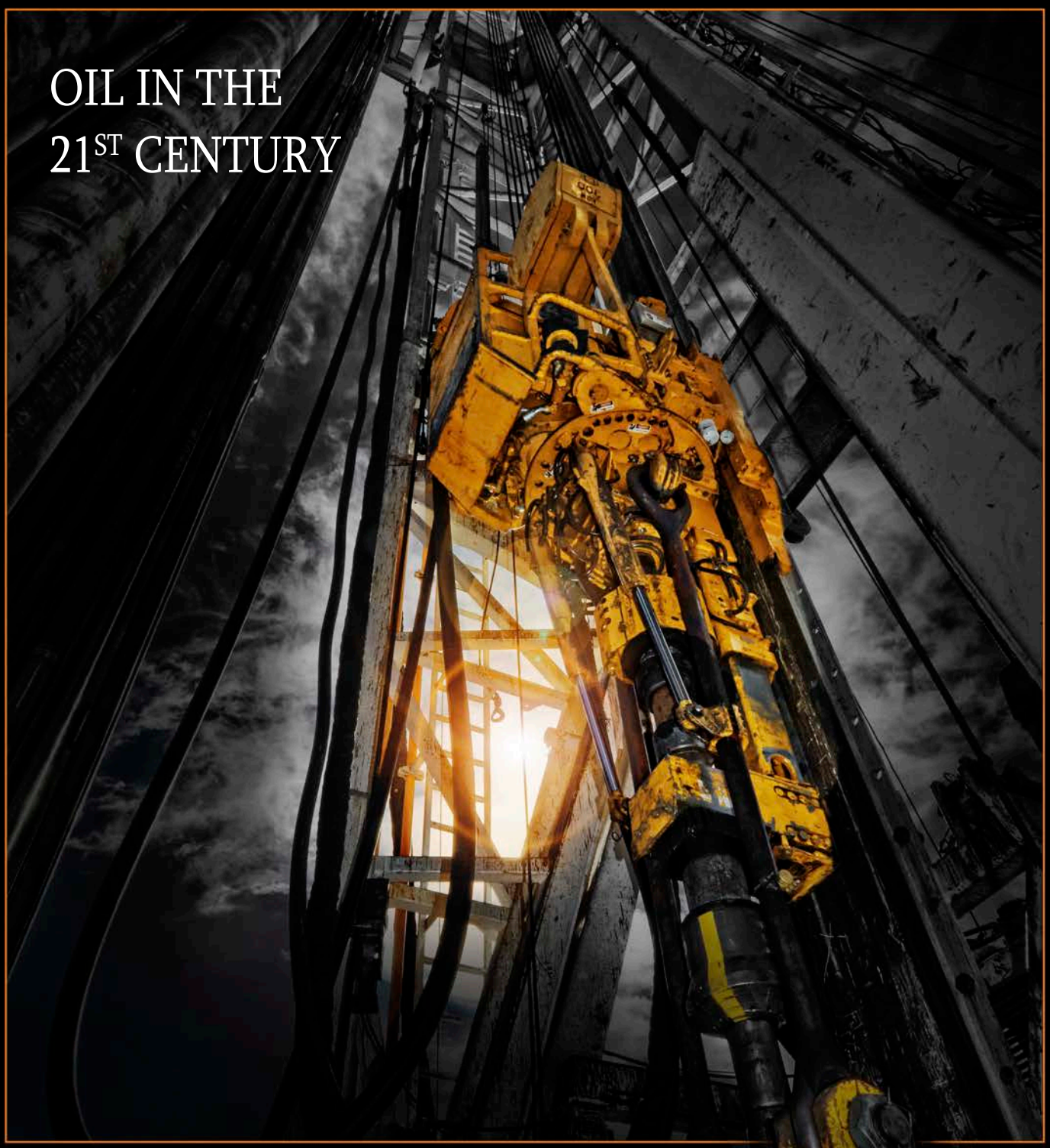

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OIL AND GAS INDUSTRY EPOCHS

800 years ago

In 1220, during the siege of Bukhara, Genghis Khan ordered his troops to fill pots with oil and charge their throwing machines with them. When the pots of oil would break against the walls of the city, they were shot at with flaming arrows.

700 years ago

In 1320, a French missionary monk, Jourdain de Severac wrote in his notes about the extraction of oil in Azerbaijan: "there is a place called Baku, where they dig wells, from which they extract oil, they called it naphtha".

600 years ago

In 1420, in one of Israel von Mehli's depictions of the Resurrection, he engraved the devil shooting Greek fire. According to Maximus the Greek, Greek fire consisted of sulfur and earth oil (crude oil).

500 years ago

In 1520, Krystof from Gendorf, the advisor to King Louis Jagiellon, was granted the long-awaited right to mine ores in practically the entire Karkonosze region. Over time, mining gave life to the coal industry in Poland and the Czech Republic.

400 years ago

In 1620, Jan Baptist van Helmont, placed a piece of marble in a solution of hydrochloric acid and observed the release of "the forest spirit" which he called "gas". He introduced the term"gas" into science and pointed out the difference between gases and vapours.

300 years ago

In 1720, the lamps were first installed to illuminate the streets of St. Petersburg, by the decree of Peter the Great. They would use hemp oil.

200 years ago

In 1820, the oil extracted in the state of Kentucky was shipped to Europe. Thus, the American businessman Beatty was the first to start the production of oil in North America.

100 years ago

In 1920, oil fields in Russia were nationalised. The Nobel brothers sold a significant portion of their Russian assets to Standard Oil. The company was against the decision to nationalise, and refused to work with the Soviet government.

In 10 years

In 2030, Alberta's bituminous sands will produce 5 million barrels per day.

In 20 years

In 2040, global oil productions will reach their peak.

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pr@neftegaz.ru
Tel.: +7 (495) 650-14-82

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Editorial office address:
127006, Moscow, Tverskaya str., 18, building 1, office 812
Tel. (495) 650-14-82, 694-39-24
www.neftegaz.ru
e-mail: info@neftegaz.ru
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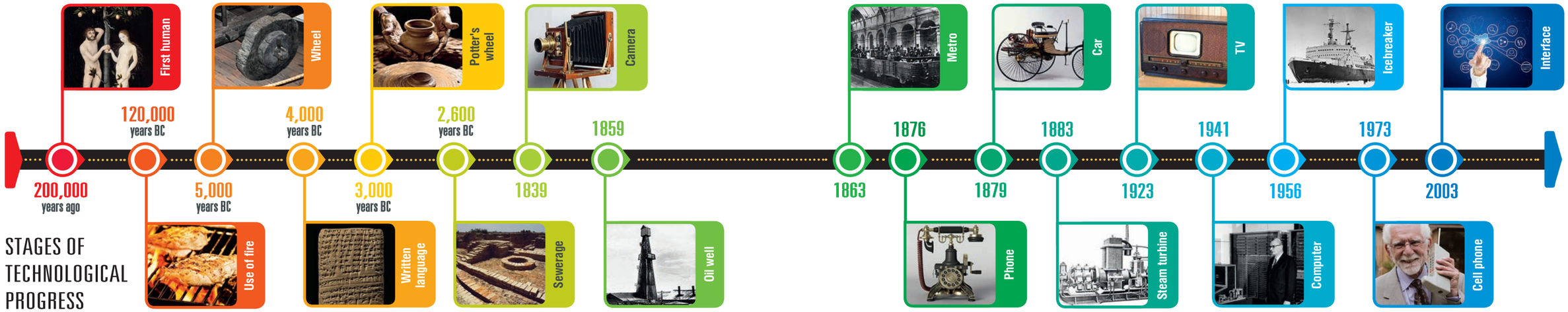


OIL
in the 21st century

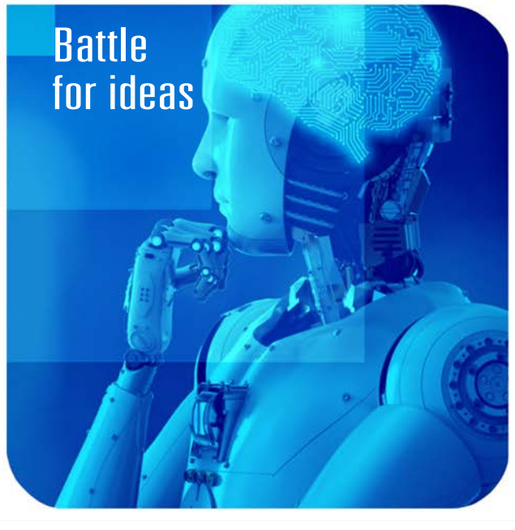
Anna Pavlikhina

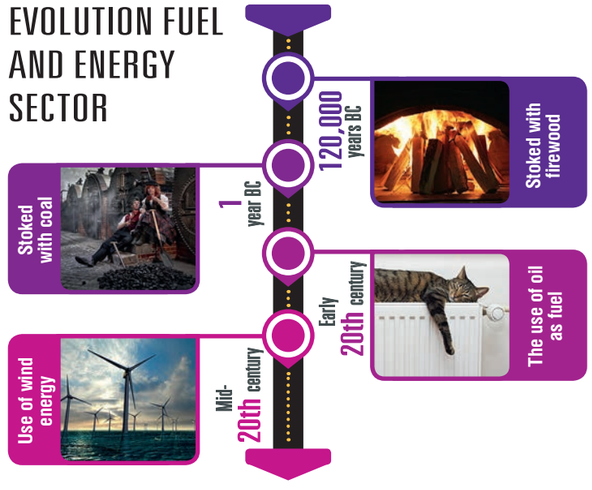
The first adequately conscious human being appeared on our planet 200,000 years ago. Some 80,000 years later, his ancestors learned how to use fire. Another 70,000 years past, they crafted the bow and arrow, 66,000 years after that, they invented literacy, an invention that accelerated and made key changes throughout history. Since then evolution took an adverse course in the Mesopotamian region, as this invention belongs to the ancestors of the ISIS savages who destroy monuments of antiquity today, but otherwise, progress made seven-mile leaps: 5 thousand years passed from the invention of writing to the steam turbine, from the turbine to the automobile – 250 years, from the first car to the cellular phone – 94 years, from the phone to cloud technologies – 30 years. You get the picture, progress is picking up pace.

The energy sector is the steam locomotive of history, the steps in its evolution are becoming more grandiose by the century. The transition from wood to coal took mankind 120 thousand years, from coal to crude oil – 2 thousand years, from oil to gas it took 50 years, today, we're already using the energy generated by the sun and the wind.

What's our next step going to look like? The beginning of the 21st century marked a new era for the developement of various human activities, including oil and gas. It's evident, that in the near future we can look forward to another revolutionary leap.

Today, Russia takes on an important global role as the timely, high-quality energy carrier. Like they say, every profession is crucial. We can disregard political views and economic aspects; as neither good or bad. For oil refineries to function, thousands of Indian nationals manually assemble fine-grade catalytic converters. For Germany to spend billions on R&D of





technologies, Russia needs to supply it with gas. At some point this seemed normal. Today, on the other hand, this arrangement seems unviable. Manual labour is being replaced by robots, whilst crude oil by renewable energy sources.

So why did declining oil prices become the economic highlight this spring? Because the age of carbohydrates will prevail very long. Although, time does change their role. Instead of being an energy source, they can become the raw material for high-tech products. Now is the time to consider shifting to a new phase that will grant us unlimited possibilities for the third millennium to come.

In your hands, you hold the 100th edition since the establishment of the publication. Particularly the evenness of this figure has served as the motivation to an overall generalisation. In the pages to follow, you will come across articles dedicated to novel technologies as well as references to a world in the not-so-distant past. These comparisons presented in parallel with the rapidly changing present, provide the most vivid image of where science is going to take us, as well as, where the key points of economic development will be centered.

THE RUSSIAN GOVERNMENT PURCHASED ROSNEFT'S VENEZUELAN ASSETS

Rosneft has signed an agreement with the company, which belongs entirely to the Russian government, to cease its operations and sell its stake in all Venezuelan projects.

The name of the purchasing company was never mentioned, but on the day when Rosneft left Venezuela, Rosimuschestvo established Roszarubezhneft with a Cap of 323 billion rubles. Presumably, Rosneft's Venezuelan assets were transferred to this company.

The top three leaders in oil production have not changed for many years: Russia, Saudi Arabia, and the USA, moreover, the United States has practically doubled its oil production in the past 10 years. Amid the growing influence of the US in terms of oil, control over Venezuelan oil and gas automatically makes Russia a super powerful oil and gas country. Together, Russia, Iran and Venezuela would be able to control the oil market.

While Russia has been the leader in oil production among this informal union, Venezuela leads the way in terms of oil reserve volumes. Venezuelan oil reserves amount to 298.4 billion barrels! Iran – 157.8 billion barrels, Russia – 80 billion barrels. By controlling approximately 33% of global oil reserves, the informal alliance could be a very powerful force.

The deal is aimed at getting Rosneft out of harm's way. On February 18, 2020 the U.S. Treasury Department imposed sanctions against Rosneft Trading, a subsidiary of Rosneft.

The sanction was imposed "for operating in the oil sector of the Venezuelan economy".

The American authorities accused the company of supplying oil from the country to foreign markets. Rosneft shifted Venezuelan oil exports to another subsidiary, TNK Trading International, however, sanctions were imposed against it as well. The US Treasury Department stressed that the restrictive measures would be lifted when the company takes concrete, tangible and verifiable actions. Rosneft now patiently waits for sanctions imposed against it to be lifted. On top of that, Russia's shift into Venezuela does not mitigate the situation. Previously, if the U.S. authorities imposed sanctions against companies, how will sanctions against the Russian government be imposed? ●

Neftegaz.RU ratings

The Russian government bought out Venezuelan assets of Rosneft in exchange for the transfer of state-owned shares of the company, in the hope that the US will lift sanctions from Rosneft. How will this affect the activities of Rosneft and the entire oil and gas complex of the country?

The Russian government bought out Venezuelan assets of Rosneft.. What to expect?

16%
Venezuelan oil and gas control makes Russia a super-influential oil and gas country

30%
The USA also wants to control Venezuelan oil, now a conflict between the US and Russian authorities may happen

13%
US imposed sanctions against Rosneft "for work in the oil sector of Venezuela", now sanctions should be lifted

42%
This is a signal for foreign partners that all work is being transferred under the control and reliable protection of the Russian government - and not only for existing assets

D. Trump signed a decree on the right of the United States to use the resources of the moon. The USA does not consider space as a “global commons” and believes that it can conduct any activity outside the Earth without additional international agreements

Can the Americans arrogate to themselves the Moon?

29%
Yes, if they conquer the territory before China

16%
No, the natural satellite belongs to all humanity

12%
Yes, if after the development they prepare the military space fleet

23%
No, by resolution of the UN General Assembly, the Moon is not subject to national appropriation

15%
Yes, the USA knows how to interpret laws to their advantage

5%
No, Trump’s order alone is not enough.” Extraction of minerals on the moon is a complex process, one state cannot manage it

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THE EVOLUTION OF OIL AND GAS TECHNOLOGY

Irina Gerasimova

RUSSIA HAS ENTERED THE NEW CENTURY AS A WORLD LEADER IN OIL AND GAS RESERVES. HOWEVER, AFTER THE COLLAPSE OF THE “NINETIES”, THE INDUSTRY LOST MANY OF THE COMPETENCIES ACCUMULATED DURING THE SOVIET PERIOD, AND RUSSIAN COMPANIES WERE “CATCHING UP”. THE NEW ERA ALMOST DID NOT GIVE TIME FOR A QUIET DEVELOPMENT. ON THE ONE HAND – UNFORESEEN TECHNOLOGICAL OPPORTUNITIES, ON THE OTHER - CHANGING MARKET CONDITIONS, STIFF GLOBAL COMPETITION, AND ESSENTIALLY, THE REDUCTION OF HYDROCARBON RESOURCES. THE CUMBERSOME AND – AS IS CONSIDERED – CONSERVATIVE INDUSTRY MUST ADAPT TO NEW CONDITIONS

Same for all

The globalization of markets, including energy, has become the leading trend of the 21st century. Thanks to the development of technology, transport, communications, local and regional oil and gas markets are increasingly removing borders. At the same time, international cooperation is increasing: complex oil and gas projects, as a rule, require a large number of participants, often from different countries.

At the same time, competition between the oil and gas producing countries is getting tougher. Over the past two decades, Russia has been cultivating its traditional sales markets, and is also fighting for new ones – primarily China and other Asia-Pacific countries.

Two powerful pipelines were built to supply oil and gas to the Celestial Empire: ESPO and Power of Siberia. At the same time, gas transmission capacities in the western direction were increased (Nord Stream and subsequent Gazprom projects). New oil loading terminals (Ust-Luga, Kozmino and others) were built. Russian Gazprom and NOVATEK began to produce and supply liquefied natural gas (LNG) to international markets.

An important challenge was the American "Shale Revolution", which turned the United States from an exporter into a net importer of gas and seriously redefined the energy market. Consumer countries got the opportunity to conclude contracts on more favorable terms (which is not in Gazprom’s favor), spot trading volumes of “blue fuel” began to grow.

In the competition between hydrocarbon suppliers, tough measures are used: price wars, sanctions and restrictions. Thus, the sanctions of the United States and the EU introduced in 2014 limited the access of Russian oil and gas companies to Western technologies and capital markets and, as a result, undermined a number of important projects for the Russian Federation – in particular, on the development of the Arctic shelf.

A positive point: sanctions stimulate Russian companies and their partners to develop their technologies, equipment, and software. If this problem is successfully solved, Russia in the global energy market will also be able to assume the role of leading source of innovation, and not just supplier of raw materials.

Globalization also strengthens the dependence of all its participants on each other and does have many threats in common. The most striking example is the COVID-19 pandemic, which resulted world oil and gas consumption in a “free fall," the consequences of which are not yet entirely predictable.

FACTS

For 30 years

enough oil in Russia and enough gas for 50 years

The Age of Hard Recoverable Oil

Domestically, Russian oil and gas industry faced a reduced availability. According to the estimates of the Ministry of Energy, Russia will have enough oil for at least 30 years, and gas for 50 years. But at the same time, the raw material base, mainly for oil, is deteriorating.

In the key region for the domestic "oil industry" – Western Siberia in 2008-2018 production dropped by 10%, although drilling meterage grew. Over the past ten years, the production rate of new wells in the region dropped by an average of 34%, and watering increased from 33% to 50% (data from the Ministry of Energy).

For new reserves, oil companies have to move to uninhabited regions with extremely harsh climates in the north and east of the country. Until 2014, high hopes were pinned on offshore production, including in the Arctic, but drop in oil prices and sanctions forced to push a number of planned projects "to the back of the drawer". Production in the Arctic is conducted only at the Gazprom Neft Prirazlomnoye field.

However, production continues on three offshore projects off the coast of Sakhalin. There are major new discoveries: the Neptune and Triton fields of Gazprom Neft in the Sea of Okhotsk, and the Pobeda of Rosneft in Kara Sea. LUKOIL operates in the Baltic and the Caspian Sea.

A certain "margin of safety" is retained by traditional areas of oil production. Oil workers are trying to support oil production by increasing oil recovery at

Brownfields, introducing the remaining deposits, as well as engaging in the development of unconventional reserves: the Bazhenov and Tyumen Formations, the Achim deposit, and bitumen oil. This gives a definite result. So, in the Khanty-Mansi Autonomous Area-Yugra (42% of Russian oil production in 2019), over the past two years they have managed to stabilize oil production at the level of 235–236 million tons.

Hard-to-recover reserves (TRIZ) should be mentioned separately. According to estimates by the Ministry of Energy, the share of such in the overall structure of oil reserves reaches 65%. At the same time, production from unconventional deposits is growing all over the world, and it is another important industry trend. In Russia, TRIZ accounts for about 7% of production, but the largest companies are working on technologies that will increase production.

A special focus is on the search for cost-effective ways to develop the Bazhenov Formation; the extraction of this oil could give a “second wind” to Western Siberia. Forecasts estimate the geological reserves of Bazhen as huge – 18–60 billion tons. Gazprom Neft promises to achieve profitable production next year. To date, the cost of producing a ton of Bazhenov oil has been reduced to 16 thousand rubles per tonne compared to 30 thousand rubles per tonne in 2017.

New technologies for extracting oil

It has become possible to implement many complex upstream projects through the introduction of advanced technologies. A special role in the last decade in production has been played by horizontal drilling and hydraulic fracturing. Both technologies were borrowed in the West, although similar operations were carried out in the USSR.

According to last year's Deloitte study, in 2013–2018 the share of horizontal drilling in the Russian oil industry grew from 21% to 48%. Further growth is projected for the future.

Today, oil workers are building technologically sophisticated wells with two or more completions, including fishbone-type wells. For the shelf, wells are drilled with an extra-long deviation from the vertical, allowing underwater production from the shore. Hydraulic fracturing is being used more and more often, although seven years ago, President Vladimir Putin called hydraulic fracturing “a rather barbaric way” – because of environmental damage. High-speed and high-volume hydraulic fracturing operations, multi-stage (up to 30 stages) are under way, and the technology of repeated multi-fracturing is being developed.

Hydraulic fracturing (usually in combination with horizontal drilling) is actively used to increase oil recovery, as well as the development of unconventional deposits of the Achimov strata, the Tyumen and Bazhenov Formations. At the same time, oil and gas and service companies form their own approaches. The most effective compositions of fluids, reagents, and cements are being selected; new samples of domestic drilling equipment, etc. are being developed.

FACTS

Hydraulic fracturing

it is used to increase oil recovery, the development of unconventional deposits of the Achimov strata, the Tyumen and Bazhenov formations

Digitalization

increase the efficiency of production processes, allow more flexible and faster response to market requirements and reduce company costs

Intellectualization and digitalization

The last decade in the domestic oil and gas industry has been marked by the active introduction of «smart» technologies. Drilling and exploitation of the same multilateral or ultra-long horizontal wells would not have been possible without high-tech equipment, numerous sensors, and specialized software that continuously collects and interprets data.

The first intellectual wells in Russia were built in the second half of the “zero”. On the shelves and in inaccessible areas, several “smart” fields have been launched, equipped with minimal manning or automated technologies.

Digital technologies are widely available throughout the oil and gas industry - from exploration to marketing. “Digital” shows high efficiency in geological exploration (for example, Gazprom Net, based on the results of digital processing of geodetic, has found new hydrocarbon reservoirs in Vyngapur). Actively promoting automation, and now digital technology are used in oil processing. Advanced technologies are “entrusted” with safety control, selection of the optimal operating mode of equipment, etc. The protection of pipelines and other objects is increasingly entrusted to drones and special systems. In the field of marketing, electronic services are being developed for company customers.

The next step is the transition from selected “smart” technologies to full-scale digitalization of companies “from the well to the gas nozzle”, and then the whole industry. It is believed that digitalization will increase the efficiency of production processes, allow a more flexible and faster response to market requirements, and, ultimately, reduce the costs of companies. In addition, digitalization will increase the transparency and manageability of the industry. However, this will require companies to transform their entire business.

LNG Growth

The main factor dividing the gas market again is the global growth in LNG production and trade. According to BP, in 2018, 11% of global gas production was already directed to liquefaction. The Russian Ministry of Energy expects that by 2025 the share of LNG in the total trade in “blue fuel” will increase to 51%, and by 2040 – to 70%, as a result of which the world gas market will become globalized.

Today, market leaders are Qatar, Australia, Norway, Canada, Russia and the United States. So far, the Russian Federation has two large-capacity gas liquefaction plants – a plant under the Sakhalin-2 project (controlled by Gazprom) and Yamal LNG (NOVATEK).

In the next 15 years, to become one of the three leaders in LNG supplies is the task set for Russian companies. “One of the goals of the energy strategy is to develop LNG production and increase Russia's share in world markets from 8% to 15–20%. Our capacities already reach 30 million tons, by 2035 we can already reach production from 80 to 140 million tons per year,”said Russian Minister of Energy Alexander Novak on the air of Russia 24 channel in early April.

This will be possible after the launch of new plants that are going to build "NOVATEK", "Gazprom" and "Rosneft". NOVATEK is the closest to the implementation of Arctic LNG-2. It is important that companies will work on Russian liquefaction technologies (existing plants operate on Western ones).

According to last year’s forecast by the Center for Strategic and International Studies in Washington, Russia has every chance in ten years to become one of the three leaders in gas liquefaction. However, the Americans believe that Qatar and the USA will be ahead of it.

According to last year’s forecast by the Center for Strategic and International Studies in Washington, Russia has every chance in ten years to become one of the three leaders in gas liquefaction. However, the Americans believe that Qatar and the USA will still remain ahead.

FACTS

LNG

share

in total gas trade by 2040 will increase to 70%

«Green» future

In parallel with the depletion of hydrocarbon reserves in the world, the trend towards the use of environmentally friendly fuels of renewable energy sources (RES) is intensifying.

So far, oil has a leading share in the overall structure of global energy demand with a share of 31.5%, and for gas – 23%. According to forecasts by the IEA and OPEC, in 2040 oil and gas will be the main types of fuel.

The share of new energy sources (sun, wind, biomass and water, not counting the generation of hydroelectric power stations) in the global energy balance is still calculated in units of percent, but many forecasts indicate future growth. Thus, the IEA believes that the total capacity of alternative energy carriers in the world will increase by 50% by 2024.

Preparing in advance for the end of the "oil" era, the largest oil and gas companies in the world in recent years have been increasing investments in alternative energy. First of all, these are the European Shell, Total, ENI, BP and Equinor (the latter abandoned its former name Statoil largely due to the “change of course”). By 2030, investments in renewable energy can take up to 20% of the total investment of the world's largest oil and gas companies, predicts KPMG.

Russian players are also involved in renewable energy, but so far not particularly active. Most often we are talking about the use of solar panels and wind turbines for energy supply of company facilities. The largest projects are located abroad. So, LUKOIL owns several photo and wind-operated power plants in Romania and Bulgaria. The company’s website explains that they are using “favorable conditions in countries where the state provides support in this area”.

RUSSIAN FUEL AND ENERGY SECTOR: DIGITISING

Mikhail Nasibulin
Head of Digital Economy Projects Department of Ministry for Digital Development, Communications and Mass Media of the Russian Federation

DIGITALISATION HAS BECOME ONE OF THE MAIN TRENDS IN DEVELOPMENT OF THE SOCIETY THAT IS STANDING AT THE THRESHOLD OF THE SIXTH TECHNO-ECONOMIC PARADIGM. ENTERPRISES OF THE FUEL AND ENERGY SECTOR TEND TO BECOME HIGHLY ENGAGED IN IMPLEMENTING DIGITAL SOLUTIONS IN THEIR PRODUCTION PROCESSES AND THUS ARE ON THE CUTTING EDGE OF THE TECHNOLOGICAL KNOW-HOW. MIKHAIL NASIBULIN, HEAD OF DIGITAL ECONOMY PROJECTS DEPARTMENT OF THE MINISTRY FOR DIGITAL DEVELOPMENT, COMMUNICATIONS AND MASS MEDIA OF THE RUSSIAN FEDERATION, HAS TOLD US HOW ENTERPRISES OF THE FUEL AND ENERGY SECTOR ARE BEING DIGITALISED

KEYWORDS: *digital technologies, national project, software products, Ministry of digital development, communications and mass communications, information technologies.*

– Mikhail Mikhailovich, it was at the end of 2018 when the Digital Economy National Program was approved. What kind of potential does it hold for digitising oil and gas industry and what is being prioritised?

– Overall, when it comes to oil and gas industry, digitalisation normally goes in two directions: first, oil field exploration and development, and second, oil and gas processing and transportation. Most commonly, digital transformation within these two directions is related to implementing technologies of predictive analytics, introducing support systems for executive decision-making and using digital models and digital twins.

This work is given support within particular federal projects of the Digital Economy National Program. For example, the Digital Technology Federal Project allows for development of indigenous Russian solutions based on "end-to-end" digital technologies – artificial intelligence, virtual and augmented reality technology, robotics and sensorics, and many others. As part of another federal project, "Information Infrastructure", a global system of transmitting, processing and storing data is being developed, and it can be also used by enterprises in the industry.

– What are the main obstacles in developing digital economy, which you have to face?

– They can be divided in three main categories.

First of all, Russian companies which operate within traditional economic sectors generally show little or no interest in implementing digital technology. One of the crucial tasks set before us in this sphere is to develop some efficient schemes of stimulating demand for digital solutions on the part of industrial players. Some initial steps were made in this direction last year on the part of publicly owned companies – today, they are working on their personal strategies of digital technology development.

FACTS

5.3
billion USD
is the figure of export of IT services from Russia in 2018

Secondly, lack of the necessary statutory and regulatory foundation under digital economy in Russia is still a certain hindrance and does not allow to regulate it effectively. As the state, we should set ultimately clear and transparent rules for all market players. A lot of work is being done in this sphere within a corresponding federal project called "Statutory regulation of the digital environment".

Thirdly, the level of competitiveness of the Russian digital solutions is rather low, and consequently, our market depends considerably on foreign products.

– Fair enough, Russia doesn't serve as a benchmark in the area of digital technology. Where exactly do you think Russian software products are placed in the global market? How competitive is the industry?

– Unfortunately, Russia is not yet among the leaders in the global IT sphere because the share of Russian companies in the world market is relatively small. In 2019, the Analytical Centre for the Government of the Russian Federation conducted a survey of market actors to define main problems and priorities in terms of digital transformation of the Russian fuel and energy sector. Participants mentioned high import dependency from server resources and software.

At the same time, our country has been steadily on the rise in the global ICT market over the last years against several indicators. According to the Analytical Centre for the Government of the Russian Federation, export of IT services from Russia accounted to 5.3 billion USD in 2018, and it is twice as high as the level of 2010 and 13% more than the amount of service export in 2017. A share of ICT services in the Russian overall export has risen significantly: from 5.3% in 2010 to 8.1% in 2018; in the first half of 2019, it was as high as 8.4%.

– What kind of interaction exists between the Ministry for Digital Development, Communications and Mass Media and the Ministry of Energy of the Russian Federation in digitising the oil and gas industry? What are areas of their common interest and mechanisms for cooperation?

– Of course, we are doing a lot of work together to bring in industry experts and have them orchestrate activities in the course of the national program. We are now on track to establish an interministerial consultative body on digital transformation within economic sectors of top priority and in social spheres, including the energy sector. We are expecting that representatives of both concerned federal executive authorities and industry experts will take part in its work. Along with the Ministry of Energy of the Russian Federation, we are simultaneously working on a plan of action to digitally transform the energy sector and on development of a method to evaluate digital changes in the industry.

– At present, do we have successfully realised projects or projects under realisation to introduce indigenous Russian development results into enterprises of the oil and gas industry?

– Of course, we do. As an example, I could give the tNavigator software product by Rock Flow Dynamics LLC, which is used efficiently in more than 200 companies all around the world. The master module of this product is a hydrodynamic simulator, which is used for modelling processes of field development.

Another example could be the Prime system by Yandex Terra. That is fully functioning Russian-made software to interpretively process 2D/3D/4D/3C/4C seismic data, which complies with all the requirements for making up-to-date statements of work and includes a whole range of innovative algorithms to solve geophysical tasks.

Among Russian-made solutions for geological modelling, we should highlight "Geoplat – Pro" (GridPointDynamic Company), the "Designer Geology" module of the tNavigator software package (by Rock Flow Dynamics LLC) and the "Sphere. Geology" module (NC DIT Delta).

On top of that, indigenous Russian software from different developers is widely used by companies of the oil sector to monitor and keep track of oil and gas production.

FACTS

8.4 %

is a percentage share of ICT services in Russian total service export in the first half of 2019

– Bearing in mind these successful projects, how dependent is Russia from foreign-made digital technologies and are there areas where this dependency is close to full, in the fuel and energy sector in particular?

– Industry experts estimate that dependency from foreign-made software products in the oil and gas sector is around 80 to 90 per cent. At the same time, the volume of indigenous Russian software in the energy sector accounts for 286 billion roubles while an annual growth rate is expected to fluctuate between 6 and 10 per cent.

Our main goal for today is to reduce dependency from import of digital solutions in economic sectors. This might become crucial against the background of threats to business continuity of many large companies that are of critical importance for the Russian economy and lack of adjusting-to-scale industrial infrastructure to introduce and implement solutions that have been made on the basis of new types of software and equipment.

In 2016, in order to address the problem, a definition of the indigenous Russian software was legislatively formalised, the unified register of the Russian programs for electronic computers and databases was created, and it includes more than 6,000 software products divided in 24 categories. Then Decree of the Government of the Russian Federation No. 1236 dated November 16, 2015 was adopted, which banns admission of foreign-made software for public procurement. As a result, a purchase share of Russian-made software in the federal executive authority and executive agencies of state power in constituent entities increased from 25 to 65 per cent in the period between 2016 and 2018. The Ministry is currently monitoring data on import substitution in 2019. We can see that Russian-made software is mainly used even today

in such categories as legal information systems (99.9%), means of antivirus protection (99.8%) and electronic workflow management systems (82%).

– Electronic workflow and antivirus protection constitute a huge share of the software market. However, there are other market segments where majors of the oil and gas industry prefer to work with foreign-made software. Do they switch willingly to Russian-made products and does this necessity really exist?

– In the Russian oil and gas industry, publicly-owned companies hold the top market share. Transition to using Russian-made software in these companies is slowed down because of some hindrances, which are related to adopting Russian software products in the well-arranged technological processes and to the need of training specialists to work with the new software.

Decrees of the Government of the Russian Federation to bolster these processes and increase efficiency of import substitution were adopted in at the end of 2018, and they suggest that publicly owned companies develop corporate road maps for the period of 2018-2020 to switch to using Russian-made software on a large scale.

As of November 1, 2019, 35 out of 50 road maps to switch to predominant use of indigenous Russian software had been approved by publicly owned companies. The Ministry of Communications of Russia orchestrates activity of publicly owned companies to establish software testing centres, which are capable of determining different approaches to implementing indigenous Russian software within industries. A preliminary review of the received action plans has shown that a purchase share of Russian-made software in publicly owned companies increased by 50.87 per cent in 2018.

– It is a considerable move. What other actions does the Ministry take to develop the tech industry in Russia? Could you give us some more details on conditions, supporting measures, preferences, promotion schemes and so forth?

FACTS

80-90 %

is the figure representing dependency from foreign software products in the oil and gas industry

– Apart from the above-mentioned measures aiming at improved import substitution of digital solutions, one can indicate granting money on development of software and technological proposals for creating national information resources by means of distributed ledger technology. In addition, we launched a program on supporting measures for "end-to-end" digital technology in 2019. Start-ups and large companies which are involved in developing their own software and innovating the existing one can get a subsidy and invest it in technological improvement. Five operators providing supporting measures announced contests, decided on the winners, and now we are waiting for the realisation of these projects. The contests were organised in six different disciplines:

- support of projects on design and commercialisation of software products and digital platforms in manufacturing industry *(RF Government Decree No. 529 dated April 30, 2019, the operator is the Ministry of Industry and Trade of the Russian Federation; a subsidy of up to 50 per cent of the cost of a product development)*;
- support of projects on implementation of indigenous Russian software in industries of top priority and potential and a possibility of in-industry replicating *(RF Government Decree No. 555 dated May 3, 2019, the operator is Skolkovo Fund; maximum amount of a subsidy is 1 billion roubles)*;
- support of projects on replicating regionally Russian-made solutions of high social and economic importance for a territorial entity of the Russian Federation *(RF Government Decree No. 550 dated May 3, 2019, the operator is Russian Fund for Development of Information Technology (RFRIT); maximum amount of a subsidy is 1 billion roubles)*;

- support of R&D centres which carry out research and development work aimed at achieving target indicators in development of end-to-end digital technologies *(RF Government Decree No. 551 dated May 3, 2019, the operator is JSC "RVC"; maximum amount of a subsidy is 300 million roubles)*;
- support of Russian leading companies which develop and commercialise indigenous Russian solutions based on end-to-end digital technology *(RF Government Decree No. 549 dated May 3, 2019, the operator is JSC "RVC"; maximum amount of a subsidy is 250 million roubles)*;
- support of smaller enterprises which implement projects on design and commercialisation of end-to-end digital technology *(RF Government Decree No. 554 dated May 3, 2019, the operator is Innovation Promotion Fund; maximum amount of a subsidy is 5 million roubles under Start Program and 20 million roubles under Development Program)*;
- complex projects in the area of end-to-end digital technology have been supported through preferential loans since that year. This particular supporting measure has been highly rated by market players; support will be provided during several years and with participation of leading banks of Russia *(RF Government Decree No. 1598 dated December 5, 2019, the operators are authorised banks; a discounted loan rate for projects in the area of end-to-end digital technology is from 1 to 5 per cent for a 6-year term)*.

The system will be changed in 2020. For instance, another two supporting measures are brought into action starting this year – these are supporting measures on implementation of end-to-end digital technology and platform solutions driven by preferential finance lease (*the operator is State Transport Leasing Company*) as well as a supporting fund for direct investments in projects on end-to-end digital technology development at the growth stage (*the operator is State Corporation Rosnanotech*).

Besides, as part of the Digital Technology Federal Project, the Ministry has come up with recommended practice in digital transformation of publicly owned companies, which was approved by the executive committee of the Government Panel in December (the Government Panel on digital development, use of information technology for improving the quality of life and conditions for entrepreneurial activities). We hope that our recommendations help publicly owned companies to build a foundation and prepare strategic documents on digital transformation.

– Does the Ministry have any suggestions to promote Russian tech companies into foreign markets? Where could Russian R&D be in demand? How could we get those markets interested?

FACTS

286
billion roubles
is the volume of Russian software market in the energy sector

– On the whole, the volume of foreign sales of Russian software companies is rising steadily. As experts say, Russia managed to achieve a volume of 10.5 billion dollars following the results of the year 2018. Compared to the previous year, it is a growth by 19 per cent.

Today's low market share of Russian suppliers is caused, to a certain extent, by problems while preparing the end product for selling and marketing. Many companies are trying to introduce not end products but separate technical services and developments into foreign markets. The competitiveness rate in foreign markets is traditionally high, and if Russian companies do not have a structured marketing policy to promote their solutions, this results in their attempts to frequently become less successful.

A systemic approach could help in solving this problem and increasing recognisability, developing a global brand and building of trust in products of Russian tech companies. The state has a special focus on financial supporting measures, including project financing, investments, preferential loans. Alongside financial assistance, the state gives a sheer marketing support to companies – support in sales, extending points of presence abroad. In doing so, a new operator, JSC Rosinfocominvest, was established, and its goal is to provide systemic support, promotion and sales of Russian IT solutions abroad. It focuses on systemic support of export of digital solutions and services via networking, formation of international assessment and analytics of top quality.

Some companies in Russia have already achieved good results in developing their brands in global markets. In the first place, we are talking here about Russian "Kaspersky's Antivirus" and Dr Web packages, solutions on InfoWatch cybersecurity, Group-IB products.

Again, I would like to emphasise that Russia is one of the few countries which has its own R&D results in the area of search engines, social networking and operational systems.

When playing globally, a particular attention should be paid to the developing markets of Latin America, Africa, Asia and the Middle East, where interest in Russian technology is historically high.

– When it comes to Russia, which industry is the most digitalised, from your point of view, at the moment?

– The highest level of digitalisation is typical of ICT and financial sectors. These industries get within touching distance of the world's level of digitalisation. The ICT sector (telecommunication, production of ICT equipment) is the key tool and basis for development of digital economy of the country. As experts say, the volume of gross added value within the sector rose to 2.4 trillion roubles by 2018 (the growth by 20 per cent compared to the year 2015). On the other hand, the rate of financial technology proliferation in the country was 82 per cent in 2019. Digital banking became most widely developed, and the highest indicators are shown in the area of daily services (payment management, transactions, use of banking cards). I would like to make a specific mention that functionality of mobile applications of the largest Russian banks is 1.5 or 2 times better than the equivalent ones of European banks.

As for industries of the Russian energy sector, the leading role is assigned to electric power industry, which is due to particular characteristics of the industry operation. Digital technology is introduced in all the segments of the industry (generation, transmission and distribution, as well as electric power supply). In terms of speed of digital technology implementation, the electric power industry is followed by the oil and gas industry in Russia. In the context of constantly deteriorating conditions for hydrocarbons production (share growth of hard-to-recover reserves and reserves in remote territories), the use of digital technology is becoming an integral part of competitiveness of an oil and gas company. Coal mining is the most conventional segment of the Russian energy sector in terms of digital transformation. However, digital technology is being implemented in coal producers as well.

– Issues of cybersecurity are quite sensitive for large companies. What is done in this direction?

– Main principles of information security are based on maximum self-sufficiency of information technology. Within the Information Security Federal Project of the Digital Economy National Program, a national certification centre, which will guarantee safe operation of gadgets in the Russian Internet, is being established. The centre will provide TLS Certificates (trust certificates) for identification of information resources, it will also ensure work of citizens and state authorities through security protocols supported by Russian cryptographic algorithms. In the course of the federal project, the Centre for Public System of Detection, Prevention and Relief of Consequences of Computer Attacks (GosSOPKA) is being made, as well as a cyber range, which will ensure information security, prevent threats in the IT sphere and train professionals to deal with modern practices of information security. To cut things short, key focus areas in terms of information security are related to providing security of the Russian Internet, personal data security and security analysis of cyber-physical systems, including the Internet of things.

FACTS

In 2016,
a definition of indigenous Russian software was legislatively adopted, the unified register of the Russian programs for electronic computers and databases was created and a ban on admission of foreign-made software for public procurement was adopted

– How do you think the job market for specialists engaged in oil production will change?

– Implementation of new digital solutions influences the job market significantly and sets new requirements to specialists in the industry and shapes new in-demand professions.

When it comes to the energy sector, industrial automation, on the one hand, allows for downsizing a number of specialists of conventional professions; on the other hand, demand for specialists with digital competences, such as big data analytics and processing, robotics, unmanned aerial vehicle exploitation, programming and 3D-modelling. As experts estimate, new occupations, such as UAV operators for oil and gas field development, architects of robotic complexes and cyber devices, ecological analysts and others will appear in the oil and gas industry over the next decade.

The lack of industry specialists causes a current delay in

realisation of digital transformation plans in the energy sector, and it requires the Russian system to train skilled workers and to establish new methodological, technical and organisational disciplines and opportunities in providing advanced development of workforce capacity in the oil and gas sector.

In order to solve this problem, the "Workforce for Digital Economy" Federal Project, which is aimed at educational system improvements, job market transformation and citizens' inclusion in development of the Russian digital economy. The federal project focuses to a great extent on increasing the population's E-literacy, training skilled workers and executives, who might be in charge of digital transformation of companies.

– The huge country of ours has settlements and whole regions where there are no roads or essential infrastructure, where gas is not laid. Do you think Russia is generally ready for large-scale digitalisation or is it not the task for the time being?

– The Ministry is orchestrating works on providing multi-purpose services to people. At the same time, more than 20 thousand settlements with a population of 100 to 250 people cannot get access to the up-to-date communication services. The Ministry of Communications has elaborated corresponding amendments to the federal law "On Communication", and they suggest providing services in settlements with a population from 100 people (not 250 people as it is now).

This section of the Digital Economy National Program calls for activities to create stable and safe infrastructure for high-speed data transmission and processing, as well as storing large amounts of data. According to target indicators, a share of households which have broadband access to the Internet should be at least 97 per cent from the total quantity in 2024, and a share of socially significant facilities of the infrastructure, that can be connected to the Internet, should be 100 per cent.

– Digital technology is treading in leaps and bounds, no one can easily copy or imitate technology to match the spirit of times; we must be well ahead of our competitors. What do you think the chances of the Russian tech industry are to take up a position that will allow Russian software products to be of top priority for leading Russian and global companies?

– Russia already has its own competitive software products, that can be applied by companies in different economic sectors – these are accounting and information systems, engineering and telecommunication solutions.

FACTS

Russian-made software

is used in such spheres as legal information systems (99.9%), means of antivirus protection (99.8%) and electronic workflow management systems (82%)

When it comes to the energy sector, Russian developers are gradually creating and implementing programs for process management of exploration surveys, evaluation of oil and gas reserves, field development and exploitation. The government policy on import substitution corresponds to the increase in Russian IT development, and some Russian-made software products are becoming prioritised for Russian oil companies in the energy sector.

To keep the positive dynamics of using Russian software products in companies, the Ministry is doing its best to give support to design and implementation of digital technology in order to fundamentally re-think the actual structure and transformation of all business processes within the industry.

The successfully implemented measures on stimulating the Russian IT industry are as follows:

- advanced measures of government support for projects that design and develop innovative solutions in the area of digital technology;
- methodological recommendations on digital transformation of government-owned corporations and publicly owned companies that were approved on December12, 2019 by the executive committee of the Government Panel on digital development, use of information technology for improving the quality of life and conditions for entrepreneurial activities;
- compiling unified register of the Russian programs for electronic computers and databases;
- adoption of the Decree on phased transition of government-owned companies to the use of indigenous Russian software.

In such a case, the Ministry is carrying out activities along with its field-oriented federal executive authority, Ministry of Energy of the Russian Federation. These activities are aimed at implementing new financial and non-financial measures to support significant projects in the industry.

DIGITALISATION

1960s The application of computing tools for reservoir modeling

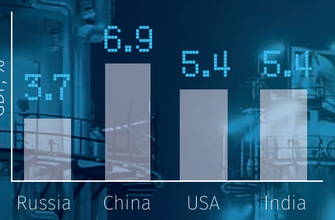
1970s The use of large scale workstations for field data processing that allowed to increase production volumes by 1%

1980s The transition from pneumatic control systems for control and management of oil refinery processes initially to analogue and later to digital

1990s 3D seismic models were created, which reduced the cost of searching for new fields by 40%, and the volume of proved reserves increased by 2.5 times

DIGITALISATION AND ECONOMICS

THE DIGITAL ECONOMY forms:



The **CURRENT VOLUME** of the global industrial robotics market is **$16 billion**

21 billion units is the **NUMBER OF DEVICES**, that will be connected to the Internet of things by 2020

1.8 trillion rubles the **AMOUNT** of funds allocated to the national project "Digital Economy", scheduled until the end of 2024

Five countries account for **74%** of **INDUSTRIAL ROBOTICS PRODUCTION**: China, Japan, South Korea, USA and Germany

48% of **RUSSIAN** industrial enterprises do not have production management processes, while operational management and administrative functions are not automated

Whilst in Russia, the level of robotisation is **5** **ROBOTS** per 10,000 workers. The global average – 99 robots per 10,000 workers

The global economy **WILL ATTRACT** **$13 trillion** by 2030 through the development of artificial intelligence

ARTIFICIAL INTELLIGENCE will account for a **14%** increase in global GDP by 2030

185 billion rubles by the end of 2024 will be required to develop **WIRELESS TECHNOLOGIES** in Russia

To establish **5G NETWORKS** across Russia, a total of **8650 billion rubles** is needed

INTERNATIONAL BIDDING AND CORPORATE SECURITY
in the oil and gas sector

UDC 303.725

THIS ARTICLE DISCUSSES THE DEVELOPMENT OF E-COMMERCE IN THE CONTEXT OF GLOBALIZATION. THE ADVANTAGES OF INTERNATIONAL COMPETITIVE BIDDING ARE CONSIDERED. THE ARTICLE ANALYZES THE TRENDS OF E-COMMERCE, SUCH AS CYBERSECURITY AT ENTERPRISES AND THE USE OF CRYPTOCURRENCY IN INTERNATIONAL COMPETITIVE BIDDING. THE ARTICLE REVEALS THE MOST IMPORTANT ASPECTS OF THE PROCESS OF CORPORATE SECURITY IN MODERN CONDITIONS. TAKING INTO ACCOUNT THE INDUSTRY FEATURES OF THE FUNCTIONING OF OIL AND GAS COMPANIES, THE MAIN ELEMENTS OF THE STRATEGY FOR BUILDING A COMPREHENSIVE SYSTEM OF CORPORATE SECURITY OF COMPANIES ARE FORMULATED AND ANALYZED

KEYWORDS: *e-Commerce, globalization, international competitive bidding, cryptocurrency, digital economy, corporate security, information security, cyber security, cyber threats, Internet of things, oil and gas sector.*

Aleksandr Zaharov
Professor, Doctor of Economics, professor of the Department of International and National Economics, Academy for Foreign Trade of the Ministry of Economic Development of Russia

International competitive bidding (tenders) is a very common tool of modern international trade practiced by state and non-state organisations of both developed and new industrial and developing countries. Diplomatic support for international competitive bidding (ICB) is provided mainly by developed countries. The legislation of many countries in relation to government procurement establishes certain rules for this process. Financial institutions also introduce certain rules for procurement using funds issued by them as loans. In particular, the procedures for purchasing goods and drafting contracts for the contract works and services established by the World Bank are the most famous and widely used in the world. Large corporations dealing with dozens and hundreds of suppliers of raw materials and components also often establish their own internal rules for procurement and orders placing. As the international practice of competitive bidding shows, the use of tenders leads to saving up to 40% of the planned funds and contributes to corporate security, according to the author.

International bidding is often done for orders for contracts and deliveries of a wide variety of goods, works and services – from unique to widely used ones. For example, among the items of deals that were featured at international bidding, one can find such tenders as the supply of several packs of nails as well as a turnkey construction project of the largest industrial and civil facilities of our time.

The widespread international competitive bidding in modern conditions is facilitated by the

fact that an increase in the scale of government orders requires impartiality in choosing a particular company as a supplier or contractor. The world trade practice knows cases when issued government contracts bypassed the bidding, which led to serious economic and political consequences. Recently, a lot of decisions have been made to improve the contract system in Russia: amendments to the law on the contract system have been made, competitive procedures have been simplified, the time to carry them out has been reduced, and additional barriers have been created for dishonest participants. Nevertheless, it is necessary to constantly improve the efficiency and transparency of the ICB, since trillions of rubles are spent on government procurement annually. At the Russian Federation Government meeting held on September 26, 2019, changes were discussed that would allow shutting down of the procurement practice from a single supplier, when the tender is declared invalid. It is known that dishonest buyers often use such schemes to cut off competitors and leave "their own" suppliers. That results in only one company participating in a tender, and it is recognised as the winner, since the tender had previously been declared invalid. Now such cases will be assessed by the Federal Antimonopoly Service. And a contract can be drafted only after its consent. These changes will affect only the contracts the starting price of which is determined by the government. And the procedure will be clearly defined in the new law [1].

Consulting firms play an important role in the ICB improvement. Tender structures are used to invite specialists from consulting firms for the process of preparing and conducting tenders. Such an approach to solving organisational tender problems is appropriate for cases where the buyer company does not have a sufficient number of employees, and staff expansion is impractical or impossible due to the absence of readily available qualified employees. Providing consulting services during preparation of international competitive tenders is of great importance for suppliers who are taking the first steps towards entering the market. Experienced professionals provide assistance at the stage of preparation for bidding or provide comprehensive support for the required period of time. This means providing legal services for participating in auctions, tenders, bidding or government procurement contracts. Consulting firms also provide legal support when the company files a complaint about unlawful actions of the buyer or other structures related to bidding.

In real situations, there are two options of consulting assistance for the duration of the ICB. First is selective assistance at a certain stage of bidding; second is comprehensive customer support throughout the entire tender. Selective option implies either non-recurring or permanent, but in any case it extends to the achievement of one specific goal. For example, the selection of a tender, assistance in the application process, etc. Comprehensive support implies assistance at all stages of bidding, and its amount is determined by the customer and their financial capabilities.

From that one can derive that consulting services are the most important area of ICB development. Now one can notice the growing role of consulting services in the development of international competitive bidding, which is of great importance for the development of small and medium businesses, and it helps them with investment advice for foreign trade activities [2].

ICBs are a progressive form of international trade that allows making the procurement process more open, efficient and economical. The ICB practice all over the world shows that this arrangement helps save budgetary funds and effectively fight corruption, and contributes to corporate security. A necessary condition for increasing the effectiveness of international trade is the modernisation of the regulatory framework, including the government procurement law [3].

In the modern economy, the state acts as the largest buyer and consumer of products all over different industries, which allows turning state demand into a powerful tool for regulating the economy, influencing its dynamics and structure to achieve strategic goals of the country's development. For example, the United States experience showed that the government procurement system is one of the most important tools for stimulating the innovative development of the American economy (the creation of the Silicon Valley). Therefore, it is important to note that Russian small and medium businesses develop formal tools that support and regulate international trade and economic relations at a very slow pace. Such tools include international bidding, opening up new opportunities for expanding the sales market and forging economic relations with foreign partners. One of the reasons restraining the participation of Russian small and medium businesses in international trade and economic relations is the lack of their own resources (human and material) to promote their products on the international market. On the other hand, many organisational and bureaucratic structures created in recent years do not yet have sufficient

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[1] *http://government.ru/news/37945/.*

[2] *Zakharov A.N., Mirzoyan M.O. The role of consulting companies in encouragement of foreign direct investment. Proceedings of 2017 Tenth International Conference «Management of Large-Scale System Development» (MLSD) Russia, Moscow, V.A. Trapeznikov Institute of Control Sciences, October 2-4, 2017. V kollektivnoj monografi i na ang. yazyke, indeksiruemom v Scopus. https://www.scopus.com/record/display.uri?eid=2-s2.0-85040541669&origin=resultslist&zone=contextBox.*

[3] *Federal Law of April 5, 2013 No.44-FZ "On the contract system in the field of procurement of goods, work, services to meet state and municipal needs" https://rg.ru/2013/04/12/goszakupki-dok.html.*

competence to provide effective support to small and medium businesses in these sectors. One of these sectors is international bidding. At the same time, it should be noted that the development of a system of international competitive bidding is an important condition for increasing the effectiveness of international government-private partnership projects and the competitiveness of the country as a whole [4].

The widespread use of bidding tools in international practice provides real incentives for the development of enterprises and firms with the best organisation of production and labor as well as a higher level of management. Oil and gas sector companies are such enterprises. Amid unstable oil and gas prices, degenerate deposits, extreme locations and new global business trends, oil and gas companies are looking for solutions to overcome these problems, including finding new procurement strategies. There is an intensive development of organisational subspecialisation, monopolistic structures are being broken up, too. Naturally, the tender procurement system is an active tool for the comprehensive integration of domestic industry in the global market for goods and services.

The problems of creating a competitive system of government procurement in Russia deserve special attention in connection with Russia's accession to the World Trade Organisation (WTO). It is necessary that the laws, norms, procedures and methods of conducting government procurements in Russia comply with the WTO Government Procurement Agreement. In order to comply with it, the procurement of goods and services must be completely open (and cannot be limited to the procurement of goods and services only from countries that are WTO members), it also must be organised using international bidding model, if appropriate, and such bidding shall be truly competitive. The main directions of development of the ICB are: maximum disclosure of national procurement markets of government and municipal bodies for suppliers from other countries; unification and standardisation of tender procedures, tender documents and requirements for suppliers due to changes in the fundamental documents governing the ICB and the use of new technologies, in particular the Internet and electronic commerce possibilities. It is obvious that the general process of globalisation and world economic relations in particular has its effect on the ICB, allowing to maximise the advantages of competitive tools over traditional methods of organising procurement and placing orders on the world market of goods, works and services. For example, in 2019, the Australian mining energy group BHP announced the world's first tender for the supply of LNG fuel to transport up to 27 million tons of its iron ore exports to Asia with the goal of “eliminating emissions of nitric oxide and sulfur oxide and significantly reducing carbon dioxide emissions along the busiest mass transportation route in the world” [5]. Speaking about the importance of the role of business in this sector, President of the Russian Federation Vladimir Putin noted in his Address to the Federal Assembly: “Companies, especially large ones, are obliged to remember their social and environmental responsibility” [6].

ICBs provides the buyer with many advantages: the opportunity to save budgetary funds, to choose services with the best price-quality ratio, and to avoid corruption in the procurement process. At the same time, the service provider is guaranteed an order with a fixed payment. The winner of the tender becomes the leader in their market segment and thereby ensures the growth of their company. Participation and victory in the tender for manufacturers and suppliers is an impetus for further business development, it contributes to corporate security in the context of globalisation.

ICB opens up new opportunities for optimising procurement strategies, which in the context of globalisation and digitalisation of the world economy is a necessary condition for the competitiveness of the Russian Federation [7]. The socio-economic nature of electronic commerce is inextricably linked with the globalisation of international economy [8]. A necessary condition for competitive business also is the digitalisation of the economy. Digital technology plays a large part here. Digital Technologies is one of six federal projects included in the national Digital Economy program. The project is to be implemented until 2024. Financing for the implementation of the federal Digital Technologies began in late 2019. It is necessary to use ICB tools here to efficiently spend budget funds, as billions of rubles are involved.

The introduction of information and communication technologies (ICT) in the system of international and domestic trade in the context of globalisation and the Internet provides ICB participants with a number of opportunities: prompt decision-making based on the internal flow of information, expanding the circle of consumers, reducing the cost of customer service, collecting and analysing information about consumer preferences. The above benefits are of great value to companies. The leak of internal corporate information can cause unfair competition from other firms.

[4] *Zakharov A.N., Ovakimyan M.S. Using the foreign experience of public-private partnership in solving the economic problems of Russia (on the example of France). // Russian Foreign Economic Bulletin. 2012. No.6. P. 12-24.*

[5] *https://www.miningglobal.com/sustainability/bhp-releases-worlds-first-lng-fuelled-freight-tender-shipping-iron-ore.*

[6] *Presidential Address to the Federal Assembly on January 15, 2020. URL: http://kremlin.ru/events/president/news/62582 (access date:15.01.2020).*

[7] *Zakharov A.N. Skachko E.S. The use of electronic commerce tools in international competitive bidding in the XXI century // Russian Foreign Economic Bulletin. – 2018. – No. 6. – P. 86-97.*

[8] *Vorobyov K.Yu. The essence of electronic commerce in the system of international trade relations // Russian Foreign Economic Bulletin. 2015. No.3.*

According to representatives of the international company Kaspersky Lab, which specialises in developing systems for protecting against cyber threats, today there are tens of thousands of hackers in the world. Each hacker community has a clear specialisation. The most impressive group in terms of the number of participants is financial cybercriminals, who seize the assets of banking structures, businesses and individuals. According to analysts, in 2019, losses from cybercrime in the global economy might reach $2 trillion. Currently, the existence of cybercrime is causing enormous damage to the Russian economy. According to Vladimir Novikov, Deputy General Director of Sberbank Insurance IC, 16 enterprises in Russia are subjected to cyber attacks daily [9].

In Russia, close attention is paid to cybersecurity issues. 96% of large companies in Russia plan to introduce new cybersecurity solutions in the next three years (VMware data). The first International Cybersecurity Congress (ICC), in which India participated, took place on July 5–6, 2018 in Moscow. Congress brought together over 2,200 participants from more than 50 countries. President of the Russian Federation Vladimir Putin took part in the ICC, and emphasised that in order to successfully combat cybercrime, it is necessary to develop effective international cooperation at the corporate level. It was decided to make this congress annual. In June 2019, the second ICC congress was held, during which OFFZONE, the international practical conference on cybersecurity, and Cyber Polygon, the world's first online cybersecurity training for the largest international companies, were held [10].

With at least half of the oil and gas companies worldwide exposed to cyberattacks, the responsibility of the corporate security service is growing significantly. The main objectives of hacker activity in the oil and gas sector are:

- economic (preventing the flow of resources into international markets);
- political (the use of cyberattacks for political purposes, for example, seizing technical means of control of an oil and gas company can lead to a violation of the environmental situation or create a threat to environmental safety).

The study of foreign and domestic experience of business enterprises in the field of corporate security and the market for services in this area is important for improving the activities of the corporate security service. Based on the analysis and summary of the foreign experience of corporate security structures, recommendations can be developed to improve approaches and methods to ensure the functioning of the company's security system [11].

Thus, an important aspect of the further development of electronic commerce is the issue of improving its protection system. This is necessary for the smooth functioning of the e-commerce platform, ensuring information security and safety, and protection against leaking confidential information containing commercial and production data. Improving the protection of commercial and production data in the electronic commerce system implies that measures must be taken both by companies and by the government.

Improving systems to combat information leakage can be worked out by companies collectively – through conferences and round tables. The joint development and acceptance by the business community of framework agreements aimed at creating an international system for monitoring the dishonest behavior of competing firms is an important and effective step in protecting the electronic commerce system. Maintaining a system for exchanging information about violators, the reputation of contractors and equipment suppliers is also seen to be effective. A requirement for protecting corporate information is taking the measures aimed at corporate staff. The information technology department should consist of highly qualified employees and specialists in the field of cybersecurity, who constantly improve their professional knowledge. The company shall undergo recurring inspections for dishonest staff members, as well as monitor the dismissed employees. The company must also aim to increase the loyalty of security personnel [12].

On the part of the government, measures to promote and improve the electronic commerce system may be such as updating legal norms that would prevent the leakage of information both in the course of business structures activity and in interaction with government institutions, primarily foreign, and improving legislation on liability of individuals who have leaked information constituting a commercial or production confidential data. The Russian regulatory framework in the field of the digital economy is in the process of reforming: in the summer of 2017, the Russian government approved the Digital Economy of the Russian Federation program. The program is designed to be implemented until 2024, 1.5 billion rubles have been allocated to improve the regulatory framework in the field of the digital economy [13].

Another area of e-commerce development is the use of cryptocurrency. The pioneer

[9] *D. Korotaev, Kaspersky Lab named the number of hackers in the world [Electronic resource] // Izvestia newspaper https://iz.ru. 2019. No.079. URL: https://iz.ru/873387/2019-04-29/laboratoriia-kasperskogo-nazvala-chislo-khakerov-v-mire.*

[10] *https://icc.moscow/ru/about/.*

[11] *Zakharov A.N. Corporate Security. M.: Neftegaz.ru. – No. 1, 2, 3, 2019.*

[12] *Zakharov A.N. Cybersecurity of the oil and gas sector: specifics of international relationship. M.: Neftegaz.ru. – No. 3, 2019. – P. 16–24.*

[13] *Teryokhin K. What bills on cryptocurrency will be adopted by the State Duma in the spring of 2019? [Electronic resource] // Information portal on cryptocurrencies RusCoins.info 2019. URL: https://ruscoins.info/news/kakie-zakonoproekti-o-kriptovalyute-budut-prinyati-vesnoy-2019-goda/#i-2.*

of the cryptocurrency is David Chaum. He invented cryptography for confidential payments in the DigiCash system, but in 1998 the company went bankrupt. This payment system was centralised [14]. A new impetus to the development of cryptocurrency appeared as the decentralised payment system Bitcoin, which was developed in 2009 by an unknown programmer [15]. Today, cryptocurrency is one type of digital currency. Its emission and accounting are based on various cryptographic methods, the functioning is decentralized in a distributed computer network. Cryptocurrency is a real software product, the growth rate of which depends on supply and demand, and not on subsequent investors.

The most popular cryptocurrency is Bitcoin (the generation of a decentralised digital currency that works only on the Internet). Next is Litecoin (a modified analog of Bitcoin), Ether (a platform that allows you to register any transactions with any assets on the basis of a distributed database of contracts such as blockchain (a distributed database that stores information about all transactions of system participants), without resorting to traditional legal procedures), Ripple (provides instant and direct transfer of funds between the two parties in any form, while the commission is set at a minimum level). In total, there are about 700 cryptocurrencies in the world [16].

It should be noted that Bitcoin, as the most popular currency in the cryptocurrency market, has some advantages compared to the national currencies for the ICB: unlimited possibilities of transactions; instant mobility; free access to information about all transactions, which prevents fraudulent schemes; operations without intermediaries; the impossibility of blocking the transfer by any organisation; non-collection of taxes when making a payment, as Bitcoin is not the national currency of any country; independence from inflationary processes; the ability to pay anyone, anywhere and for anything. The disadvantages of using Bitcoin are: the currency is not backed by anything but demand; the risk of a new separation of cryptocurrencies; a strong exposure of the Bitcoin exchange rate to news influence and market changes; lack of a single legal regime regarding cryptocurrency in a number of countries; lack of a proper system of protection against theft, loss and other risks. The last two disadvantages exclude the possibility of using Bitcoin as a form of payment in competitive bidding on the international stage. However, with the improvement of the protection of cryptocurrency and with the recognition of it by the laws of most countries, this type of payment would be possible.

The world in general has ambiguous attitude to cryptocurrency. For example, in some countries, Bitcoin is a legal instrument of payment (Japan, USA, Canada). A network of crypto-ATMs exists in these countries, and it is possible to pay for various services with Bitcoin [18].

At the same time, in a number of countries, cryptocurrency circulation is either prohibited by law (Nepal, Bolivia, Bangladesh, Algeria), or there are restrictions on certain types of transactions (China, India, Russia, Vietnam, Indonesia, Thailand, Kyrgyzstan, Ecuador, Iceland, Morocco, Malaysia). The legal status of cryptocurrencies in Russia is being discussed. The current draft law On Digital Financial Assets and amendments to the Civil Code of the Russian Federation provide for restrictions for unskilled investors, purchase and sale of cryptocurrency only at registered national sites, full deanonymisation of participants, mining (activities to create new structures to ensure the functioning of cryptocurrency platforms) are qualified as an entrepreneurial activity with the obligatory sale of what was mined on national exchanges. With all that, cryptocurrency is considered a digital asset, but not a form of payment, etc. Advertising is also prohibited on certain advertising platforms, for example, Yandex system [19].

The experience of Belarus, the union state, a close economic and political partner of Russia, should be noted. Transactions with tokens (cryptocurrency accounting units) and all types of cryptocurrencies were legalised in Belarus by a decree On the Development of the Digital Economy, which President Alexander Lukashenko signed on December 21, 2017. The decree allowed individuals to own tokens, buy and sell them for Belarusian rubles, foreign currency and electronic money, carry out mining, as well as give, exchange and give tokens in will [20]. Moreover, on January 15, 2019, the first cryptocurrency exchange in Belarus was opened. On the Belarusian cryptocurrency exchange Currency.com, potential investors can buy or sell tokens and invest in traditional financial instruments using cryptocurrencies and ordinary money [21]. It is possible to talk about the use of cryptocurrency in ICB only after it is legally approved by many countries. The advantages of this system are that it is transparent, safe and simplified, which will contribute to the improvement of ICB in the context of globalisation and digitalisation. The use of new technologies in the management of ICB is an important condition for the competitiveness of any country and, in particular, the Russian Federation.

Based on the trends in electronic commerce mentioned above – strengthening the protection of enterprises in the context of growing cybercrime and the use of cryptocurrency – one can conclude that both areas need to improve the legal framework and introduce the latest systems of protection against hacking, theft, loss and other risks. In the context of globalisation and digitalisation of the global economy, information is one of the most important resources of enterprises.

The development and improvement of electronic commerce is a requirement for the competitiveness of any national economy.

The problem of ensuring the safety of enterprises, corporations, companies and firms in recent years has attracted more and more attention of scientists and specialists directly involved in production activities. The actualisation of the need to ensure the safety of such enterprises is due to an increasing set of destructive factors, threats and criminal attacks, causing concern for shareholders and corporate executives because of their negative impact on business results. The success of any enterprise has become directly dependent on its security.

Adverse factors and threats are generated by the complicated global economic relations, aggravated as a result of toughening Western economic sanctions, financial restrictions and the started trade war against our country, as well as unfair competition. But the potency of US sanctions and their effectiveness are exaggerated. The US could not even force North Korea to do anything. For decades, backed up by UN decisions, they organised the rigid blockade of this small country, which has virtually no natural resources. Russia is not North Korea. The Russian Federation has vast natural resources and economy that can guarantee self-sufficiency. It is important to note that this ability has greatly strengthened recently, including due to sanctions, the example of that is the Nord Stream.

The aggravating international situation and the difficult situation in the Russian economy do not contribute to the neutralisation of undesirable macroeconomic trends, the solution of internal problems and the successful development of Russian business. And here the role of economic diplomacy is great. So, for example, despite the fact that Russia and Turkey historically have competing goals in the Black Sea region, cooperation between the countries in the energy sector – the successful launch of the Turkish Stream – can be considered as an example of the successful use of one of the tools of economic diplomacy, the result of which, among others, may be a resolution of conflict in the geopolitical sphere [21].

The problem of effectively ensuring the security of the private sector of Russian economy in modern conditions is of national importance, since the ongoing projects of numerous corporations, firms and enterprises make a significant contribution to the gross domestic product being created in the country, especially corporations in the oil and gas sector. Therefore, the effective guarantee of corporate security not only creates favorable conditions for increasing the competitiveness and successful functioning of each enterprise, but also contributes to the sustainable socio-economic development of the country as a whole.

It should be noted right away that the task of enterprises to ensure their security, although independent, does not exist in isolation from government actions in the field of national security. Currently, such actions are being taken through the formation of a self-sufficient effective system that is constantly dynamic and improving, in accordance with the current situation and long-term predictions regarding world trends and features of the socio-economic development of the Russian Federation.

National security is ensured by a unified state policy in all spheres of public relations through the implementation of a system of measures of an economic, political, organisational and other nature, corresponding to existing and potential threats. With respect to the national security system, all other systems for ensuring the safety of government and society existence are subsystems. The provision of economic security realised through its subsystem is no exception. Its component is ensuring the security of the enterprise.

Corporate security of an enterprise is interpreted as the state of protection of the enterprise and its vital interests from internal and external threats, which ensures the successful operation of the enterprise and its sustainable development as a result of the integrated implementation of regulatory, legal, organisational, managerial, performance, technical, physical, preventive and propaganda measures.

Improving the organisation of economic processes has led to the introduction into the official political and economic vocabulary of a number of new concepts that are

[14] *Matkovsky I. Who invented secure electronic money? [Electronic resource] // Project "People" https://www.peoples.ru/. 2014. URL: https://www.peoples.ru/technics/programmer/david_chaum/.*

[15] *Babkin A.V., Burkaltseva D.D., Pshenichnikov V.V., Tyulin A.S. Cryptocurrency and blockchain technology in the digital economy: the genesis of development // Scientific and Technical Journal of St. Petersburg State Polytechnic University. Economic sciences. 2017. No.5.*

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[18] *Anti-rating: 15 countries that have limited operations with cryptocurrencies [Electronic resource] // ForkLog magazine forklog.com. 2018. URL: https://forklog.com/antirejting-15-stran-ogranichivshih-operatsii-s-kriptovalyutami/.*

[19] *Yastrebova S., Kantyshev P. Belarus legalised cryptocurrencies [Electronic resource] // Vedomosti newspaper www.vedomosti.ru. 2017. URL: https://www.vedomosti.ru/finance/articles/2017/12/25/746361-belorussiya-legalizovala-kriptovalyuti.*

[20] *E. Gunkel The first cryptocurrency exchange opened in Belarus [Electronic resource] // Deutsche Welle newspaper www.dw.com. 2019. URL: https://www.dw.com/ru/в-беларуси-открылась-первая-биржа-криптовалюты/а-47092496.*

[21] *M. Khanov. Turkish Stream: Will the Pipeline Change the Energy Market in Europe? URL: https://tass.ru/opinions/7510353 (access date:15.01.2020).*

directly related to corporate security: *economic security, national interests of the Russian Federation in the economic sector, threat to economic security, challenges to economic security, economic security risk, ensuring economic security*.

An important component of integrated security is an early warning system about real and potential threats. The most effective results in detecting threats in the early stages are achieved with the arsenal of modern methods of information and analytical work, which provides for continuous search, collection of diverse information, its systematisation, generalisation and analytical processing. Data and analytical work allow to draw certain conclusions and make predictions. The data obtained is used in the planning process for countering threats in the near or distant future. In such a way conditions are created for working in proactive mode.

Since the mid-90s of the last century, a forgotten effective management tool, strategic planning, has been introduced into the practice of government management activity, the implementation of socio-economic development policy and ensuring national security of the Russian Federation. One of its important components is prediction.

Strategic planning significantly expands the country's ability to more prudently use its domestic potential to achieve strategic goals, systematically solve nationwide large-scale problems, concentrate and rationally use the available limited resources, forces and means in the most important areas of socio-economic development and national security. Currently, a comprehensive regulatory framework for the implementation of strategic planning has been formed. It is most fully reflected in the federal law On Strategic Planning in the Russian Federation, signed on June 28, 2014 No.172-FZ [22].

One of the goals of strategic planning is to combine the interests of the domestic economy and its industries with the interests of private business. Unlike the Soviet historical past, strategic planning in a market economy is based on an indicative method. This is how an official term appeared that sometimes replaces "strategic planning" – *indicative planning*. This is advisory planning without directives, using tools of indirect regulation of economic development for national purposes with the help of incentive means: access to government procurement, tax benefits and preferences, low credit rates, the formation of free economic zones and priority territories with a favorable business regime.

The created strategic planning system and its regulatory framework are intended for use mainly in the public sector of the economy and can only indirectly affect private entrepreneurship. Today it can be argued that the elements of strategic planning began to introduce themselves gradually into the economic life of the entrepreneurial community. Many successful corporations develop predictions that make it possible to successfully navigate the world of business and take early steps to ensure security.

A number of leading companies in the oil and gas sector practice long-term development strategies that are based on projected findings. Strategies contain the main goals, objectives, directions and ways of business development, determine the need for financial, material, human and other resources necessary to achieve the intended results. One of the forms of implementation of long-term strategies is general strategic plans, entrepreneurial projects or business plans. Streamlining the activities of corporations to ensure their security is achieved through legal regulations. The legal framework includes three main blocks: ***legislation, by-laws, and departmental legal documents.***

Legislation serves as an essential (fundamental) source for the formation of two other blocks of corporate security regulation – by-laws and departmental legal acts. *The main legislative documents* related to ensuring business security are:

The Constitution of the Russian Federation as the basis of the entire Russian legal system. In relation to the topic of this work, the provision of the Constitutional Law on guarantees to each citizen of the Russian Federation of rights and freedoms that may be limited for the purpose of economic security, protection of the legitimate interests of others, and ensuring the security of the state is important [23].

Federal constitutional laws serve as the foundation for building and specifying the entire complex of legal acts of the country. For example, Federal constitutional law On the Government contains [24] starting provisions on the role, place and functions of the highest executive bodies of the Russian Federation, including in the field of national security.

Federal laws regulate relations in the main areas of civil life. The most significant among them are the Federal laws On Security [25], On Defense [26], On Police [27], On Information, Information Technologies and the Protection of Information [28], On National Security Information [29], On the Law Enforcement Tactical Intelligence Operations in the Russian Federation [30], On Countering Terrorism [31], On the Private Detective and Security Activities in the Russian Federation [32].

Federal laws give corporations the right to organise their own security at their discretion, including the creation of their own security units with the appropriate functions and powers.

The second block, which regulates corporate security activities, is ***by-laws and regulations*** that are adopted in the development of laws in order to specify their actions in the relevant sphere of public relations. This series of legal acts should include the National Security Strategy of the Russian Federation [33] and the Economic Security Strategy of the Russian Federation for the period until 2030 [34], approved by decrees of the President of the Russian Federation, as well as documents such as The Basics of State Policy in the field of ecological development of Russia until 2030 [35] and the Doctrine of Information Security of the Russian Federation [36].

Thus, the National Security Strategy of the Russian Federation defines national interests, goals, tasks and measures in the field of domestic and foreign policy aimed at strengthening the national security of the Russian Federation and ensuring sustainable development of the country. The strategy is designed to consolidate the efforts of federal and regional government bodies and civil society institutions in order to achieve goals and solve tasks that were set.

The third block, regulating corporate security activities, is ***departmental legal acts*** that take into account the specifics and characteristics of enterprises. These include orders, regulations, instructions, provisions approved by company management that establish certain security measures (protection of objects, access control to objects and certain rooms, access to trade secrets, storage of secret documents and business information, protection of corporate intellectual property, transportation of material assets and financial resources, etc.). This category of legal documents includes sections of an employment contract that establish the personal responsibility of corporate employees for violations of labor discipline; written obligations of employees admitted to trade secrets about non-disclosure. The entire complex of departmental legal acts has an exclusively objective orientation, specifies the goals, ways, means and methods of solving problems, indicates the necessary measures and activities, responsible executors.

Conclusion

This article analysed the relationship between international competitive bidding (ICB) and corporate security in the oil and gas sector. The development of ICB and electronic commerce in the context of globalisation is shown. The advantages of international competitive bidding are considered. Trends in the development of electronic commerce are analysed, such as ensuring cybersecurity at enterprises in the oil and gas sector and the use of cryptocurrency in international competitive bidding. The article also reveals the most important aspects of the corporate security process in modern conditions. Given the industry-specific features of the functioning of oil and gas companies, the main elements of the strategy for building an integrated corporate security system for companies are formulated and analysed. ●

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[32] *Federal Law On Private Detective and Security Activities in the Russian Federation (as amended on August 2, 2019). URL:https://fzrf.su/zakon/o-chastnoj-detektivnoj-i-ohrannoj-deyatelnosti/ (access date: 05.12.2019).*

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[34] *Decree of the President of the Russian Federation of May 13, 2017 No.208 On the Strategy for the Economic Security of the Russian Federation until 2030. URL: http://www.kremlin.ru/acts/news/54497(access date: 31.12.2019).*

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DOWNSTREAM DIGITALISATION

Predictive analytics and online IIoT surveillance systems respond to modern challenges

TODAY, BIG DATA IS THE NEW OIL. NOT PROCESSING IT FULLY IS LIKE BURNING BANKNOTES TO HEAT A STOVE, AS RUSSIAN SCIENTIST DMITRY MENDELEEV APTLY REMARKED. HOWEVER, IT IS WORTH NOTING THAT RUSSIAN INDUSTRY IS IN GOOD SHAPE REGARDING IMPLEMENTATION OF IIOT SOLUTIONS WITHIN THE CRITICAL INFRASTRUCTURE SECTORS

KEYWORDS: *hardware-software package, digital solutions, big data, industrial equipment, fuel and energy complex, predictive analytics, remote monitoring, PRANA.*

American management consulting company McKinsey included Russia in the top 5 most digitally developed countries. The report shows that from 2011 to 2015, the volume of digital economy in the country increased by 59 % (8.5 times faster than in any other sector). In 2025, its share of GDP could potentially triple and hit 10 trillion rubles.

ROTEC – a Russian energy turbine maintenance company – has built up the largest information database on rotary generators in the country. In 2011, they began developing systems that would allow them to use this information to its full potential. Four years later, Russian R&D developers launched the PRANA hardware-software package, the first of its kind, commercially available, IIoT solution independent of OEM that monitors and predicts the condition of energy systems, 2–3 months before a possible incident may occur. The company claims that the name PRANA was formed by combining syllables of two Russian words for "PRedictive ANAlytics". This facility is much like a high-tech oil refinery, processing tremendous amounts of big data to make high-precision predictions about the behaviour of various types of industrial equipment, constructing a digital infrastructure that integrates all the systems of the enterprise and monitors technical and technological relationships.

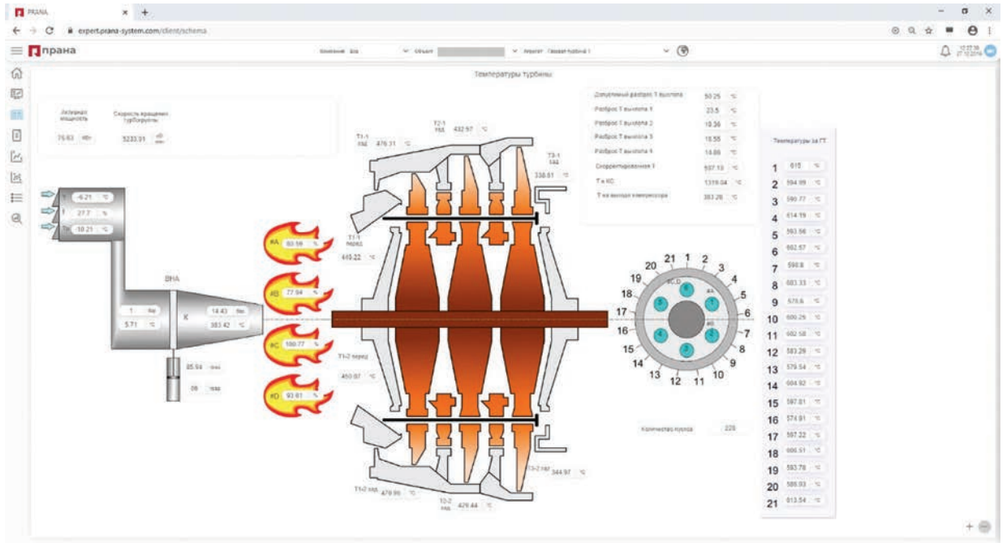
The PRANA ecosystem allows us to combine various types and models of industrial equipment within a single expert environment.

The PRANA facility is much like a high-tech oil refinery, processing tremendous amounts of big data to make high-precision predictions about the behaviour of various types of industrial equipment

"Any complex machine, be it a turbine or energy converter, will break down occasionally. And the control panel reacts only after something has malfunctioned. What do we do? We go out and look for the signals long before the breakdown occurs or when it is "set to happen", and we warn the experts about it. In reality, the depth of our prognosis is approximately 3 months for power generating facilities".

Mikhail Lifshitz, Chairman of the Board of Directors of ROTEC JSC

Since 2015, this facility has been operating on a 24/7 basis and allows us to prevent unforeseen malfunctions and breakdowns of industrial equipment, making the entire production chain transparent, and thus predictable and highly effective. After 5 years of the PRANA facility being in operation, the Russian energy industry has made remarkable progress. Having started with one thermal power plant in Perm, by 2020, ROTEC has digitised and secured 22 electrical power units under the protection system in 9 regions across Russia and Kazakhstan with total capacity of 3.5 GW. Experts have highlighted that PRANA has now virtually become the industry standard for power generating companies, and insurance companies provide more favorable conditions to those whose equipment is under the control of the System. These power engineering



Mnemonic diagram of a gas turbine in the interface of the PRANA hardware-software package

benchmarks seemed appropriate in other enterprises that included crucially important infrastructure, mainly in the oil and gas sector. Back in 2019, the System found its way into the equipment of Gazpromneft's oil production facility. Gazpromneft-Vostok LLC and ROTEC JSC implemented a project to digitise the oil production companies' equipment at the Shinginsk field. The PRANA prognostics system was connected to four 6-megawatt gas-turbine units (GTU-6PM) manufactured by

UEC-GT-R&D Saturn, three booster compression units of type TAKAT 77.3-23M3 MCC1 manufactured by Kazankompressormash JSC, and two compressor units of type JGF/4 manufactured by ARIEL, USA. Generally speaking, as of today, the PRANA package is integrated into equipment with a total value of 5 billion USD.

Hardware-software packages can be briefly described as follows. Based on the analysis of historical data, a mathematical model of the equipment's operating condition is created. When operating in real-time, the package continuously monitors the status of the connected equipment and informs the operating personnel about detected trends in developing emergency modes with recommendations for the maintenance of normal operations. Mathematical models, machine learning and artificial intelligence determine the interdependence of operational parameters that cannot be determined by existing local control systems. The PRANA package reveals long-term changes in the technical conditions of the equipment and provides additional time to locate and liquidate a problem at an early stage, whilst the local APCS (automated process control system) protects the equipment from fast-developing dysfunctions. PRANA has already been integrated into practically every APCS on the market: I&C Tekon, I&C ALSPA ControGaz, I&C KVINT 7, I&C KRUG, I&C Mark VIe, I&C PCS7, I&C OC6000e, I&C Ovation, I&C SPPA-T3000.

Various monitoring systems, predominantly operated by equipment manufacturers, have extensive industrial applications. However, it is necessary to highlight two important aspects. Firstly, every manufacturer uses their own personal solutions and interface for their equipment. This means that control over the parameter settings will have to be monitored intermittently on various devices. Whereas PRANA combines all the indicators within one ecosystem. Secondly, it might be somewhat difficult to be objective when speaking of a control system provided by the manufacturer interested in the supply of spare parts and providing maintenance services... just as difficult as it would be having to rely on a fox for the security of a chicken coop.

The economic impact from applying this hardware-software package consists primarily of improving equipment reliability and accident prevention. With the electrical sector, the cost of every unforeseen breakdown results in millions of roubles lost. ROTEC provides examples of the economic benefits deriving from the implementation of the package at one of the largest generating enterprises in Russia: over several years, it has reduced losses by over 5 times and reduced the number of incidents by almost 3 times.

This spring is proving an uneasy time for the entire world, yet industrial digitalisation has taken on new colours, giving enterprises the opportunity to respond to the costs of self-isolation in a timely manner without compromising business processes. In late March 2020, PRANA unveiled yet another frontier that enables users to remotely access all data and expert environments within the package in a matter of hours. The introduction

PRANA package mobile version on an iPad

of remote operation mode has become a massive stress test for the entire hardware-software package, bringing together over 140 professionals, energy and oil professionals from eight regions across Russia and Kazakhstan in one digital office.

"The solution that we conceived as a means of improving economic efficiency for customers (with the possibility of connecting their own professionals) proved to be one of the most effective ways of operating the technical division of the company in an emergency situation. Cloud technology solutions do not compromise employee productivity and help maintain employee health".

Maxim Lipatov, Technical Director for PRANA Hardware-Software Development

Back in 2019, the PRANA hardware-software package introduced features that enabled the establishment of a dispersed expert community. Bringing together experts to repair and operate various equipment such as gas and steam turbines, genepackage, boilers, converters and so on in one place is extremely costly, both in terms of resources and time. Therefore, an appropriate solution was developed that allows experts (through secure communication channels between the Situation Centre of the PRANA facility and linked sites) to have complete remote access to the results of analytical data processing, forecasts and tools to work with the operational parameters of equipment. In case the need arises, switching to distributed work has been made possible without reducing efficiency.

If previously only ROTEC experts had access to data, now clients were able to connect their authorised colleagues to the package as well (via secure communication channels).

Members of corporate expert networks gain remote access to machine data, reports, charts and other analytical results through mobile applications, secure chats, conference calls and thin-client. The mathematical unit of the prognostics system takes over all the work on raw data analysis, while experts are required to take decisions and provide the station personnel with recommendations. Thus, the PRANA facility brings together experts from different cities, branches and departments without interrupting production. The package has reached a fundamentally new level – for the first time in the industry, an expert centre can be dispersed.

Challenges to modern civilisation, which has no boundaries, are diverse and abundant. Yet today, we already possess digital solutions capable of not only building production processes more responsibly, but also making once large and sluggish industrial systems more flexible, rapidly adapting to economic demands, as well as to emergencies that no one is immune to. ●

Digitalisation and human resources

The Russian market for industrial VR/AR solutions may reach **9.2** billion rubles in 2022

60% of all professions will be automated by 2030

375 million people will learn new skills in connection with industrial automation

One in two employees in Russia can be replaced with machines

Digitalisation and industrial facilities

By 2021, half of the largest industrial companies will employ digital twins, which will increase their efficiency **by 10%**

In 5 years the market of digital duplicates will reach **$16 billion**

Companies save between **5 and 20%** of capital expenditures by using digital twin wells

Digitalisation and production

HUMAN ERROR accounts for **42%** of industrial accidents

The development of **DIGITAL TECHNOLOGIES** will enable a growth of up **to 35%** of recoverable oil reserves globally by 2050, while the total cost of production will be reduced **by 30%**

THE FIRST DIGITAL FIELDS in Russia emerged some 10 years ago, and in 2018 there were about **40** of them

PRODUCTION from a digital field reduces operating costs **by 20%**, and capital costs **by 50%**

THE OIL RECOVERY INDEX for digital fields is **2-10%** larger

THE COST of the oil fields developing is reduced **by 20%** on average

CORPORATE QMS DESIGN

Key Elements Involved in Building CQMS

THERE ARE MANY PUBLICATIONS, GUIDANCE MATERIALS AND RECOMMENDATIONS ON DEVELOPMENT, MAINTENANCE AND IMPROVEMENT OF A QUALITY MANAGEMENT SYSTEM (QMS) AIMED AT MAKING IT SUITABLE, RELEVANT TO THE ORGANIZATION'S BUSINESS MANAGEMENT SYSTEM AND CUSTOMER ORIENTED. HOWEVER, THE BASIC REQUIREMENTS OF QUALITY MANAGEMENT STANDARDS ARE JUST A VECTOR FOR BUILDING A SYSTEM THAT ALLOWS BUSINESSES TO APPLY THE REQUIREMENTS OF THE MANAGEMENT STANDARD, ADAPTING THEM TO THE CERTAIN CONDITIONS IN WHICH THE BUSINESS IS DEVELOPING, TAKING INTO CONSIDERATION THE CONTEXT AFFECTING IT, PARTICULARLY THE EXISTING CULTURE, GEOGRAPHICAL LOCATION, MARKET SEGMENTS, MACRO- AND MICRO-ECONOMIC TRENDS, ETC. THEREFORE, AS THERE ARE NO TWO IDENTICAL COMPANIES IN THE WORLD, SO THERE ARE NO TWO IDENTICAL QMSS. IT IS IMPOSSIBLE TO USE A SINGLE TEMPLATE FOR THE WHOLE WORLD. THEREFORE, IT IS AN EVERLASTING, DEBATABLE AND RELEVANT TOPIC: BUILDING AND, MOST IMPORTANTLY, ENSURING SUITABILITY, RELEVANCE AND EFFECTIVENESS OF THE QUALITY MANAGEMENT SYSTEM AND LINKING IT WITH THE STRATEGIC DIRECTION OF THE ORGANIZATION. THE ARTICLE DISCUSSES A PRACTICAL EXAMPLE OF BUILDING A PROCESS-BASED MODEL OF THE CORPORATE QUALITY MANAGEMENT SYSTEM IN A COMPANY WITH A HOLDING MANAGEMENT STRUCTURE. SPECIAL EMPHASIS IS PUT ON THE IMPACT OF THE CONTEXT IN DETERMINING THE APPROACHES TO THE PROCESS-BASED MODEL MANAGEMENT, TO THE PLANNING OF THE LIST OF THE QMS PROCESSES DEPENDING ON THE LEVEL OF MANAGEMENT AND TO THE BUILDING OF A LANDSCAPE OF THE PROCESSES WHILE SOLVING A PARALLEL TASK OF MAINTAINING THE UNIFORM CERTIFICATION

KEYWORDS: *quality management system, management standards, local enterprise, oil and gas holdings, divisional management.*

Lyudmila Beltseva
Head of Quality Management System Service, PAO TMK

Requirements for management systems in holding companies

Despite the fact that the quality management standard is the basis for confirmation of QMS compliance, there are some additional regulatory requirements defined by accreditation bodies and imposed on certification communities. These requirements directly affect the building and management of the QMS.

For 14 years, TMK Group (TMK) has been working with Lloyd's Register Quality Assurance Ltd (LRQA), which is part of the Lloyd's Register Group and assesses compliance with basic standards of quality, environmental protection and industrial safety. The unique audit methodology of LRQA Business Assurance contributes to the development of a quality management system and risk management to improve and protect current and future business performance indicators. A fundamental feature is the approach to auditing, as a tool of assistance (the so-called "value added") in the implementation of strategic goals and objectives. When conducting a QMS conformity assessment, particular importance is given to the effectiveness of process management within the framework of the declared application and extension of the corporate quality management system in the company. In particular, one of the innovations in assessing corporate QMS was the requirement of IAF MD 1: 2018 "Mandatory Document for the Audit and Certification of a Management System Operated by a Multi-Site Organization" [1], a document of the International Accreditation Forum prescribing the requirements for holding audit and certification of the management system of Companies / Organizations having several production sites in different places. In other words, the requirements for evaluating corporate QMS for organizations with a holding structure for managing enterprises.

IAF (The International Accreditation Forum) is an international association of accreditation bodies, associations of certification bodies and other organizations involved in conformity assessment activities in various fields, including management systems, products and personnel.

LRQA (Lloyd's Register Quality Assurance Ltd) – A certification body accredited by UKAS.

UKAS (United Kingdom Accreditation Service) – The national accreditation body of the United Kingdom, is a member of the IAF.

According to the requirements of IAF MD 1: 2018:

"– The organization* must have a single management system.

– The organization must determine its key site. The key site is part of the organization.

– The key site should have organizational powers to determine, establish and maintain a unified management system.

– The unified management system of the organization is subject to centralized review by management.

– The organization's internal audit program should be extended to all sites.

– The key site is responsible for ensuring the collection and analysis of data from all sites and should be able to demonstrate its authority and ability to initiate organizational changes in accordance with, but not limited to, the requirements for the following items:

- system documentation and system changes;
- management review;
- claims;
- assessment of corrective actions;
- internal audit planning and evaluation of results;
- legislative and regulatory requirements related to the applicable standard (s)..."

TMK is a dynamically developing company. In order to maintain and strengthen its position, the strategy guides the business towards achieving one of the strategic objectives – "To be a recognized supplier in the world pipe market and a leader in the domestic pipe market". An effective corporate quality management system confirmed by independent bodies and recognized by customers helps to achieve this objective.

Therefore, in the course of the upcoming recertification, TMK Group needs to confirm that the corporate management system not only complies with ISO 9001-2015 [2], but also demonstrates centralized management of the QMS and the ability to achieve the expected results in the divisions and at the enterprises included in the holding's contour, according to IAF MD 1: 2018.

Specifics of building QMS in holding companies, in particular in those with the divisional management principle

How to ensure the requirements of the certification body and what are the main differences in management of QMS at local enterprises and in holding companies, including international holding companies built on a divisional basis?

The process model of the QMS of a local enterprise with legal independence is usually based on a chain of business processes, the sequential activity of which makes up a single administrative management system. The synchronization of administrative management and the quality management system, as a rule, ensures the effectiveness of management; there is no conflict of interest, because the organizational structure of the enterprise forms the basis of the QMS process model.

In contrast to the QMS of a local enterprise, when developing a process model of a corporate QMS of a holding company the IAF requirements must be taken into account.

In particular, the business structure of TMK Group is an association of a number of enterprises based on property rights headed by the management company and located both in the Russian Federation and abroad. The enterprises produce tubular products, engage in procurement and sales activities and provide follow-up services to support the use of products of the holding company at the customer's site.

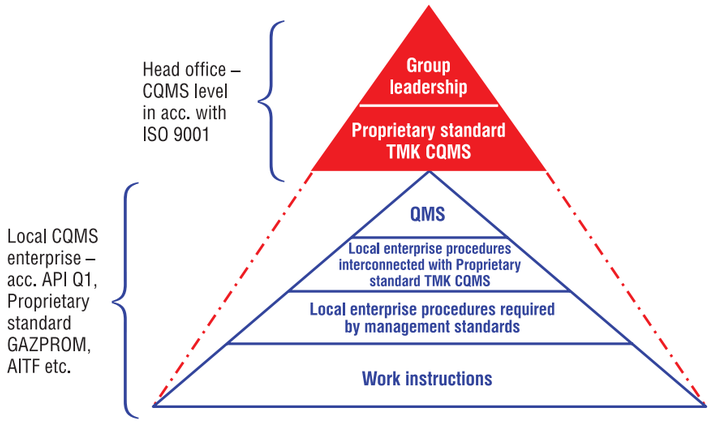
The corporate quality management system (CQMS) of TMK Group at the initial stage of its development was built on the basis of a functional management system. The CQMS was built on the collective principle of including local QMS of enterprises with account of the degree of their development.

The decision to implement the CQMS in TMK Group was made by the management company and it took into account the individual characteristics of the enterprises.

** "Organization" – an organization with several sites in which a unified management system is applied and which includes a certain key site (not necessarily the organization's headquarters), where certain processes / actions are planned and controlled, as well as a number of sites (permanent, temporary or virtual (using an online environment) on which such processes / actions are performed in whole or in part (IAF MD 1: 2018, 2. DEFINITIONS).*

FIGURE 1

The process model at the stage of CQMS creation



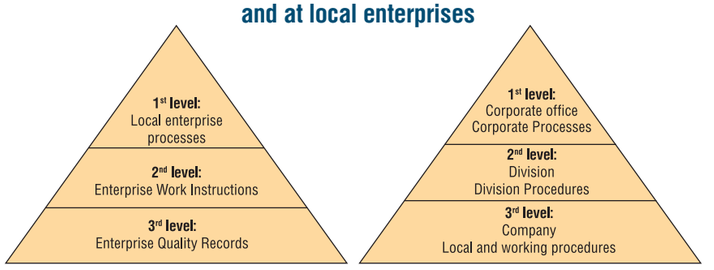
Therefore, the process model (Figure 1) at the first stage was created with account of the local processes that are typical of most of the Group's enterprises (without standardization for creation of a process model at local levels), and their relationship with the processes that are implemented by subdivisions at the level of the management company.

A minimum essential set of corporate requirements was formed and it, in its turn, determined the requirements for managing processes to be implemented at the enterprises. This approach turned out to be absolutely justified at the initial stage of building the CQMS and had its advantages such as minimizing the risks connected with the integrity of the CQMS, since its integrity was made up by the fundamental corporate requirements and additional local requirements established by the enterprise individually. Each of the TMK Group enterprises had an opportunity to maintain and develop its local QMS within the corporate system, taking into account its specifics and integration with other applicable management systems; and at the same time, it could provide communications on interconnected corporate processes with the management company.

At the later stages of improving the Company's management system, organizational changes in TMK Group and implementing management on a divisional basis, the CQMS process model should have changed taking into account new management levels, creating new processes, interpreting the applied processes according to the total quality management principle implemented through all management levels of TMK Group.

FIGURE 2

Applicable QMS construction models in holding companies and at local enterprises



a) An example of QMS management at an enterprise

b) An example of QMS management in a holding company with a QMS with uniform certification

c) An example of QMS management in a holding company without certification in the management company

d) An example of QMS management in a holding company with local enterprise certification

To achieve this objective, the over-arching processes at the corporate level should include uniform requirements for all TMK Group Divisions and local enterprises. The unity and continuity of requirements was partially achieved through unified criteria, objectives and processes established for all TMK Group enterprises. But under the influence of local territorial requirements and the external context, in particular, the legislative specifics of the countries where TMK Group enterprises operate, the task turned out difficult to achieve at the enterprises of foreign divisions. For this reason, a part of corporate processes was fully applicable only to the divisional processes within the area of responsibility of the Russian Division of the Company.

This factor had an impact on the integrity of the CQMS, the recording of observations during the audit of Lloyd's Register and required a study of the experience of building process models of CQMS management in external large holding companies, in order to assess the possibility of applying this experience in TMK Group and make decisions acceptable to TMK Group with a view to improving the CQMS.

The results of the review showed that the key factor in making a decision on the design of the process model was the presence of CQMS processes of the highest level in the management company, built on the basis of the holding's administrative management system (Figure 2).

Figure 2a shows the classical management model of the QMS of a local enterprise; formation of the process model and distribution of responsibility and authority in the QMS is carried out in accordance with the administrative management system.

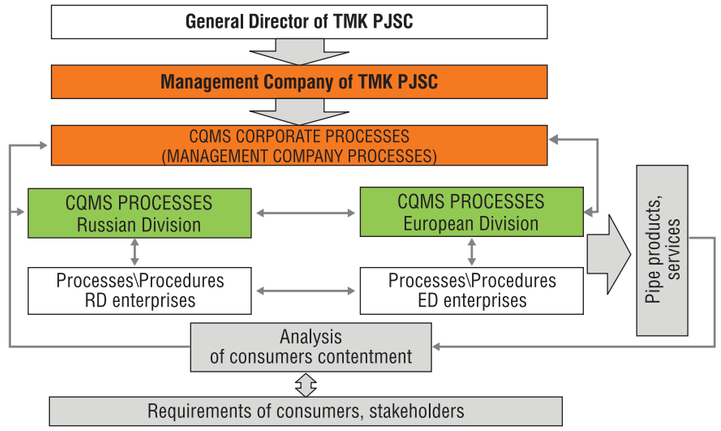
An example of building a QMS in a foreign holding company with divisional management (Figure 2b) is based on identification of corporate processes at the level of the management company that apply to divisions, enterprises of the holding for the formation of divisional procedures and enterprises equally. This model simplifies communication with the divisions, enterprises and subdivisions without any discrepancy of requirements between the hierarchical levels, provides centralized management and control of corporate requirements in the holding company.

An example of a corporate process model with corporate governance, but with QMS certification only at the level of the enterprises of the holding company is presented in Figure 2c. The management company determines the corporate process model and corporate rules for development and functioning of the QMS at the divisional level and at the level of enterprises with local certification; it manages and controls implementation of requirements at the level of the divisions with selective verification to the level of the enterprises without maintaining QMS certification in the management company.

Another way to build a corporate QMS with management levels, when the management company determines corporate requirements, but at the same time maintains a local QMS at its level along with local certifications of QMS of the enterprises, is presented in Figure 2d.

FIGURE 3

The generalized management model of CQMS in TMK Group



Guided by the main objective of development of the CQMS in TMK Group, namely, to create a management model that will make it possible to maintain its integrity, ensure that processes at all levels are strictly interconnected, control and regulate the impact and performance of all components of the system – the division, enterprise, process, activity and document on the system as a whole, measures have been developed and implemented to change the process model and design of the CQMS of TMK Group by way of:

1) Changing the approaches to process model management. Using the principle of uniformity with the divisional organizational management system of TMK Group.
2) Definition of common approaches to management of CQMS processes.
3) Ranking the hierarchy of processes by management level (corporate, divisional and local).
4) Bringing corporate CQMS processes to the target business scheme.
5) Unification of CQMS processes and CQMS documentation.

Process model and process landscape design selection

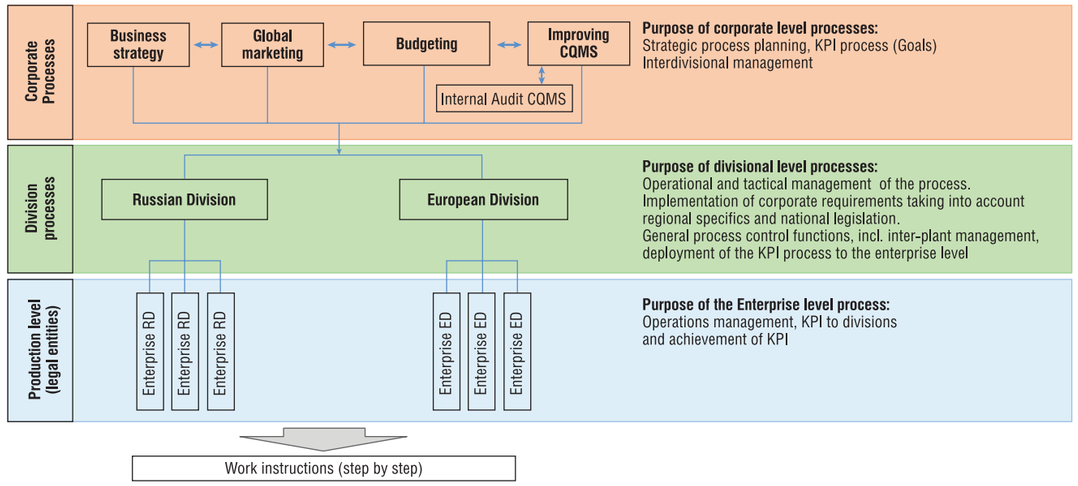
At the stage of determining a new design of the process model, the following was considered: the structure of the Group with the divisions and the enterprises that they are comprised of; identification of the governing body depending on the availability of management functions at each level; and legal relationships between local enterprises and the management company. A general scheme of the CQMS is shown in Figure 3.

Thus, a three-level process model was formed and the purpose of processes for each level were defined (Figure 4):

- The management company of TMK Group implements the functions of corporate process management and centrally controls the performance of these functions. For divisions outside the Russian jurisdiction, general requirements in the area of activity are established, on the basis of which divisional processes are developed. The purpose of corporate processes is strategic planning and setting of key indicators as well as divisional management within CQMS.
- The divisional management level in the CQMS carries out

FIGURE 4

Scheme of the purpose of CQMS processes by management levels



planning and management of divisional processes, develops targets, implements corporate requirements with account of the regional specifics of location of the production sites and the national legislation.

- The production level carries out operational management of the processes of the local enterprise taking into account the divisional requirements, setting and achievement of targets for the enterprise processes.

To form a landscape of processes for each level of management, the list of CQMS processes is determined by the decision of top management based on:

1) the strategy and strategic priorities of TMK Group / division / enterprise;
2) the area of activity of TMK Group / division / enterprise;
3) the area of distribution of the CQMS;
4) the context of TMK Group / division / enterprise;
5) the financial model of TMK Group.

Processes of the corporate level include processes based on activities that are carried out in relation to all divisions of the Group. These are management processes that determine strategic orientation of the company, form the structural framework and relate to the area of responsibility of the management. Management: PAO TMK (management on the basis of the target business structure "organization of provision of other services"). Owner of the corporate process: TOP manager of the relevant business area in the management company.

Processes of the divisional level include divisional processes in the Group, which are formed on the basis of corporate processes and processes that are carried out in the division. At the same time, the composition of processes is formed based on the field of activity, territorial legal norms, and local legislation of the division. Management: management company (head office) of the division (MC of the division). Process Owner: TOP manager of the relevant business area in the division.

Processes of the production level of the enterprise include local processes of the enterprise, defined by the production infrastructure and specialization that in their turn are formed on the basis of divisional processes. Process Owner: Manager of the relevant business area at the enterprise.

In this landscape, corporate, divisional and local processes are

FIGURE 5

The concept of CQMS process model of TMK Group (by management levels) based on the example of the Russian Division

	Key business principles	PROCESS	SUBPROCESS A	SUBPROCESS B	PROCEDURE
1st level corporate	1. Strategy 2. Quality Policy 2.1. Key Sales Principles 2.2. Key Procurement Principles 2.3. The main principles in the field of personnel management 2.4. Basic principles of infrastructure development	1.1. Definition of a business strategy 1.2. Global Marketing 1.3. Budgeting 1.4. Improvement of CQMS	1.4.1. Internal audit		1. Risk Management 2. Documented information management 3. Non-compliance management
Division 2 Level		2.1. Sales 2.2. Production planning 2.3. Management 2.4. Purchases 2.5. Shipping 2.6. Infrastructure management 2.7. Personnel Management	2.2.1.1. Planning for NVP 2.2.1.2. Work with notifications. Analysis of consumers contentment 2.1.4 Improvement of CQMS 2.1.4.1 Internal audit	2.1.4.1. Internal audit	1. Management of special processes 2. Knowledge Management
Level of enterprise			4.2.1. Sales (products, services) 4.2.2. Productions Management. Production 4.2.3. Inspection and testing 4.2.4. Purchase 4.2.5. Delivery 4.2.6. Infrastructure management 4.2.7. Personnel Management	4.2.2.1.1. Design and Development 4.2.1.4. QMS improvement 4.2.2.1.2. Work with Consumer Notices and Claims 4. Metrological support	1. Analysis of consumer demand 2. Measurement management 3. Internal audit

interconnected and, on the one hand, implement the requirements of customers and create additional value for customers and, on the other hand, they make it possible to set and implement TMK development strategy, support, monitor and improve CQMS processes within the Group (Figure 5).

The unifying factor in this model is the processes and provisions of the corporate level, within which the key indicators of the CQMS are established (quality policy, quality objectives, process targets, etc.). Divisional processes, which are over-arching processes, are set up as a tool to increase customer satisfaction, both internal and external, ensuring repeatability and stability of positive results. Aggregation, monitoring and analysis of data on key indicators of the CQMS are carried out at the divisional level.

Implementation of corporate requirements is monitored at the level of TMK Group management company through the CQMS internal audit system as one of the ways of monitoring the efficiency of the system. Review of performance of the CQMS at the level of top management of the management company and divisions is one of the ways of determining the status of the system's development, making timely decisions and taking measures to confirm the suitability, adequacy and ability of the CQMS to meet the requirements of quality management standards; it is a platform for planning actions in order to achieve intended results and increase customer satisfaction both at the level of the group as a whole and across the divisions.

As part of development and improvement of the CQMS, TMK Group has developed and implemented a flexible and effective business management tool that can be adapted to changes in the context and business environment of the company.

The proposed design of the process model of the CQMS for the Group with a divisional management system makes it possible to cooperate and jointly manage the corporate quality management system in the divisions and at the enterprises that are part of the Group even though they are located in different countries with different legal jurisdictions, and at the same time maintain a common corporate culture, long-term partnership relations and unified certification; it makes possible to position TMK Group in the market as a single company – a supplier, focused on the values of internal and external customers.

However, in order to see opportunities to fulfill customer expectations, to improve performance and efficiency of the quality management system, and to eliminate or prevent undesirable consequences to take no further action is not an option. The company needs to keep pace with the times and for this reason the next objective is to reach a new level in CQMS development, which will include optimization, automation and digitalization of the process model management, planning and implementation of life cycle processes, management of CQMS key performance indicators. TMK Group is already implementing its development plans in this area, but we will cover that in the following publications.

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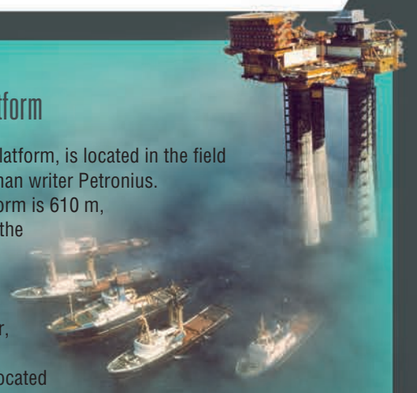
1. *IAF MD 1:2018 "IAF Mandatory Document for the Audit and Certification of a Management System Operated by a Multi-Site Organization", Issue 2 © International Accreditation Forum, Inc. 2018.*
2. *ISO 9001 International standard. Quality Management Systems. Fifth Edition. 2015.*

10 OFFSHORE PLATFORMS

The largest crude oil platform



Petronius, the world's largest oil platform, is located in the field with the same name, after the Roman writer Petronius. The length of the deep-water platform is 610 m, enabling it to take the 4th place in the list of the highest structures built by mankind. This is of course up for debate, as most of it, 535 m to be exact, is submerged underwater, while the upper part is only 75 m above sea level. The Petronius is located in the Gulf of Mexico, 210 km from the coast of New Orleans. It is operated by Chevron. The size of the decks span 60 x 43 m, weighing approximately 43 thousand tons. The platform has 21 wells, producing about 50 thousand barrels of oil and 2 million m^3 of natural gas per day. The Petronius cost 500 million US dollars to build. Commissioned in 1997

The largest gas producing platform

The world's largest gas producing platform – "The Troll" reaches a height of 483 m and weighs 656,000 tons. The Troll is located on the Norwegian continental shelf, 60 km from the coast. It is the largest man-made facility on the planet that has been relocated relative to the Earth's surface. Its construction was completed already offshore. It took 7 tugboats and a whole week to reach the installation site. The base of the platform consists of huge concrete cylinders, which are 303 m high. Both of them are equipped with elevators that take 9 minutes to reach the top. The walls of the cylindrical stems are more than a meter thick. In 1996 the platform set the Guinness World Record for "the largest offshore gas platform"

Unconventional "platform"

The Turritellais a platform, whose productions operate at the greatest depths. Technically though, it isn't a platform. The former Suezmax tanker was refurbished into a giant floating oil production and storage unit at Keppel shipyards in Singapore on the SBM Offshore project. Turritella Stones is the deepest oil production project in the world. It reaches a depth of 2.9 km. The Turritella was designed to accommodate the seasonal storms in the Gulf of Mexico: in the event of severe weather conditions, it can disconnect from the underwater infrastructure and sail away to safety

The first ever oil platform

The first stationary oil platform was built in the USA by the independent oil company Superior Oil (part of ExxonMobil) and Pure Oil (part of Chevron). The platform was placed in the coastal area of the state of Louisiana 1.5 km from the coast in the Gulf of Mexico in 1938. Water depth at the installation site is only 4.3 m. In the same year, the first well was drilled from the platform and the Creole field was discovered

The oldest platform in existence

The oldest operating oil platform is located in the Caspian Sea near the coast of Azerbaijan. It is quite literally a whole city on stilts. It is situated on metal overpasses built in 1949. The North and South Harbours are located off the west coast of the island and are formed by sunken ships. Drilling towers connected by overpasses are located there, where there is workers' camp. The total length of the roads connecting the facilities of the Oil Rocks is 350 km. Oil Rocks are listed in the Guinness Book of World Records as "the oldest offshore oil platform". The Oil Stones were even featured in one of the James Bond sequels – "The World Is Not Enough"

The northernmost oil rig

In April 2015, the Goliath platform was delivered from the South Korean shipyard Hyundai to Norway for exploitation from the field with the same name. The Goliath is the northernmost field in the world. An innovative spherically shaped production platform developed by Sevan Marine was handed over and deployed in the field with a 2-year delay. Eni's project operator voiced plans to put it into service within a few weeks, but these plans dragged on for months. Safety Inspection of the authorities, revealed a number of shortcomings, noting that the Arctic project is unprofitable under conditions of low prices and enormous cost hikes during the construction of the platform – the project cost had already exceeded $6 billion

Russia's only Arctic platform

The Prirazlomnaya offshore ice-resistant stationary platform (OISP) is the only platform to produce oil on the Russian Arctic shelf. The platform is 55 km north of Varandey settlement in the Nenets Autonomous Okrug. The unique feature of the Prirazlomnaya is that it is the first ever hydrocarbon production facility in the world that operates on the Arctic shelf from a stationary platform under difficult conditions of drifting ice fields. The platform is capable of withstanding extreme ice loads

A completely burned oil production platform

The Piper Alpha was built in 1975 and oil production began in 1976. On July 6th, 1988, the industry witnessed the largest catastrophe in history. A gas leak, along with a poorly devised action plan and hesitant measures of the personnel as a result the accident took the lives of 167 people out of 226 that were on the platform. That being the largest amount of people who have succumbed to accidents whilst on the platform. Insurance losses amounted to about 3.4 billion USD

The platform that caused the greatest environmental damage

The Deepwater Horizon is a semi-submersible oil rig for ultra-deepwater drilling with a dynamic positioning system. Built in 2001 by South Korean Hyundai Heavy Industries on commission from R&B Falcon. On April 20, 2010, 80 km off the coast of the state of Louisiana in the Gulf of Mexico, a massive explosion occurred on the platform. At a depth of 1.5 km over the span of 152 days about 5 m barrels of oil spilled into the ocean, the spill reached 75,000 km^2, which is about 5% of the entire Gulf of Mexico. The oil spill that followed the accident was the largest in US history

The deepest oil platform

The beautifully named Perdido is the deepest oil platform in the world, with a water depth of 2,450 m at its installation point. It was built at the request of the American company Shell Oil, Finland, in 2008. The Mighty Servant sea barge transported this platform from the Baltic Sea to the Gulf of Mexico and was then installed, 320 km off the coast of Texas. The tremendous depth makes it impossible to install support beams, which is why this platform is fastened to a floating base and the entire structure is supported by steel cables on the seabed. The platform has 3 decks, a drilling rig and living quarters. The platform pumps oil and gas out of 30 wells from 3 oil fields – Great White, Tobago and the Silvertip. It cost roughly $3 billion. It is run by Shell, Chevron and BP

CP 38XX SERIES
ADDITIVE FOR POUR-POINT DEPRESSION OF CRUDE OIL

ADDITIVES OF THE TOTAL LINE FOR CRUDE OIL ALLOW TO ENHANCE EFFICIENCY OF OIL PRODUCTION, FACILITATE AND SECURE THE TRANSPORTATION PROCESS. THE ARTICLE DESCRIBES THE LINE OF ADDITIVES WHICH IS USED BY CONTRACTORS IN ORDER TO ENSURE PRODUCTION SAFETY

KEYWORDS: *depressor additives, field chemistry, optimisation of production processes, transportation of oil and gas, solidification of crude oil.*

Murat Isaev
Technical Expert of Special Chemistry Department
TOTAL VOSTOK LLC

Dmitry Gusev
Sales Development Manager of Special Chemistry Department
TOTAL VOSTOK LLC

How it works

On temperature exposure to paraffin-base crude oil when the temperature is lower than its pour point, paraffins start to crystallise and settle out. This leads to viscosity growth and gel formation of crude oil. The process of paraffin precipitation creates a 3D net which completely decreases oil mobility. The effect of paraffin structuring limits the pumping ability and thus sets a lower temperature limit. The process of crystallisation can be controlled by introducing additives, such as depressants (CP) which act as modifiers of paraffin separation.

Additives of the CP line are fully organic and act by decreasing the size of paraffin crystalls and/or changing their shape in order to break the crystall net and facilitate cold pumping of crude oil.

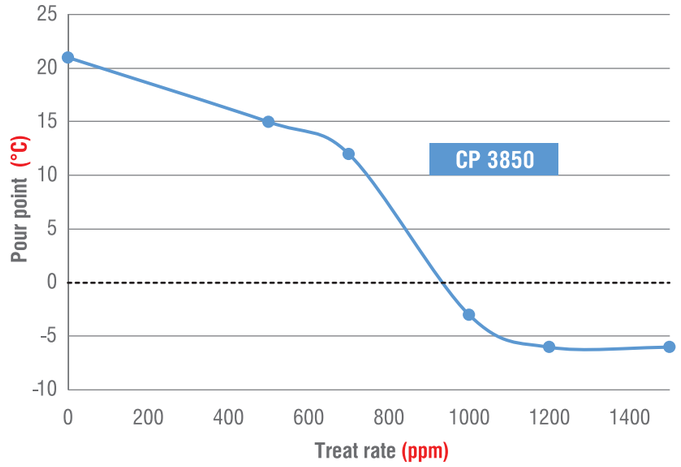
CP additives modify paraffin crystallisation in crude oil and prevent crystals from binding together.

CP and Total additives make for an economically efficient solution to improve the performance ability of paraffinous crude oil as well as heavy fuel oils, atmospheric residues and VGO. The CP series is compatible with all other types of additives.

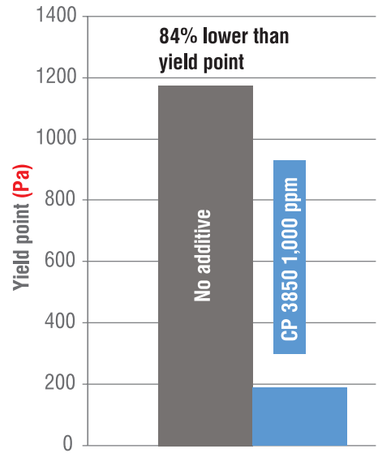
Why CP additives?

- They decrease pour point of paraffinous crude oil;
- They decrease transportation and storage limitations and provide flexibility in the supply chain;
- It is an easy way to transport high pour point crude oil at limited investment possibilities;
- They guarantee a simple restart after production suspending: yield point reduction;
- They are capable of processing a wide range of paraffinous crude oil;
- They can also be used to process paraffinous fuel oils and residues.

CP 3850 (ASTM D97) Pour Point Curve



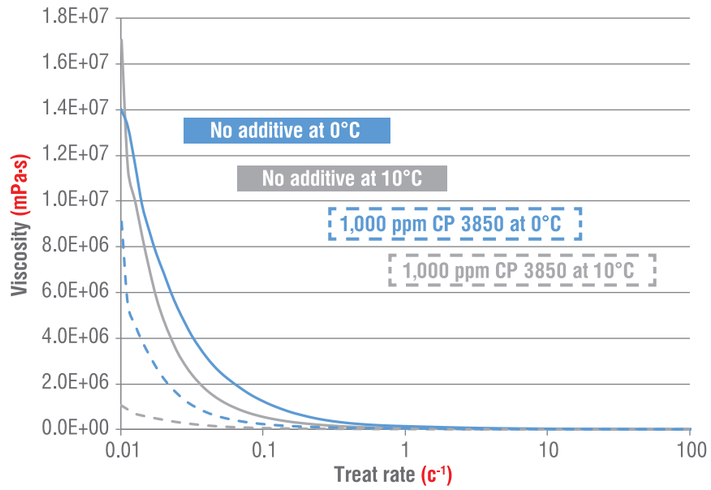
Viscosity of crude oil from RF with no use of an additive compared to CP 3850 additive



Why Total?

Rich experience and knowledge in making additives for hydrocarbons (fuels, heavy fractions, crude oil, etc.) and controlling problem features which are related to paraffin crystallisation, organic sediments, dispersion and emulsions. Vast knowledge in making additives for controlling paraffins and asphaltene dispersion agents. With this aim in view, a specialised line of Total additives to monitor problems related to paraffins and asphaltenes has been developed. They also have other features

Viscosity of crude oil from RF at different temperatures with CP 3850



A real-life example – Crude oil from the Russian Federation

It was hard to process crude oil from the Russian Federation and transport it at low temperatures (below 0°C). CP 3850 additive, which was used for such oil, is capable of decreasing the pour point from 24°C to 0°C at a treat rate of 1,000 ppm.

The effect of CP 3850 additive is proved by rheological analysis: drop in yield point (84%); drop in viscosity at different shear stress and low temperature (drop by up to 80% at 10). ●

PETROPHYSICAL MODEL OF THE BAZHENOV FORMATION

in the Priobskoye field of Rosneft Company

Darya Fyodorova
Lead Discipline Engineer of Reserve Calculation of West Siberian oil-and-gas province (OGP) of Geology and Reserve Calculation Management
RN-BashNIPIneft LLC

Aleksey Astafyev
Principal Discipline Engineer of Drilling Services and Downhole Drilling System (the Priobskoye field) of the Priobskoye Field Exploitation Management
RN-BashNIPIneft LLC

Oleg Nadezhdin
Head of Development of Innovation and HTR Management Analytics Department
RN-BashNIPIneft LLC

Ilyas Latypov
Senior Expert of Innovation and HTR Management Analytics Department
RN-BashNIPIneft LLC

THE BAZHENOV FORMATION (BF) IS A LARGE GEOLOGICAL STRATUM LOCATED IN THE AREA OF THE WEST SIBERIAN PLAIN OF RUSSIA. THE DEPOSITS OF THIS FORMATION ARE UNCONVENTIONAL PETROLEUM AND GAS RESERVOIRS. DUE TO THE SEARCH OF ALTERNATIVE SOURCES, A NUMBER OF OIL AND GAS PRODUCERS, INCLUDING ROSNEFT OIL COMPANY PJSC, ARE CURRENTLY FOCUSED ON EXPLORATION OF THE BAZHENOV FORMATION AND ITS RESOURCE

Keywords: *Bazhenov formation, unconventional reservoirs, alternative sources of hydrocarbons, hard-to-recover reserves, mineral component model.*

RN-BashNIPIneft LLC, being a subsidiary of Rosneft Company, is the largest corporate research and design institute, having Specialized HTR (hard-to-recover reserves) Exploitation Institute on its basis. The Institute, in collaboration with the other entities of the Company and other leading groups of scientists in the country, directly participates in a complex and comprehensive study of the object. Specialists develop currently important geological and petrophysical models, update reserves of raw hydrocarbons (RHC), develop strategies and RHC production methods for the Bazhenov formation within boundaries of RN-Yuganskneftegaz LLC, in particular the Frolovskaya oil-and-gas bearing area, including the largest fields in terms of oil reserves in deposits of the Bazhenov formation – Priobskoye and Salymskoe. The Bazhenov formation is characterized with complex geology and high content and properties variability both vertically and laterally, having specific lithological and geochemical properties. In spite of a large amount of data collected, studies undertaken and work performed on this topic, there is not a general consensus on the issue of geological and petrophysical interpretation methods applied to these deposits.

FIGURE 1. The example of well section in the interval of the Bazhenov formation with identified units and their typical shape according to photos of the core

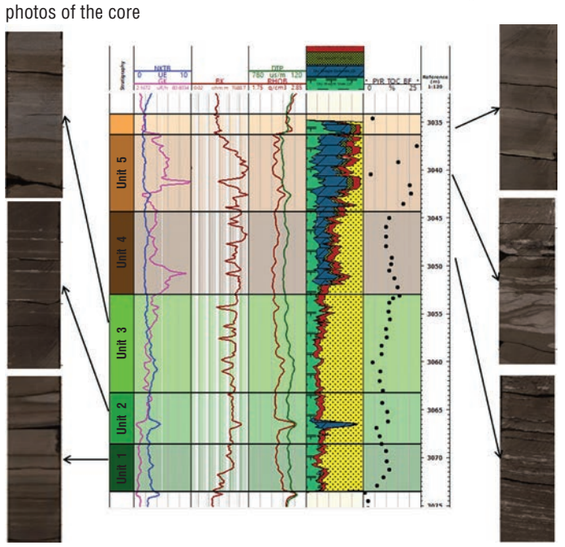
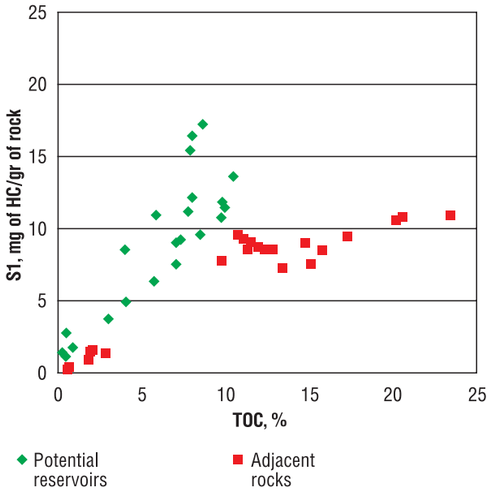


FIGURE 2. Correlation dependence between the organic carbon content, idiogenous (in adjacent rocks) and migrational (in reservoirs) hydrocarbon fuels



The main issue of this work is to develop a proper petrophysical model of formation deposits, allowing us to effectively estimate the resource of the object and plan its further exploitation. For this task, we need to understand the geological structure of the object, position of reservoir intervals in section, material composition of the rock, voids morphology and hydrocarbons spreading in voids.

During work performance, not only did we use the experience available [1], [6], but also accumulated our own experience. Specifically, we developed and proved our own methodological approaches to determine estimation of petrophysical parameters and reservoir containment practices through the section of the formation.

The Bazhenov formation reservoirs

The object under study is the Bazhenov formation deposits of the Priobskoye field. As mentioned earlier, the Bazhenov formation has complex geology and a high lithological variability. It should be noticed that this feature is even shown in a single field. We can find several common factors in the subsurface structure, such as correlations of rock material composition, accumulation conditions, porosity and geochemical properties.

The Bazhenov formation consists of two sub-formations, which can be divided into units. One of formation characteristics is a biogenic origin of most rock-forming elements. Therefore, rock composition and shape correlates with high bioproductivity periods, consequently, the section can be divided into units depending on biota extracting. Identified units have their individual composition characteristics: material composition distinctions, rock types and other features [14].

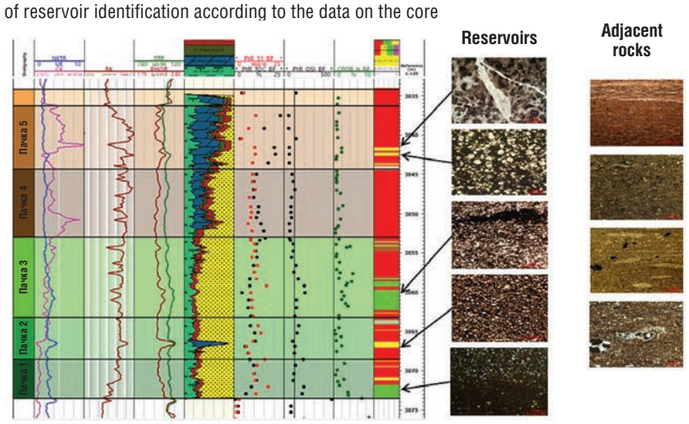
Figure 1 shows an example of section divided into units by one well of the object studied.

The first unit is composed by argillaceous-siliceous low-carbon rock layers and charcoal grey radiolarite layers. There are fragments of fish bones and onychites in the rocks. The second unit is composed by charcoal grey carbonaceous rocks and has detritus of bivalve shells. The third unit is composed by high silicious rock layers, radiolarite and clay layers with dolomitized and calcitated interlayers. The fourth unit is composed by kerogenic argillaceous-siliceous highly organic rock layers with inoceramus shells. The fifth unit is composed by kerogenic carbonate-argillaceous silicious rocks with carbonatized lenticle- and concretion-shaped interlayers. The sixth unit is composed by charcoal grey argillaceous-siliceous rocks with increased concentration of pyrite [15]. Deposits of the sixth unit in the territory of the studied field are thin and represented as intermediate variations from deposits of the Bazhenov formation to overlying rocks.

The explored well with core recovery and high oil saturation have mostly fragile low-argillaceous radiolarian silicites and radiolarites and also brittle carbonatized radiolarites. These rocks contain minimum amount of hard organic material (HOM) and argillaceous minerals and are synonymous with particular intervals of the section. These rocks have high permeability, migrational bitumoids in the interstitial space, high brittleness and ultraviolet radiation (UV-R) dimension.

The presence of migrational bitumoids in the interstitial space (hydrocarbons pulled away from their parent organic material and migrated inside oil source mass)

FIGURE 3. An example of a well section at an interval of the Bazhenov formation with results of reservoir identification according to the data on the core



can be determined by geochemical parameters with rock pyrolisis as the main method of estimation. The presence of migration processes in rocks is indicated, first of all, by the loss of correlation between Organic carbon content and S1, increased value of S1 maximum, S1 and S2 maximum values correlation and increased values of indexes of productivity (PI) and oil saturation (OSI). Figure 2 shows correlation dependence between the organic carbon content and S1 with rock divided into reservoirs and oil source adjacent mass.

Figure 2 shows an example of identified intervals of reservoirs by one of the field wells and the correlation between the organic carbon content and S1 as well as OSI. There is a crossover between the organic carbon content and S1 opposite the reservoirs intervals and OSI uprating.

Intervals of radiolarites and radiolarite silicites are associated with the interval of a lower subformation. The main interval of rocks in the reservoirs is accumulated in the third unit and is composed by brown partially carbonatized radiolarites and charcoal grey argillaceous-siliceous rocks. The lower part of the fifth unit has an interval of limestone with crumby structure filled with carbonatized radiolarites.

Tasks to exploit the Bazhenov formation require reservoir identification and potentially productive intervals – brittle rocks kind for technical stimulating (fracture stimulation) – to be performed efficiently and confidently. Such objects in the Bazhenov formation section are distinguished by a set of features:

- Low content of argillaceous ingredient and HOM in mineral composition.
- High mechanical brittleness of rocks;
- Increased values of porosity according to core and geophysical well logging (GWL) data.

All these features generally correlate with each other – reservoirs are represented as the most brittle and 'pure' intervals (Fig. 6).

Consequently, reservoir intervals are determined according to GWL data by means of finding solutions to the following sub-problems:

- Material composition determination
- Rock brittleness determination
- Porosity determination for rocks with migrational hydrocarbons.

Such intervals are qualitatively characterized by low values of gamma ray logging, acoustic well logging and high values of gamma-gamma density logging and neural logging. Mineral composition and elastodynamic modules should be quantitatively calculated during GWL.

Rock material composition modelling according to GWL

One of the main and specific characteristics of Bazhenov formation deposits is a complex composition of the rock matrix. According to the data of the core, main rock-forming elements of the mineral part of the rock matrix are quartz, calcedony, albite, calcite, dolomite, illite, mixed layers, kaolinite, pyrite, siderite. The non-mineral part of the matrix consists of hard organic material (HOM) – kerogen.

Due to its abnormal physical properties, some of which are close to features of the fluid, kerogen complicates mineral-compositional analysis and petrophysical model simulation. The task to factor in all minerals composing the Bazhenov formation during petrophysical modelling within the conditions of standard or even advanced GWL can be quite challenging. As a consequence, the statistical approach is prior to be applied comparing with the deterministic approach to determine mineral elements. This method uses a system of linear and nonlinear equations and implements a modification of the least square method, which, having a set of solutions, selects a solution that fulfils the condition of minimal difference between determined GWL graphs, deductive constants estimated according to the given model elements and physical constants [5].

For MCM statistical modelling according to GWL the complex is applied, having such ways of research as lateral logging, gamma ray logging, neutron-neutron logging, gamma-gamma density logging and acoustic well logging. This complex is applied to a fair number of wells of the Priobskoye Field, which provides a technical possibility to determine six main macro components of lithological rock composition. Consequently, a detailed model according to the core, which consists of 11 elements, has been enlarged into six larger units: 'silicious material', 'argillaceous material', 'carbonaceous material', HOM, pyrite. During properties determination, characteristics of minerals were mixed up in enlarged elements according to the statistics on the core. The statistic model was adjusted with respect to two parameters: material composition convergence by the core and model, as well as reconstruction error of deductive GWL graphs.

When the existing GWL complex is not enough to create an MCM, an approach is presented, based on clustering (macro components) according to mineral composition data received in the process of laboratory research of the core using cluster analysis, which allows to present the initial mineral content through a linear combination of macro components with a minimum error (basis). In this case there is such a possibility to identify a macro component that it is possible to determine macro components using an existing GWL complex and reconstruct the entire MCM using macro components.

If a three-dimensional mineral model is adjusted to the standard GWL complex (lateral logging, neural logging, gamma ray logging), there are several issues related to the lack of GWL required for mineral composition determination. If the full GWL complex cannot be applied, it is offered to use a two-stage method based on the continuous model building using the advanced GWL complex and adjusting the model by the standard GWL complex to a continuous model of macro components on the second stage. As the number of GWL methods is smaller than the number of components on the core, the enlarged MCM on the core has been compacted to have four components using cluster analysis, and the MCM was built for macro components with further reversion to the enlarged MCM.

There are four macro components for the Bazhenov formation (Fig. 4), with a dominant mineral in each of them.

Macro components are selected in order to minimize the error of dissolution of mineral components on the core. Figure 5 shows the mineral composition of Bazhenov formation according to the entire core data, and the reconstructed ones after dissolution to macro components.

As it is shown in Figure 5, the mineral composition according to the entire core data of MCM, and after dissolution to macro components is similar.

TABLE 1. Mineral Component Model (MCM) according to the core and percentage rating of the elements on the core

Elements	Albite	Quartz	Dolomite	Calcite	Illite (hydromica)	Mixed layers + kaolinite + chlorite	Pyrite	Siderit	Kerogen (HOM)	Bitumen	Factor of porosity_dyn + VS1de	Apatite
Macro components	Wcr		Wc		Wcl		Pyrite		HOM			-
Content, %	4.7	40	5.2	6.1	9.7	3.4	2.2	0.7	22.6	1.7	3.5	0.2

FIGURE 4. Macro components identified on the core

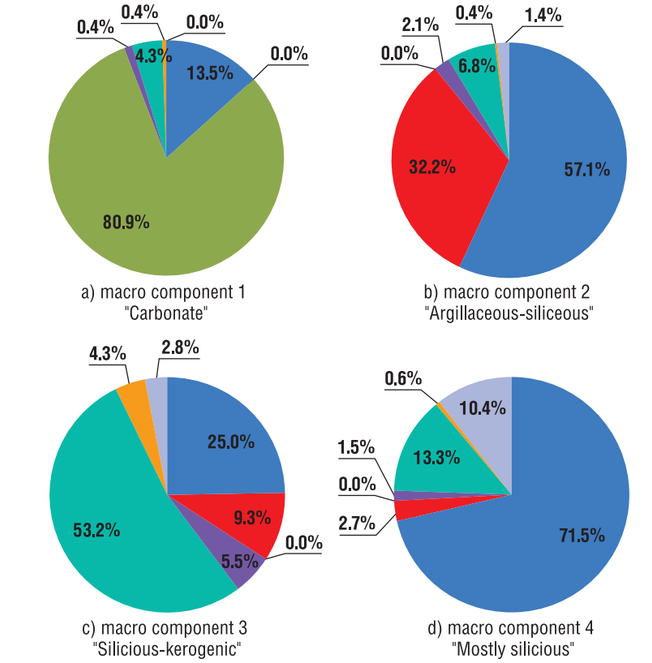
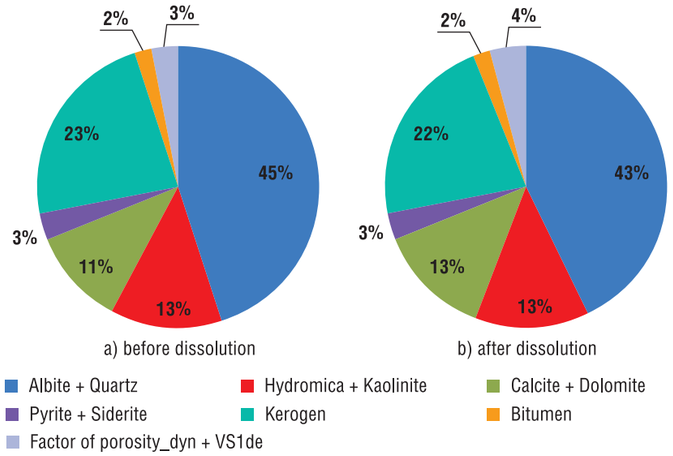


FIGURE 5. Mineral composition according to the entire core data, and the reconstructed ones after dissolution to macro components



Then, for the macro components received, the petrophysical constants are adjusted, and the mineral model is built on the base of existing GWL complex according to the data of the core. The adjustment ranges of petrophysical constants for macro components are recalculated from the ranges of petrophysical indexes for mineral components from literary sources [7–12] applying the basis. It is worthwhile noting that petrophysical constants were adjusted on the basis of correlation-regression analysis [7, 13] under robustness of well index selection determination and target values range constraint in order to provide physical conditions of the solution obtained. The quality factor for constants received is comparability of the entire GWL values and deductive ones that are calculated by macro components on the core.

Thus, a three-dimensional mineral model based on the standard GWL complex is adjusted and calculated when a continuous macro component model is built with transition to the enlarged MCM applying the basis.

The accuracy of the MCM based on the method presented is lower comparing with the model built directly with the full GWL complex, as some information is lost during transition from the bigger amount of minerals to the smaller one. However, the main asset of the method described is that it allows to use a smaller GWL complex to build an MCM as compared to the section complexity.

Figure 8 compares the MCM received using advanced (lateral logging, gamma ray logging, neutron-neutron logging, gamma-gamma density logging and acoustic well logging) and standard (lateral logging, gamma ray logging, neutron-neutron logging) complexes with the use of the data compression method.

Rock brittleness determination

The determination is limited by technical issues. For example, for dynamic modules, such as Young's modulus, it is necessary to record, in addition to the volume density value and compressional velocity, shear velocity, which is possible by applying a cross-dipole device for sonic waveform logging (SWL). Due to objective reasons, the lighting intensity of the deposit is rather low (21%) when using such a GWL complex. The existing MCM provides an opportunity to solve this problem. For example, a satisfactory correlation was noticed between mineral components and Young's dynamic modulus.

FIGURE 6. Clay and HOM sum correlation with Young's dynamic modulus

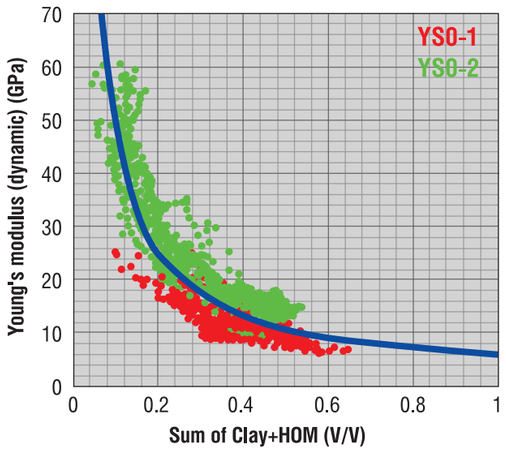


FIGURE 7. An example of Young's dynamic modulus from MCM

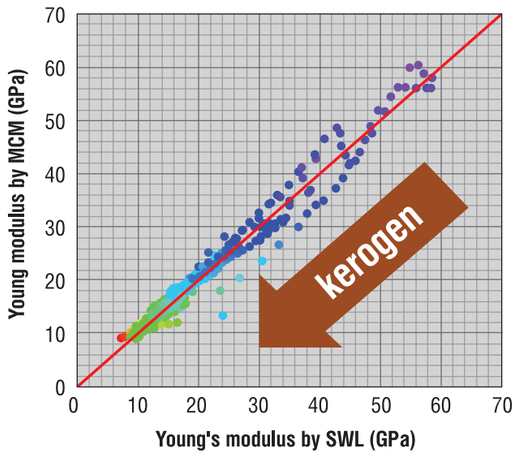


FIGURE 8. GWL surveying panel with an example of MCM modelling in the well of the Priobskoye field

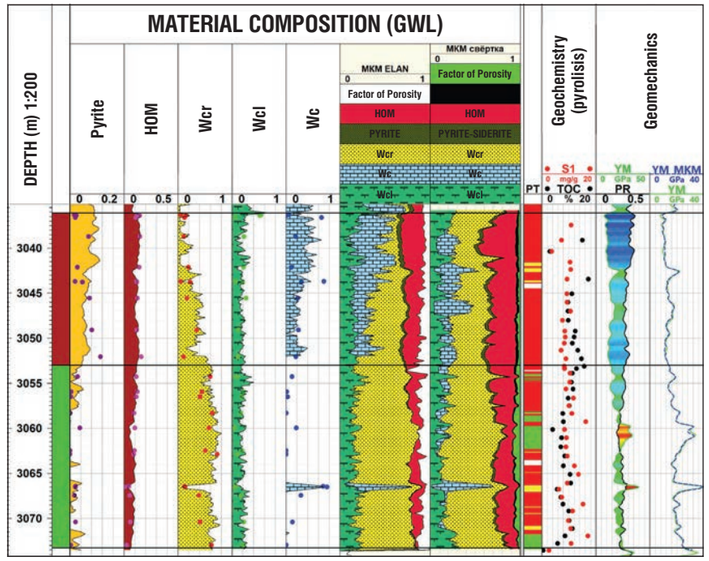
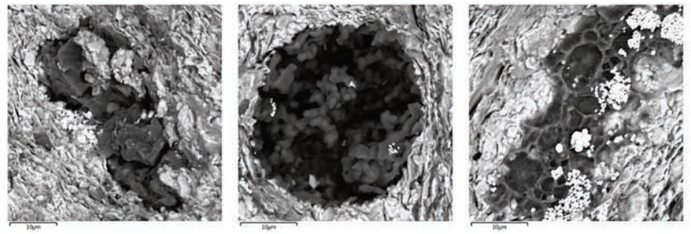


FIGURE 9. Example photographs of interstitial space according to SEM data (magnification x 3000)



Determination of porosity

Rocks in the Bazhenov formation are characterized by an increased content of not only organic matter, which is found in the form of both solid kerogen insoluble in organic solvents and bitumoids, which are motionless, either in closed pores, or being physically bound to kerogen, or due to the physical properties of high molecular weight compounds.

FIGURE 10. An example of a core sample from the Bazhenov formation interval after exhaustive extraction

Care samples porosity can be changed by the gas volumetric method or liquid saturation method. Porosity index values for high-carbon rocks received via naphtha saturation method are different from porosity values for gas to the higher side, which is connected with dissolution and washovering of hydrocarbons from the interstitial space when naphtha is applied. Thus, the porosity of the Bazhenov formation reservoirs is recommended to be performed by the gas volumetric method.

Other important issues are a type of the solvent and extraction time. Exhaustive extraction causes destruction of the sample according to GOST 26450.0-85 (Fig. 5) The same happens while applying corrosive solvents, washing heavy bitumoids from the sample, which are part of the rock cement in the Bazhenov formation.

During a series of experiments on core samples in the laboratory, it has been discovered that hexane is a suitable solvent, which allows to extract mainly light and movable hydrocarbons with optimized time for extraction for reservoirs to be 3–3.5 days (Fig. 6, 7).

Thus, it is possible to determine rock porosity of the Bazhenov formation collectors after a short-term extraction with a non-corrosive solvent using the gas volumetric method.

FIGURE 11. Effect of solvent type on porosity according to the date on the core

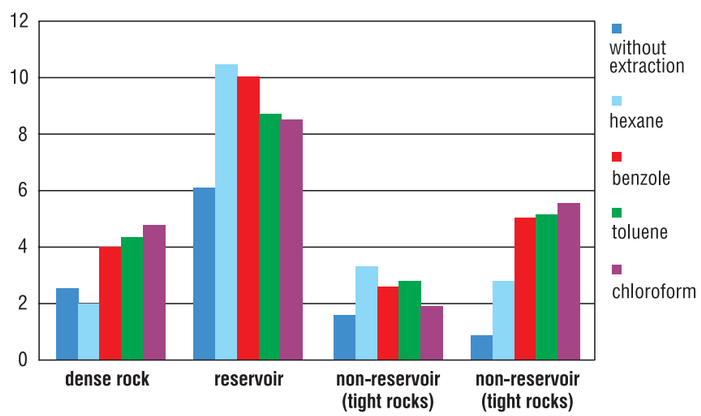


FIGURE 12. Effect of extraction time on porosity according to the data on the core

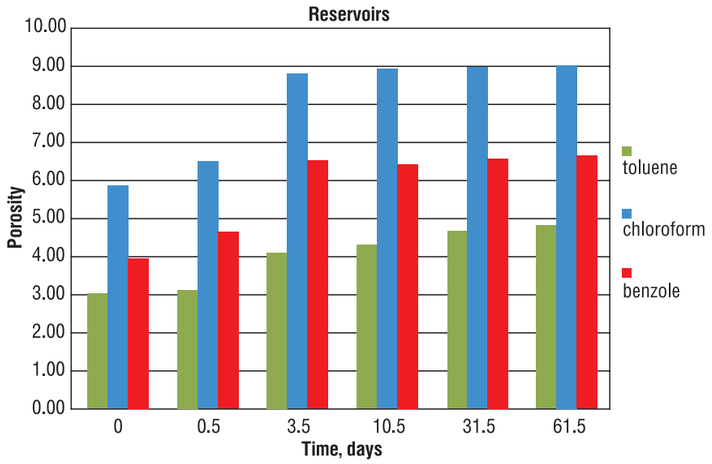
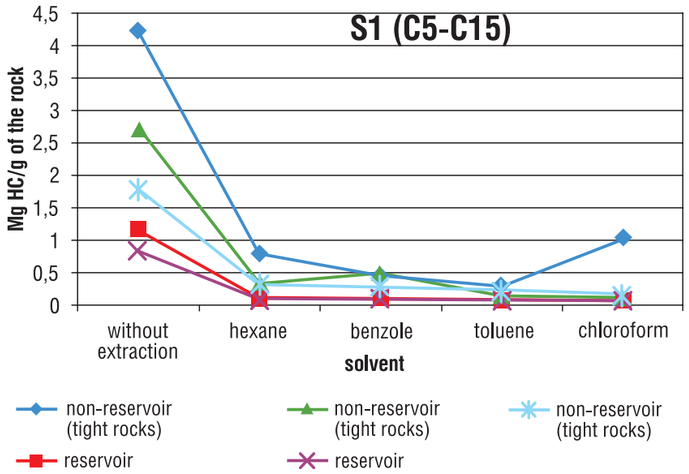
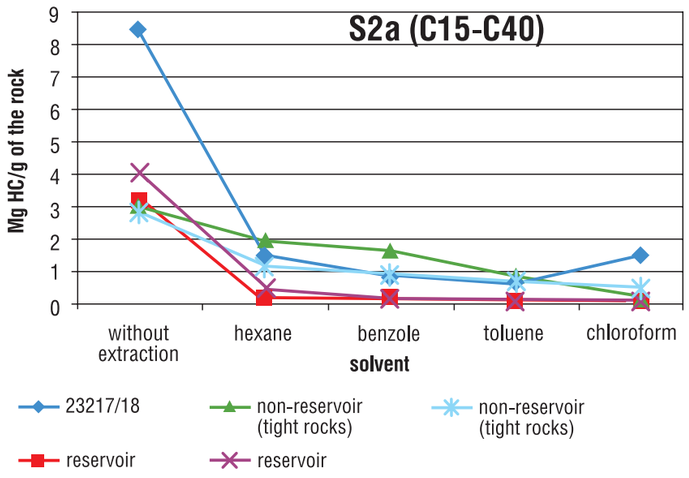


FIGURE 13. Dynamic content pattern of S1r (C1-C15) mg/g of the rock and S2a (C15-C40) mg/g of the rock when solvents are changed in sequence





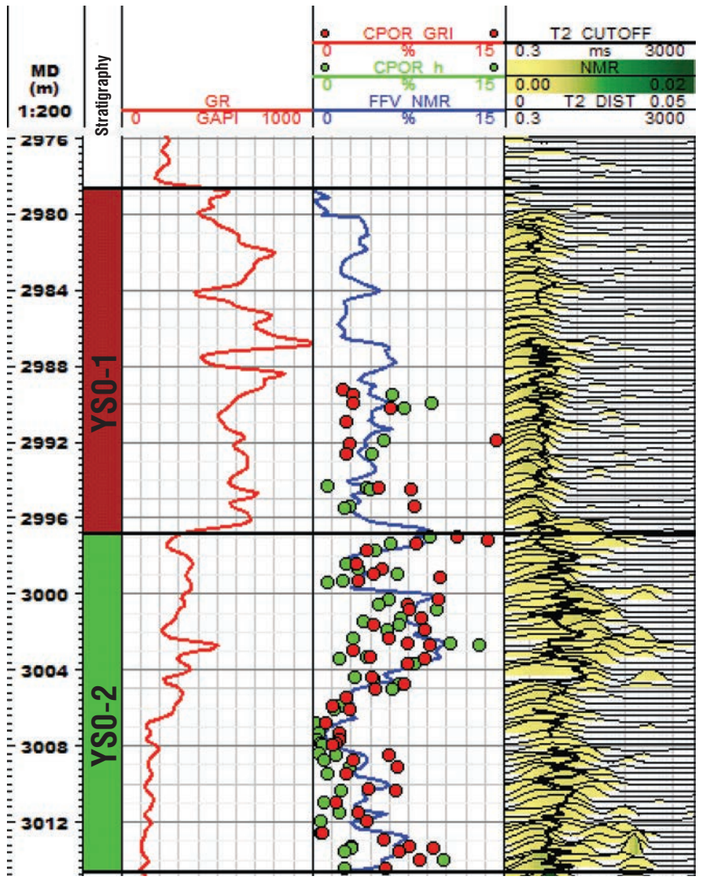
On a separate note, the relevant methods to determine the volume of the voids in the Bazhenov formation are Nuclear Magnetic Resonance Logging on the core, pyrolytic research and reservoir porosity and permeability measurement (gamma-ray index - GRI). With due regard to specific character of these studies, the results of porosity determination are comparable to each other.

The high content of the hard organic material (HOM) in rocks of the Bazhenov formation makes it extremely difficult to apply direct methods to determine the porosity index by using the standard GWL complex. It is associated with abnormal physical properties of HOM, which are close to the properties of saturating fluids. Additional difficulties in the GWL interpretation arise due to variety and significant changes of the mineral composition of the rocks, which causes inability to apply none of traditional methods of porosity determination without reference to the mineral composition. In conclusion, the existing situation is complicated by the total value of porosity determined: total porosity of Bazhenov formation rocks does not exceed 10-15%, and connected porosity, determined on non-extracted samples by gas, is within first percent. Thus, while using a traditional approach to determine the total porosity value, recording mineral composition of rocks in the Bazhenov formation is necessary, and inaccuracy in porosity determination may be comparable with a factor of porosity determined.

With reference to the above mentioned, it is worth pointing out that nuclear magnetic resonance logging (NMR) shows great results for porosity determination in the interval of the Bazhenov formation, being the most reliable method for compound mineral composition. NMR method:

- Adjustment in indications for lithology is not required, as compared to other methods;
- Is applied in reservoir conditions to measure the voids volume;

FIGURE 14. An example of comparing porosity by core and by NMR after relaxation time T2 cutoff selection



- Above all, NMR method allows to determine connected porosity after T2 cutoff selection and establishment, which is particularly topical under conditions of the compound and changing structure of interstitial space. Clay bound water and bitumoids of high viscosity form a signal in the left part of T2 NMR spectrum, which simplifies the procedure to determine connected porosity in the Bazhenov formation.

Conclusion

Within the scope of this work:

- The results of core sample studies have been analysed, providing the base to determine mineral and volume components of the formation.
- The signs and criteria for net pay identification in the interval of the Bazhenov formation have been tested and clarified.
- Statistical approach to reservoir modelling with compound mineral composition according to the GWL data has been tested.
- A new method to determine mineral composition by limited GWL complex has been developed and tested.
- The NMR method and cutoffs applied for porosity determination according to the GWL data have been established. ●

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HIGH-TECH FASTENERS of the BERVEL factory

UDC 669

DEVELOPMENT OF DISTANT NORTH REGIONS AND FAR EAST IS ONE OF THE MAIN NATIONAL PRIORITIES. DUE TO THIS, PLANTS ARE BEING CONSTRUCTED MORE AND MORE ACTIVELY, COMMUNICATIONS ARE BEING LAID, DEPOSITS IN THE AREAS THAT ARE LOCATED ABOVE THE PARALLEL CIRCLE ARE BEING DEVELOPED. SPECIALIZED MATERIALS AND EQUIPMENT ARE REQUIRED TO DEVELOP INDUSTRY IN THESE REGIONS, WHICH ARE SPECIAL IN TERMS OF CLIMATE AND GEOGRAPHY. WHICH TECHNOLOGIES DO RUSSIAN PLANTS PROPOSE?

KEYWORDS: *fasteners, weather-resistant steel, high-tech production, modern technologies, metallurgy.*

Yuri Medvedev
General director
BERVEL

– Yuri Viktorovich, a few years ago the plant was launched with a unique rated output: 30 thousand tons of calibrated rolled products per year and 27 thousand tons of fasteners. What was the reason for the belief that all these products will find demand?

– Before starting this project, we, of course, studied the Russian market of fasteners thoroughly. The volume of this market is measured not in tens, but in hundreds of thousands of tons per year. According to various estimates, 60-70% of the demand for fasteners is met by imports. Therefore, we understood that we can also gain market share. Another question is that this is a niche market, and the products that we collectively call "fasteners" also show a fairly differentiated picture. The main thing was to properly understand in which particular segment of the fastening market we should concentrate our efforts and resources. I think that we were not mistaken in engaging in high-strength fasteners. We built a plant with the most modern equipment and technologies with upgrated to offer state-of-the-art laboratory center. We have all the conditions in order to produce sophisticated fasteners and fasteners with the highest characteristics, including one that has not been produced in our country before. And we are actively engaged in its development. But, of course, this process is not simple, it requires the diversion of significant resources. But it is in the production of complex types of fasteners that we see our main task. At the same time, we, of course, produce and will continue to manufacture widely demanded on market traditional fasteners, but at a new level of quality.

– How much is the Russian market dependent on imports and how did the fact that the plant was launched affect this situation?

– In my opinion, today there are two types of imports on the fasteners market. There is import, which I would call forced. This is when a consumer simply cannot buy fasteners in Russia due to the fact that this type of fastener is not produced at all or is being made, but does not meet the quality requirements. And there is import caused by the fact that Russian manufacturers of fasteners cannot satisfy all demand at affordable prices.

> Our main task is to produce fasteners of such a quality that domestic enterprises do not have to think about import

In the first case, it is mainly about imports from the West, in the second – from the East. The BERVEL plant contributes to solving the problem of substitution of both of these types of imports. But we still consider priority work in the first direction, in the development of sophisticated fasteners with the highest quality requirements. It is absolutely unacceptable, in my opinion, that in our country some consumers are forced to buy fasteners abroad. Our main task is to produce fasteners of such quality so that domestic enterprises do not have to think about import, and our position on the global market was determined only by the economic feasibility of our presence there, both for us and for foreign consumers. Ideally, there should be an impeccable quality of the product, and then both consumers and manufacturers will decide where to sell and buy them – within the country or abroad, for this there are market laws and criteria for the economic security of their own production.

– Production of fasteners – is it a high-tech production? How often do novelties appear, innovative developments are introduced in the production of the product and the equipment involved in its manufacture?

– People far from our production traditionally believe that manufacturing of fasteners is something very simple. Bolts, nuts, washers - What the big deal is?! In fact, the production of fasteners is a technologically very complex and high-tech production, which should always use the most advanced achievements of both metallurgy and mechanical engineering.

> Development and implementation of mass production of innovative products and technologies is one of the main directions of BERVEL's activities

High-strength fastener plant BERVEL has a full production cycle: from metal preparation to coating. This is hot galvanizing that has already become traditional, and zinc flake coating that is completely new to the Russian market.

We constantly conduct research work together with specialists from various scientific institutes. The development and implementation of mass production of innovative products and technologies is one of the main areas of our activity. We regularly introduce new types of products to the market. For example, we were the first in Russia to master the mass production of fasteners made of weather-resistant steel. As the name implies, weather-resistant steels are not subject to corrosion and therefore do not require any additional protection. Weather-resistant steel products do not need coatings. Recently, in construction, for example, in bridge building, they began to use metal structures made of weather-resistant steel. Such designs do not require painting, and this is their main advantage over traditional steel grades. This is especially important for remote and inaccessible regions. In our opinion, in the future, these products should also be of interest to other industries.

– While preparing for the conversation with you, we found out that the enterprise has its own double line railway. Please tell us in more detail what its purpose is, what points it connects.

– First of all, we need our own railway line for delivering raw materials to our production:

cold-drawn steel in coils and round bars. Well, of course, for the shipment of finished products.

– How in general is the company logistics policy based?

– One of the important advantages of our company is its good location. This was one of the criteria when choosing the place of its construction. The plant is located almost on the federal highway M5, which makes deliveries by road very convenient. Most consumers of fasteners and calibrated rolled products are used to getting goods from us exactly by road. At the same time (as I said above), we also have the opportunity to receive and ship products by rail. As for in-plant logistics, here we have almost all production concentrated “under one roof”. Now we are commissioning a new warehouse building with a finished product processing area. This will allow us to significantly increase the level of efficiency and quality of supplies of fasteners to our consumers and this is one of our priority tasks.

– Speaking of large industries, it is impossible to ignore the main industry-wide trend – digitalization. Tell us about what processes are automated at the plant, whose equipment and software are used, and what results has it already brought?

– Since the beginning of the design of our plant, the issue of automation and digitalization of all processes has been one of top priority. We immediately laid the entire infrastructure to ensure the automation of production processes. Then the most difficult began – the introduction of a production management system. We made our choice in favor of the Russian product 1C ERP. These are obvious advantages in technical support compared to import solutions, and relative ease of use. Now we can already say that this choice was fully justified. The rules-based accounting, inventory and supply management is fully implemented, the implementation of quality management and the implementation of technical and preventive maintenance in final preparations, and, of course, the main purpose of any ERP system is to plan the entire activity of the enterprise. According to the implementation schedule, we will see the full functioning of the entire system by the end of this year.

– What are the main problems you have to face (legal, logistics, production, etc.)?

– Like any enterprise, we also have enough problems. The main issue is the complexity of production planning. As I said above, I hope that with the full implementation of ERP we can handle it.

– Metallurgy is traditionally considered a polluting industry, what environmental programs work at the enterprise?

– Although the plant belongs to the metallurgical industry, we are nevertheless closer to metalworking, that is, to deeper processing. Given that the BERVEL is a completely new enterprise, for putting into operation the rigorous requirements were applied. We have our own storm water treatment plant, chemical treatment station, industrial smoke treatment system and so on. In addition, we have a system of internal environmental control. Well, both the federal and regional supervisory authorities control offers no chance.

– A typical misfortune of many industries is the lack of qualified personnel. Have you faced the challenge? Where do you get specialists, what is drive strategy in the personnel policy at the enterprise?

– The presence of qualified workers and engineering personnel in the region was also one of the criteria for choosing the place of construction of the plant. But given the fact that the plant was equipped with the most modern equipment, it is almost impossible to find a sufficient number of employees with working experience on similar equipment in any region. Of course, we paid a lot of attention to the training of our employees and constantly continue training. And this is not only about equipment operators. Practically all technical personnel have to learn constantly. Indeed, not only equipment, but also production technologies are new, so “ready-made” specialists cannot be envisaged.

– How do you see the plant in the foreseeable future (new markets, expanding the product range, increasing production volumes)?

– In the future, we always see the development of new types of products, and, as a result, new markets. However, but the reverse is also true: access to new markets forces us to master new types of fasteners. Since the BERVEL plant has unique equipment and the most advanced technologies, we also consider it a priority to develop high-tech fasteners: complex products, high-strength products with advanced types of coatings.

EVENT CALENDAR

MAY

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

20–22.05

II International Conference

Corrosion in the Oil and Gas Industry

St. Petersburg, congress hotel "Saint Petersburg"

20–22.05

9th International Kazakhstan Exhibition Powerexpo Astana 2020

Energy, Electrotechnology and Power Engineering

Kazakhstan, Astana, Korme Exhibition Centre

26.05

II Specialised conference

Advanced Automation Technologies. PTA - Nizhny Novgorod 2020

Nizhny Novgorod, Sheraton Hotel

26–27.05

V International Conference

Industrial Oils and cooling mixtures in Metallurgy, Metalworking and Mechanical Engineering – 2020

Moscow, Expocentre

26–29.05

Russian Oil and Gas Chemical Forum and XXVIII International Exhibition

Gas. Oil. Technologies – 2020

Ufa, VDNH EXPO

27–28.05

3rd congress and exhibition

Nitrogen, Synthetic Gas in Russia and CIS

Moscow, Baltschug Kempinski

28.05

X Annual Conference

Construction in the Oil and Gas Complex

Moscow, InterContinental Moscow Tverskaya Hotel

GLOBAL OIL RESERVES

GLOBAL **OIL RESERVES** CONSTITUTED OVER **1,695 BILLION BARRELS** (268.5 TRILLION LITERS)

THESE FIGURES DEPICT A LITTLE **OVER 80% OF CONFIRMED** RESERVES

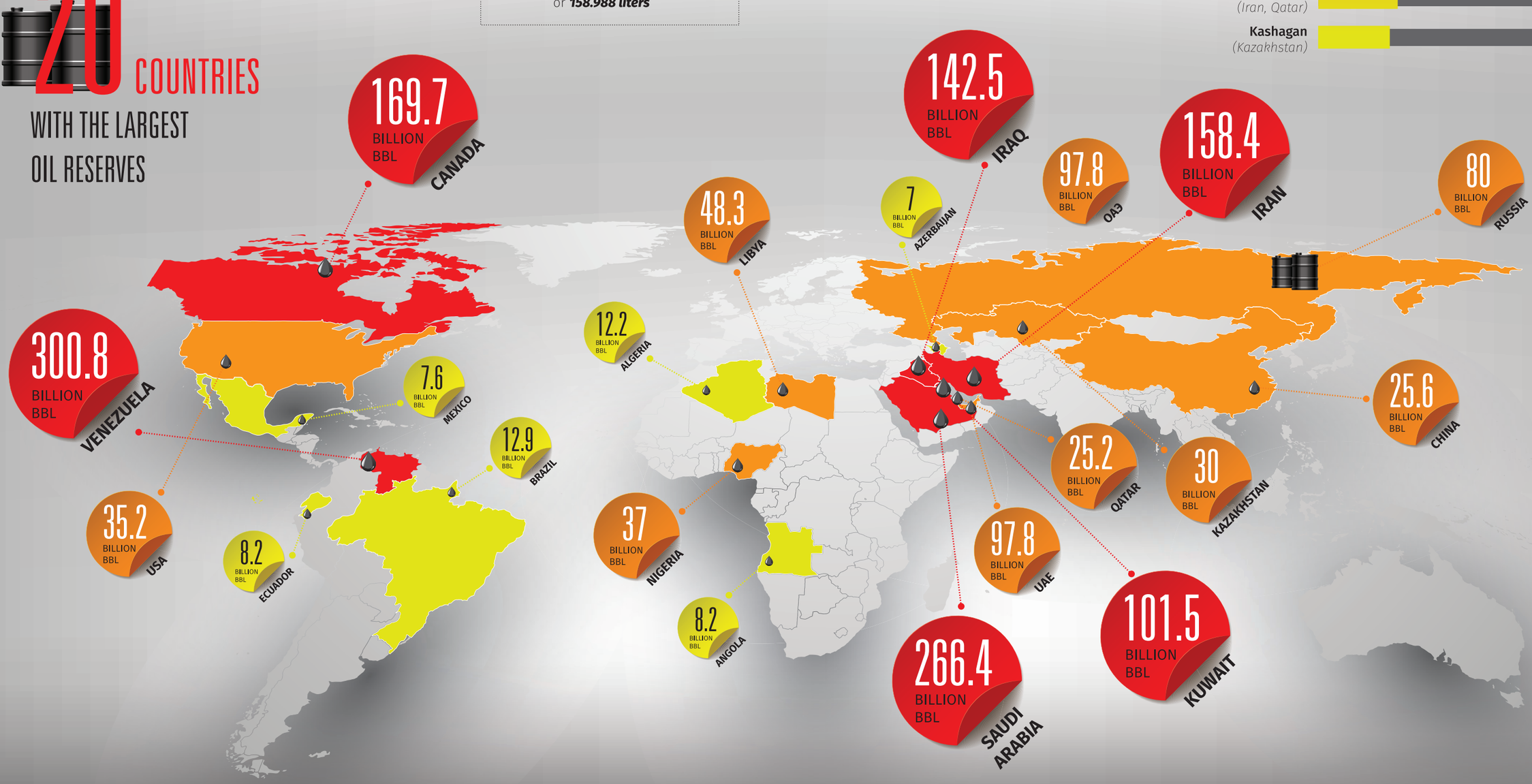
Oil barrel *(bbl)* — a unit of measure for oil, it's equivalent to **42 gallons** or ***158.988 liters***

20 COUNTRIES WITH THE LARGEST OIL RESERVES

10 LARGEST OIL FIELDS

billion tons of oil reserves

Chicontepec *(Mexico)*	19-22
Al-Ghawar *(Saudi Arabia)*	18-20
Burgan field *(Kuwait)*	13
Carioca Pan de Azucar *(Brazil)*	11
Zakum *(UAE)*	9,5-10
Safania Hafji *(Saudi Arabia and Kuwait)*	6-10
Bolivar Costal *(Venezuela)*	8,3
Samotlor *(Russia)*	7,1
North Dome / South Pars *(Iran, Qatar)*	7
Kashagan *(Kazakhstan)*	6,4



THE STATE OF THE HYDROCARBON RESOURCE BASE OF RUSSIA

and support measures provided by the government and aimed at its replenishment

Denis Khramov
First Deputy Minister of Natural Resources and Environment of the Russian Federation

GLOBAL ENERGY PRODUCTS DEMAND CONTINUES TO GROW. TO MAINTAIN THE LEVEL OF OIL AND GAS PRODUCTION, IT IS NECESSARY, FIRST OF ALL, TO REPLENISH THEIR RESERVES. DENIS KHRAMOV, FIRST DEPUTY MINISTER OF NATURAL RESOURCES AND ENVIRONMENT OF THE RUSSIAN FEDERATION, SPOKE ABOUT THE TECHNOLOGIES AND EQUIPMENT PROVIDED TO RUSSIAN EXPLORATION GEOLOGISTS, HOW MUCH COMPANIES AND THE STATE SPEND ON GEOLOGICAL EXPLORATION, AND WHAT MEASURES ARE TAKEN BY MINISTRIES AND DEPARTMENTS WORKING IN THAT SECTOR

KEYWORDS: *exploration, investment, strategy, resources, reserves.*

– Russia is one of the leaders in hydrocarbon reserves and production, that provides almost 40% of the budget. How much does the government spend on the reproduction of the mineral resource base and what is the percentage of state participation in the corporate geological exploration?

– The costs of hydrocarbons in 2019 amounted to 14 billion rubles of federal budget (taking into account unfulfilled obligations of Rosgeologia JSC). According to preliminary data, the expenses of companies for geological exploration for oil and gas in 2019 are more than 300 billion rubles, exceeding the investments of 2018 (283 billion rubles). It is planned to maintain the achieved level of funding in 2020.

– And what about the extent of exploration and the scale of investments over the past year? Are there any regions where the interest of companies is most significant?

– In 2019, the federal budget spent on exploration 25.5 billion rubles, including 14.1 billion rubles on oil and gas.

According to the results of 2019, the costs of subsoil users for geological exploration are about 350 billion rubles (300 billion rubles for hydrocarbons and 47.7 billion rubles for solid minerals).

The regions of Western Siberia, the Arctic and the Far East are of the greatest interest for investment.

– Where is it planned to direct budget funds first?

– Geological exploration at the expense of the federal budget will be aimed, as in previous years, to clarify the geological structure of promising territories of the unallocated subsoil fund; to localize forecast resources, to prepare licensed sites for auctioning so that they can be subsequently processed by subsoil users.

FACTS

25.5
billion rubles
amounted to the federal budget for geological exploration in 2019

Geological exploration is localized mainly in Eastern Siberia and the Far East.

– What are the main challenges facing Russian geological exploration?

– The objective industry challenges include:

- the need to search for deposits in remote areas with undeveloped infrastructure;
- the tendency of discovering predominantly small and medium deposits ("fading" of deposits);
- the need to use new technologies for mineral search and exploration.

The answer to these challenges is systematic work to improve the legislation on subsoil, including one aimed at stimulating subsoil use and removing administrative barriers.

The challenges in the field of state regulation of the geological study of subsurface resources and subsoil use include:

- insufficient funding for geological exploration of the early stages;
- imbalance between the localization of forecast resources – the so-called “search reserve,” the increase in proven reserves and production.

The answer to these challenges is the development of measures to stimulate exploration activities and

the work of Federal Subsoil Resources Management Agency to justify the directions of regional exploration in collaboration with scientific organizations and mining companies.

– In 2019, the Strategy for the development of the mineral resource base until 2035 was approved, what is being done today as part of the implementation of the Strategy?

– By order of the Ministry of Natural Resources of Russia dated May 13, 2019 No. 296, the Action Plan for implementing the Strategy for the Development of the Mineral Resources Base of the Russian Federation until 2035 for the next five years was approved.

The measures of the Plan are aimed at achieving the goals and objectives for the development of the mineral resource base specified in the Strategy for the Development of the Mineral Resources Base of the Russian Federation until 2035 (approved by Decree of the Government of the Russian Federation dated December 22, 2018 No. 2914-r) within the framework of the first stage of implementation (years 2019–2024).

The plan includes measures aimed at increasing the geological exploration of the territory of the Russian Federation and its continental shelf, the development of a highly liquid mineral resource base for existing and emerging mineral resource centers. Measures are being taken to stimulate the discovery of hydrocarbon deposits and solid minerals, to ensure the reproduction and rational use of the mineral resource base.

For example, in 2019, as part of the implementation of the Plan, normative legal acts were adopted, that:

- have established the possibility of conducting a geological study of the subsoil as an independent type of subsoil use, in areas of federal subsoil located in inland sea waters or the territorial sea of the Russian Federation (No. 355 Federal Law of 04.11.2019);
- have improved legal regulation of relations in the field of geological exploration and production of hard-to-recover mineral reserves (No. 396 Federal Law of 02.12.2019);
- have established a new rate and procedure for calculating the tax on production of minerals in relation to rare metals in order to increase the investment attractiveness of projects for the development of domestic rare-metal deposits (No. 284 Federal Law of 02.08.2019).

– Denis Gennadievich, to what extent is Russia provided with hydrocarbon reserves and how urgently, in your opinion, does the country need to replenish its resource base?

– Hydrocarbon raw materials – oil and natural gas are the main types of strategic mineral raw materials.

FACTS

350
billion rubles

amounted to the costs of subsoil users for exploration in 2019

Given the economic conditions for the development of mineral resources, the profitable reserves of strategic and most important types of minerals of currently exploited deposits may last for about 25–30 years.

Moreover, in terms of quantity and quality, the balance of gas reserves under any scenario of economic development will satisfy the necessary long term needs.

Oil reserves, in accordance with the Strategy for the Development of the Mineral Resources Base of the Russian Federation until 2035, approved by Decree of the Government of the Russian Federation dated 22.12.2018 No. 2914-r, belong to the group of mineral resources, achieved production levels of which are insufficiently provided with reserves of developed deposits for the long term.

In accordance with the action plan ("road map") for implementing measures to develop oil fields and increase oil production in the Russian Federation No. 598p-P9, approved by the Chairman of the Government of the Russian Federation D.A. Medvedev on 25.01.2019, Medvedev, the Ministry, together with interested federal executive bodies, prepared and sent to the Government of the Russian Federation proposals to stimulate exploration work carried out on land and on the continental shelf of the Russian Federation with a plan to expand the resource base by improving legislative regulation of economic measures and administrative impact.

– In your opinion, is it already necessary to develop the hydrocarbon reserves of the shelf of the Arctic seas today, or does it make sense to work more actively on the continent?

– The Arctic has a significant place in the economics of Russia.

Currently, more than 90% of nickel and cobalt, 60% of copper, 96% of platinum group metals are produced there, about 80% of gas and 60% of oil are being extracted.

Further development of the Arctic is one of the strategic goals of modern Russia. It is quite obvious that the Arctic can be developed only through large-scale and highly profitable projects that will become the locomotives of the development of its constituent regions.

Profit, compensating for the inevitable additional costs, will allow us to solve the whole range of tasks for the development of the territories while maintaining the profitability of the projects themselves.

Large-scale programs that serve as the engine for the development of the Arctic zone of the Russian Federation should be based on the specific competitive advantages of the Arctic: rich resources and transport communications that can maintain profitability over the next 20 years.

At the same time, transport projects in this zone can exist only if they have guaranteed loading as a necessary condition for the settlement of the macro-region.

The development of the Arctic region can be driven by hydrocarbon production, including the one on the shelf. The complexity of the implementation of such projects requires the need for innovative solutions, which, in turn, leads to the creation of high-tech industries, and hence high-paying jobs. The basis for the formation of localized effective demand appears, stimulating services and livelihoods, modern social infrastructure emerges. The need for oil delivery motivates the construction and expansion of transport networks.

All this complex of factors in total creates a multiplier effect and involves the integrated development of territories.

I want to draw attention to some nuances that are not immediately evident, but that are important. There is a difference between the total cost of the project and the running costs. For example, the development of the Prirazlomnaya platform on the sea shelf was expensive, but in the future, high-yield wells of this field will produce fairly cheap oil. The Novoportovskoye and Vostochno-Messoyakhskoye deposits are projects worth billions of dollars, but given their scale, they will also produce cheap oil.

FACTS

In the Arctic region

more than 90% of nickel and cobalt, 60% of copper, 96% of platinum group metals are produced, about 80% of gas and 60% of oil are extracted

In general, there are few deposits of this class left on land, but they still exist in Russia, and we are developing them. In addition, do not underestimate the potential of Western Siberia, because it is great. In addition to the Bazhenov suite, which everyone hunts for, there are many other layers and suites in which reserves are hidden, even if not many billion tons, just 1–2 billion, but the permeability of the rocks there is so much higher than in the Bazhenov suite. At the same time, Western Siberia is a well-equipped area with developed infrastructure. The cost of producing this oil may be higher, say, not 5–6, but 15–20 dollars per barrel, but not 40 dollars per barrel.

– Yes, hard-to-recover reserves require both additional costs and new technology. What is being done to stimulate the development of HTR reserves production technologies? What measures does the ministry offer to increase extrabudgetary investments in geological exploration?

– In order to stimulate the development of unconventional sources of hydrocarbon raw materials, Federal Law No. 396 was adopted on December 2, 2019 "On Amending the Law of the Russian Federation "On Subsoil" in terms of improving the legal regulation of relations in the field of geological exploration, exploration and production of hard to recover useful minerals" (hereinafter referred to as Federal Law No. 396), developed by the Ministry of Natural Resources of Russia in order to execute a number of instructions of the Government of the Russian Federation.

The law aims to stimulate the study, exploration and production of hard-to-recover mineral reserves (HTR reserves). The specific types of HTR reserves for which the new licensing regime will apply will be established by the Government of the Russian Federation.

At the open acreage, where the subsoil block contains only HTR reserves and does not contain other hydrocarbon deposits, it is provided for testing technologies at a competition for 15 years with the possibility of repeated extensions for up to 5 years.

In the subsoil areas of the distributed reserve, a subsoil block containing HTR reserves can be cut out from a larger block provided for the field development of hydrocarbon deposits in the upstream and downstream deposits. In this case, a site for the development of technologies is provided by decision of the commission created by Federal Subsoil Resources Management Agency, based on a request from the user of the main assembly for a period of up to 7 years with the possibility of a single extension of the use of subsoil for a period of 3 years.

At the end of the validity period of the technology development mode, the user has the right to switch from experimental work to industrial production in the usual production regime "for exploration and production".

The establishment of deadlines for combined licenses is introduced in order to stimulate subsoil users to accelerate the transition from the pilot stage (technology development) to the industrial stage (exploration and production).

When working in the technology development regime in the provided area, it is allowed to produce HTR reserves in the amount limited by the design documentation. The regime implies the obligation to prepare specialized project documentation in a simplified format, which should be developed after the adoption of the law.

Federal Law No. 396 provides for the exemption of subsoil users from the payment of one-time and regular payments for the use of subsoil during the development of technologies.

– Companies operating in the Arctic region also need new technologies; does Russia possess these technologies?

– Obviously, to accelerate the study of the Russian Arctic shelf, it is necessary to modernize and expand the seismic exploration fleet, equipped with modern equipment.

This will make it possible to identify and localize structures with potentially highly profitable resources, the detailed exploration and development of which using a significant number of expensive offshore drilling rigs and supporting vessels may prove economically viable.

FACTS

15 years

are provided for the development of technologies on a competitive basis with the possibility of repeated extensions for up to 5 years on an unallocated subsoil reserve fund containing only HTR reserves

Among the promising underwater technologies of domestic production, I can point out a unique Russian robotic complex under design as part of the Iceberg project of the Rubin Central Design Bureau, which has no foreign counterparts (http://tass.ru/opinions/interviews/4572997). The project presented at the Neva-2017 exhibition (St. Petersburg) provides for the under-ice development of hydrocarbons, primarily in the Arctic zone.

– To what extent are Russian exploration geologists provided with modern equipment and technologies?

– Innovative technologies and equipment in geological exploration allow us to detect oil deposits, to study the regularities of location, formation conditions, and features of the field structure as accurately as possible. Thanks to these technologies, many companies are able to significantly improve the quality of work on the study and development of oil and gas fields.

Among many modern geological exploration technologies, I should single out the Green seismic. Unlike traditional seismic work, the Green Seismic technology is based on a wireless data acquisition system and is used in hard-to-reach places without cutting clearings in forests.

I can use PAO Gazprom Neft (GPN) as an example. When conducting seismic surveys in the Khanty-Mansiysk Autonomous Okrug in the winter season of 2017–2018, the company applied Green Seismic 2.0 technology in Zapadno-Pokurskaya block, in the winter season of 2018–2019 this technology has already been applied in several areas of works: Zapadno-Zimny, Salymsky 2, Palyanovsky, Vatinsky, which made it possible to reduce the clearing area due to the use of light drilling rigs and snowmobiles instead of bulky equipment.

LUKOIL also implements this technology in the Samara Region, Khanty-Mansiysk Okrug and the Komi Republic. In particular, it is planned to use wireless seismic surveys next season in the Yakhlinsky and Vostochno-Tugrovsky areas, and narrow clearcuts will be used in the Severo-Yagunsky and Zapadno-Ikilorsky license blocks.

Green Seismic 2.0 technology is based on a wireless data acquisition system, which allows:

- to reduce the width of the clearcut for seismic exploration,
- to abandon the use of heavy equipment,
- to increase industrial safety,
- to speed up the process of placing sensors in difficult terrain.

In order to reduce environmental pollution, oil and gas companies are developing and introducing new environmentally friendly technologies. Pitless drilling is being mastered, which can significantly reduce the volume of industrial waste. Technologies are being developed for the effective cleaning of contaminated surfaces using bacterial preparations and various flushing liquids.

Oil spills remain the main risk of environmental damage for the oil and gas complex. At the same time, it should be noted that all enterprises of the oil and gas complex of Russia have necessary Oil Spill Response Plans, their own off-nominal emergency formations and contractual relationships with professional emergency organizations, the necessary equipment and reagents.

The Ministry is resolving issues on the legislative regulation of relations in the field of preventing and eliminating oil spills on land. The relevant bill (No. 376642-7 "On Amendments to Article 46 of the Federal Law "On Environmental Protection" and certain legislative acts of the Russian Federation") is being prepared for consideration for the second reading in the State Duma of the Federal Assembly of the Russian Federation.

Special environmental technologies are used in the study and development of deposits in the Arctic zone of the Russian Federation. Here, at the request of the Russian Ministry of Natural Resources, oil and gas companies have developed and are successfully implementing targeted programs for the conservation of vulnerable Arctic biodiversity.

– What are the main areas of regulation of the geological exploration industry is the Ministry focused on today?

– Improving the legislative regulation of economic and administrative measures in order to stimulate exploration work carried out on land and on the continental shelf of the Russian Federation remains one of the priority areas of the Ministry.

FACTS

3,176

deposits with a total current technologically recoverable oil reserves of 29.9 billion tons were taken into account by the state balance of mineral reserves as of January 1, 2019 in the Russian Federation

The relevant problem today is related to the fact that the provision for use of subsoil plots not completed by regional studies significantly increases the geological risks of subsoil users and often leads to negative or unclear results of exploration work, does not accelerate, and in some cases can even slow down the pace of geological exploration.

To overcome the deficit of promising territories, it is necessary to overcome the negative trends of recent years and increase the volume of regional exploration for oil and gas. Thematic work, quantitative assessment of resources and large regional generalizations are of great importance for substantiating the areas of exploration, and they need to be performed as the stages of regional study are completed.

In the coming years, it is planned to carry out regional correlations on the Barents and Okhotsk Seas, the Eastern Pre-Caucasian region, the framing of the Vilyui syneclise, to update the geological model of the Gydan-Khatanga zone, and to begin a new cycle of quantitative assessment.

In addition to the ongoing study of the Gydansko-Khatanga, Argish-Chun and Karabash zones, it is proposed to add to the adjusted list of priority oil-prospective zones: Preduralskaya, Poluiskaya and Kochechum-Markhinskaya.

– Tell us more about measures to monitor and oversee compliance of subsoil users with license obligations. What are the main violations you encounter, what's causing them and what measures are taken to stop and punish violators?

– Federal Supervisory Natural Resources Management Service (Rosprirodnadzor), in accordance with the Regulation on the Federal Service for the Supervision of Natural Resources, approved by Decree of the Government of the Russian Federation of July 30, 2004 No. 400, carries out

federal state supervision of geological exploration, rational use and protection of subsoil, guided by the Regulation on state supervision of geological exploration, rational use and protection of subsoil, approved by Decree No. 293 of the Government of the Russian Federation dated 12.05.2005.

Compliance with the conditions for the use of subsurface resources by the subsoil user are monitored through scheduled and unscheduled inspections.

According to the results of inspections of subsoil users, violations are identified in terms of rational use and protection of subsoil, environmental legislation of the Russian Federation.

The main and most frequently detected violations during inspections of compliance with the terms of license agreements are violations in terms of work due to the absence of agreed and approved technical projects in the established manner or the violations of such; mining allotment documentation violation or absence of such; not registration of negative environmental impact objects, lack of permits for environmental protection (including emissions, discharges, waste disposal).

Also, there is often a violation of the established requirements for the development of technical projects. Sometimes project documentation does not contain specific environmental measures.

Based on the results of the violations identified, Rosprirodnadzor issues orders to eliminate the violations, administrative measures in the form of fines are applied; the damage caused to the components of the environment is also calculated and presented, information is sent to Rosnedra to take measures on the early termination of the right to use subsoil.

– Recently, much has been said about introducing the best available technologies. What is their purpose in geological exploration?

– In accordance with Federal Law dated 10.01.2002 No. 7-ФЗ “On Environmental Protection”, the application of the best available technologies is aimed at comprehensive prevention and (or) minimization of negative environmental impacts.

Areas of application of the best available technologies may include economic and (or) other activities that have a significant negative impact on the environment, and technological processes, equipment, technical methods and methods used in carrying out economic and (or) other activities.

By order of the Government of the Russian Federation dated April 30, 2019 No. 866-r, a phased schedule for updating information and technical guides on the best available technologies for 2020–2024 was approved.

FACTS

89 years

are the years of gas reserves at existing volumes of production

In particular, in order to reduce emissions of pollutants into the atmosphere, work is underway to use associated petroleum gas to produce gasoline and generate electricity. By order of the Ministry of Natural Resources of Russia dated May 21, 2019 No. 319, a regulatory document in the field of environmental protection “technological indicators of the best available technologies for processing natural and associated gas” was approved. The regulatory document in the field of environmental protection “Technological indicators of the best available technologies for oil production” was also approved (order of the Ministry of Natural Resources of Russia dated 13.06.2019 No. 376.

– According to your estimates, for how many years is Russia provided with hydrocarbons?

– State balance of mineral reserves as per January 1st 2019 says that the Russian Federation recorded 3,176 fields with a total current technologically recoverable oil reserves of 29.9 billion tons, of which: 2,098 fields are at the stage of industrial development (currently being developed) with oil reserves of 23.2 billion tons; 1078 fields are under investigation and test operation (exploration) with oil reserves of 6.7 billion tons.

The current recoverable oil reserves of Russia in categories AB_1C_1 are 18.6 billion tons, in categories B_2C_2 –11.3 billion tons.

Oil production security for existing production is: 47 years (taking into account the transfer of reserves of lower categories to industrial ones).

The reserves of free gas and gas caps in the AB_1C_1 category are 49.3 trillion m^3, and in the B_2C_2 category 23.7 trillion m^3.

The gas production security at the existing production is 89 years (taking into account the transfer of reserves of lower categories to industrial ones).

GIANT FIELDS with reserves of more than 2 billion tons

SAMOTLOR

OPENING: 1965, expedition by V. Abazarov
PRODUCTION COMMENCED in 1969
LOCATION: Khanty-Mansiysk Autonomous Okrug – Yugra
AREA: Over 3 thousand km²
Estimated geological oil reserves: **7.1** bil tons
VOLUME OF RECOVERABLE RESERVES: 2.7 bil tons
ANNUAL PRODUCTION: 22 mil tons
OPERATOR: PJSC "Oil Company Rosneft"
70% exhausted

ROMASHKINSKOYE

OPENING is 1948, S. Kuzmin and R. Khalikov's team
LOCATION: Republic of Tatarstan, Almetyevsk
Estimated geological oil reserves: **5** bil tons
VOLUME OF RECOVERABLE RESERVES: 3 bil tons
ANNUAL PRODUCTION: 15 mil tons
OPERATOR: PJSC "TATNEFT"

PRIOBSKOYE

OPENING: 1982
PRODUCTION COMMENCED in 1988
LOCATION: Khanty-Mansiysk Autonomous Okrug – Yugra, Seliyarovo village
Estimated geological oil reserves: **5** bil tons
VOLUME OF RECOVERABLE RESERVES: 2.4 bil tons
ANNUAL PRODUCTION: 40 mil tons
OPERATOR: PJSC "Oil Company Rosneft", PJSC "Gazprom Neft"
Over a thousand oil wells have been drilled in the field

LYANTOR

OPENING: 1965
PRODUCTION COMMENCED in 1969
LOCATION: Khanty-Mansiysk Autonomous Okrug (KMAO), Surgut district, on the river Pim near Liantor, 90 km from Surgut
Estimated geological oil reserves: **2** bil tons
VOLUME OF RECOVERABLE RESERVES: 380 mil tons
ANNUAL PRODUCTION: approximately 7.5 mil tons
OPERATOR: PJSC "SurgutNeftegas"

FEDOROVSKOE

OPENING: 1971, expedition by N. Morozov
PRODUCTION COMMENCED in 1973
LOCATION: KMAO, near the city of Surgut
Estimated geological oil reserves: **2** bil tons
VOLUME OF RECOVERABLE RESERVES: 189.9 mil tons (figures as end of 2009)
ANNUAL PRODUCTION: 2004 – 12.5 mil tons, 2012 – 8,275 mil tons
OPERATOR: PJSC "SurgutNeftegas"

RECENT TRENDS IN SEARCHING AND EXPLORATION OF HYDROCARBON CRUDE CLUSTERS

Sergey Agalakov
Deputy Director General divisions on regional geology and geological exploration, Geological exploration management – North of Western Siberia, Department of support of geological exploration in the Arctic regions, General Manager

Elena Gaifullina
Deputy Director General divisions on regional geology and geological exploration, Geological exploration management – Western Siberia, Geological exploration support department – West Khanty-Mansi Autonomous Okrug, Chief Officer

Marina Grischenko
Deputy Director General science divisions, Expert Analytical Management, Expert Department, Chief Expert

Aleksey Novokreschin
Deputy Director General science divisions, Expert Analytical Management, Expert Department, Chief Expert

Maya Novoselova
Deputy Director General divisions on regional geology and geological exploration, Geological exploration management – North of Western Siberia, Department of support of geological exploration in the Arctic regions, Chief Officer

Larisa Torgashova
Deputy Director General divisions on regional geology and geological exploration, Geological Exploration Management – New Projects and Eastern Siberia, Geological Exploration Support department in Eastern Siberia, Manager

Natalia Chikina
Deputy Director General divisions on regional geology and geological exploration, Geological Exploration Management – New Projects and Eastern Siberia, Department of Geology and Seismic Interpretation, Petrophysics Expert

Rosneft
Tyumen Petroleum
Research Center, OOO

MAKING REPLACEMENT OF RESERVES MORE EFFICIENT IS ONE OF THE KEY ELEMENTS OF THE ROSNEFT-2022 STRATEGY. THE COMPANY HAS COMMITTED TO REPLACEMENT OF AT LEAST 100% OF THE HYDROCARBONS PRODUCED. IN MODERN CONDITIONS, SUCH A DIFFICULT TASK IS ONLY POSSIBLE TO ACHIEVE WITH THE ACCELERATED DEVELOPMENT OF INNOVATIVE TECHNOLOGIES, INCREASED EFFICIENCY OF GEOLOGICAL EXPLORATION AND INVOLVEMENT OF NEW STRATIGRAPHIC HORIZONS IN THE DEVELOPMENT

Keywords: *geological exploration, replenishment of the resource base, development of deposits, seismic exploration, oil and gas potential.*

Tyumen Petroleum Research Center (TNNC), OOO, is the fundamental corporate research and design institute of Rosneft, PAO, performs field engineering and desktop support for the processes of geological studies and exploration, as well as for oil and gas deposits development of the Company's subsidiary oil and gas companies in Russia (Ural-Volga region, Western and Eastern Siberia, Sakhalin Island) and abroad (Vietnam, Venezuela, Brazil, Kurdistan, Egypt). TNNC supports over 90% of free gas production and 34% of the Company's oil production.

One of the key areas of TNNC, OOO activity is geological exploration: regional and local basin geology research from assessing oil and gas potential (basin modeling) to the localisation of reservoirs of various sizes, design and support of seismic exploration, processing and interpretation of seismic data, support for exploration drilling. From a geographical perspective, geological exploration is carried out in licensed areas of three large oil-bearing basins of Russia (Western and Eastern Siberia, Timan-Pechora Basin).

Among the innovative directions developed by the geological exploration unit there is the development and widespread use of stochastic inversion of seismic data, which allows not only to reduce the uncertainties in the predictions of the lithological structure of oil reservoirs and assess the degree of uncertainty of these predictions, but also to construct accurate three-dimensional digital geological models of pay beds.

In addition to developing innovative solutions in the field of seismic data interpretation technology, one of the key priorities of the Rosneft oil company is to increase the resource base of hydrocarbons in the areas of large oil and gas basins in Russia (West Siberian and Timan-Pechora oil and gas basins, Eastern Siberia). In addition to developing hydrocarbon reserves concentrated in the main pay bed of the West Siberian oil and gas Basin and in sediments of Eastern Siberia, the company plans to develop new stratigraphic intervals, which were previously considered unpromising or having little promise. For example, in the south and southwestern periphery of the West Siberian Basin, objects in the upper part of the pre-Jurassic formation are becoming more interesting. In the central regions, the Upper Jurassic oil and gas play as part of the Bazheno-Abalak play is beginning to actively develop. In the northern regions, new discoveries are associated with large deposits in the supra-cenomanian Upper Cretaceous play: Kuznetsovskaya, Berezovskaya and Gankinskaya formations, where, according to experts of TNNC, OOO, 1 billion m³ to 1.5 billion m³ of gas is concentrated. The replacement of hydrocarbon reserves on the territory of the Botuobinsky petroleum region of the East Siberian Basin, is going to be carried out with the development of new promising objects in the Ustun, Kursk and Verkhnebuk formations of the Upper Vendian.

Use of stochastic seismic inversion for lithology prediction in the interval of the Bazheno-Abalak play at the Krasnoleninsky arch

The problem of oil and gas potential in the Bazhenov and Abalak formations within the Krasnoleninsky arch is one of the most acute problems associated with hard-to-recover reserves of Western Siberia. On the one hand, high-rate oil inflows were obtained from these deposits in many wells, and on the other hand, the success rate of exploratory drilling at the Bazhenov-Abalak section interval is still very low. The reason for this is the significant uncertainty in the lithological composition of the considered formations.

Currently, one of the main methods for reducing the uncertainty of the lithological structure of oil and gas reservoirs is stochastic inversion of seismic data. It is a geological simulation, consistent with borehole and seismic data:

- The resulting model has geological limitations defined by the probability-density functions of the distribution of lithotypes in the field of elastic parameters;
- Alignment with seismic data is ensured through an iterative procedure, that inculdes the calculation of the synthetic wavefield according to the model and its comparison with the observed wavefield.

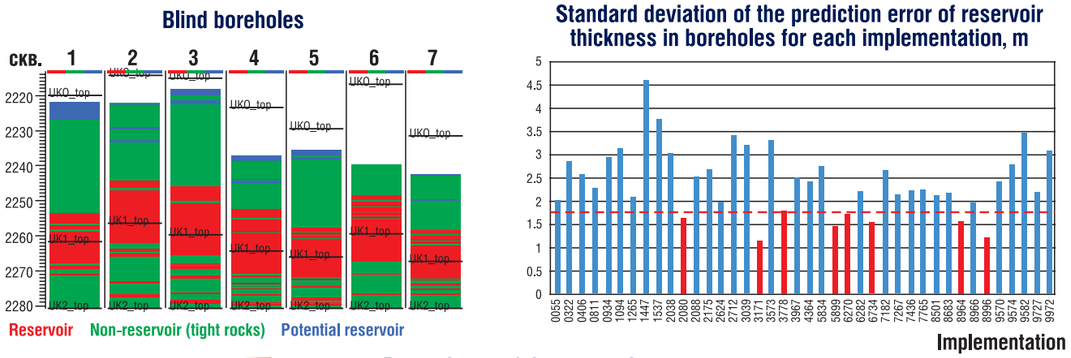
As a result of stochastic inversion, many equally probable implemantations of cubes of elastic properties, lithology, and reservoir porosity and permeability parameters are obtained, with vertical resolution comparable to the scale of the borehole survey. The fact that there are several implementations allows to assess the degree of uncertainty of the obtained predictions.

The presented results of stochastic seismic inversion are part of a large project for predicting the oil and gas potential of the Bazheno-Abalak play (BAP) within the Krasnoleninsky arch, in which specialists from various research centers are involved. Considerable work has been done on core sample research, as well as petrophysical and petro-elastic modeling, fracture characterisation, conceptual modeling, processing and interpretation of seismic data, which became the basis for stochastic seismic modeling and later served as the basis for constructing a 3D geological model.

One of the key issues in interpreting the results of stochastic inversion is the choice of implementations that are most appropriate for the studied object. In our case, the selection criterion was the standard deviation of the reservoir thickness prediction error in blind boreholes (boreholes evenly distributed over the area and not used in the calculation of the inversion due to incomplete borehole logging) for each implementation. The minimum error was noted in 8 implementations (Figure 1).

An assessment of the predicted reservoir capacity for all implementations was also performed. The difference between the minimum and maximum options is very small – therefore, the obtained implementations are stable. Based on the histogram of the reservoir thickness distribution, the implementations corresponding to the average values are selected (Figure 2).

FIGURE 1. Selection of the most probable implementations by blind boreholes



* The average standard deviation of the prediction error of reservoir thickness in boreholes is 1.75 m, which is approximately 10% of the average reservoir thickness over the area (16 m)

Three of them were selected that satisfy both selection criteria (blind boreholes and reservoir capacity).

Based on the results of stochastic seismic inversion, it was possible to predict the lithological properties of the object, as well as to identify productive and promising zones in the BAP interval and to assess the degree of prediction uncertainty. It should be noted that the prediction of properties (reservoir lithotype thickness, fracture density, carbonate thickness, brittleness, organic carbon content) based on the results of a previously performed deterministic inversion, the vertical resolution of which is comparable to the seismic, turned out to be insufficient for constructing a 3D geological model, because it was characterised by unsatisfactory correlation coefficients with borehole data. On the contrary, stochastic inversion made it possible to achieve stable correlation with borehole data.

The three-dimensional digital geological model of the Bazhenov and Abalak formations created on the basis of stochastic inversion data in the study area became the foundation for developing a further exploration strategy.

The potential growth of gas resources of the supra-cenomanian play in Western Siberia

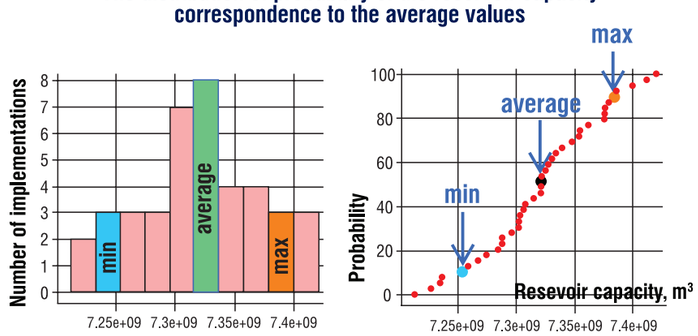
Contemporary view suggests that the Upper Cretaceous strata above the Cenomanian is a strata composed of alternating seals and reservoirs (Figure 1).

The presence of regionally distributed fine-dispersed clays with contrasting acoustic properties allows to confidently distinguish four seismic sequences (SS) in the Cretaceous supra-cenomanian deposits. The same clays act as regional seals (Figure 2).

The structure of the lowest seismic sequence ОГ Г – С4 of the Turonian age includes a single sandy-aleuritic reservoir of the Gaz-Salinskaya unit and Ipatovo formation. Seal – Markhinskaya unit (Figure 3).

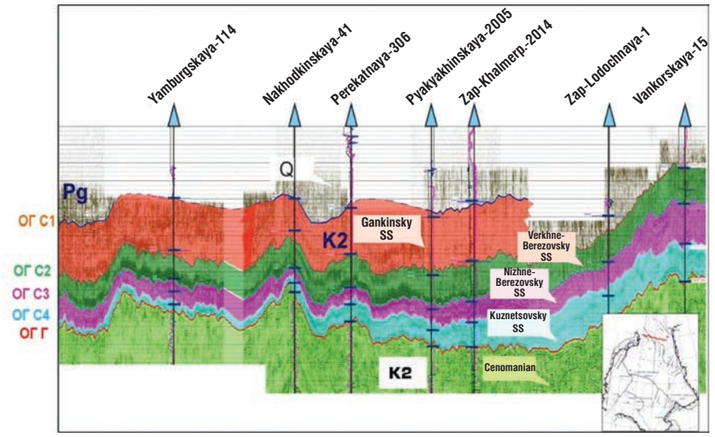
Above the section, the seismic sequence ОГ С4-С3 (Coniacian-

FIGURE 2. Selection of the most probable implementations by reservoir capacity



The difference between the minimum and maximum options is very small – therefore, the obtained implementations are stable

FIGURE 3. Seismic section of the Upper Cretaceous sediments in the northern part of the West Siberian basin



Santonian) is distinguished, including the Nizhneberezovskaya sub-formation and its stratigraphical analogues: the Nizhnechasselskaya sub-formation and the lower part of the Slavgorod formation. The reservoir is special because of its non-conventional type of reservoir – gaize and opoka clay. Seal – lower part of the Verkhneberezovskaya subformation.

The next seismic sequence ОГ С3-С2 (the Campanian) is represented in the section by sediments of the Verkhneberezovskaya formation and its analogues: Verkhnechasselskaya formation and the upper part of the Slavgorod formation. The prospects of the gas potential of the sequence are connected to the appearance of reservoirs in the middle of the sub-formation (bed VB1) under sanding in the north-east direction. Seal – upper part of the Verkhneberezovskaya subformation.

The seismic sequence ОГ С2-С1 (Maastrichtian) is confined to the Gankinsky horizon. In the central part, it is represented by clay

FIGURE 4. The structure of the Upper Cretaceous deposits, Yaroyahinskaya-10 well as an example (regional seals are in grey)

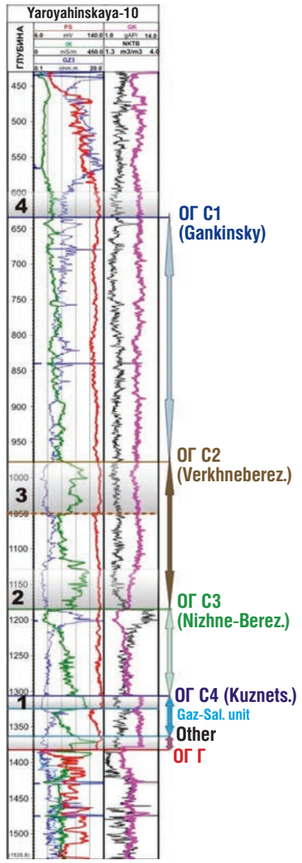


FIGURE 5. The concept structure of each sequence of Upper Cretaceous deposits

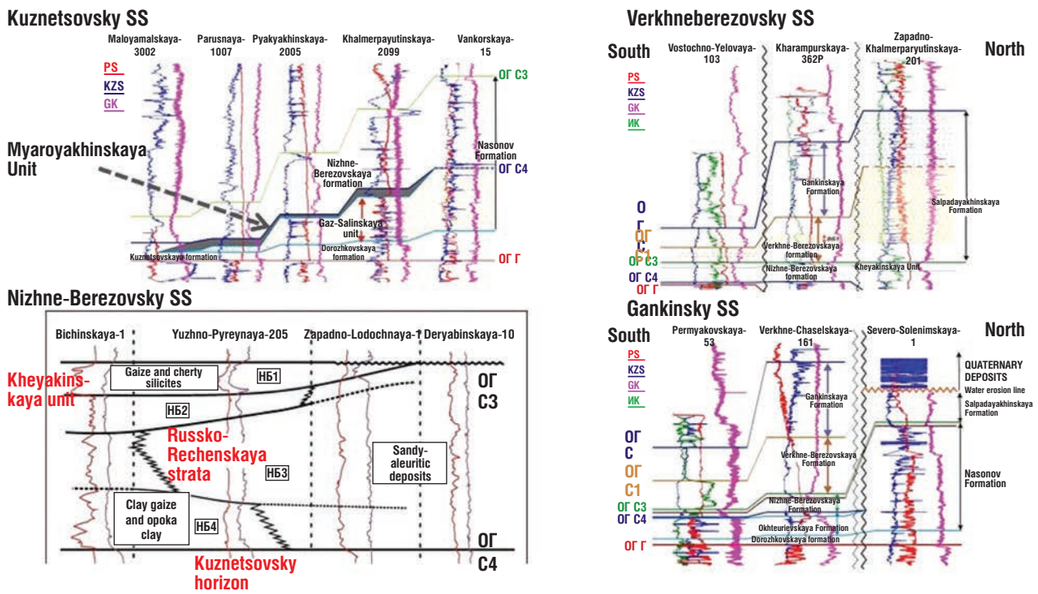
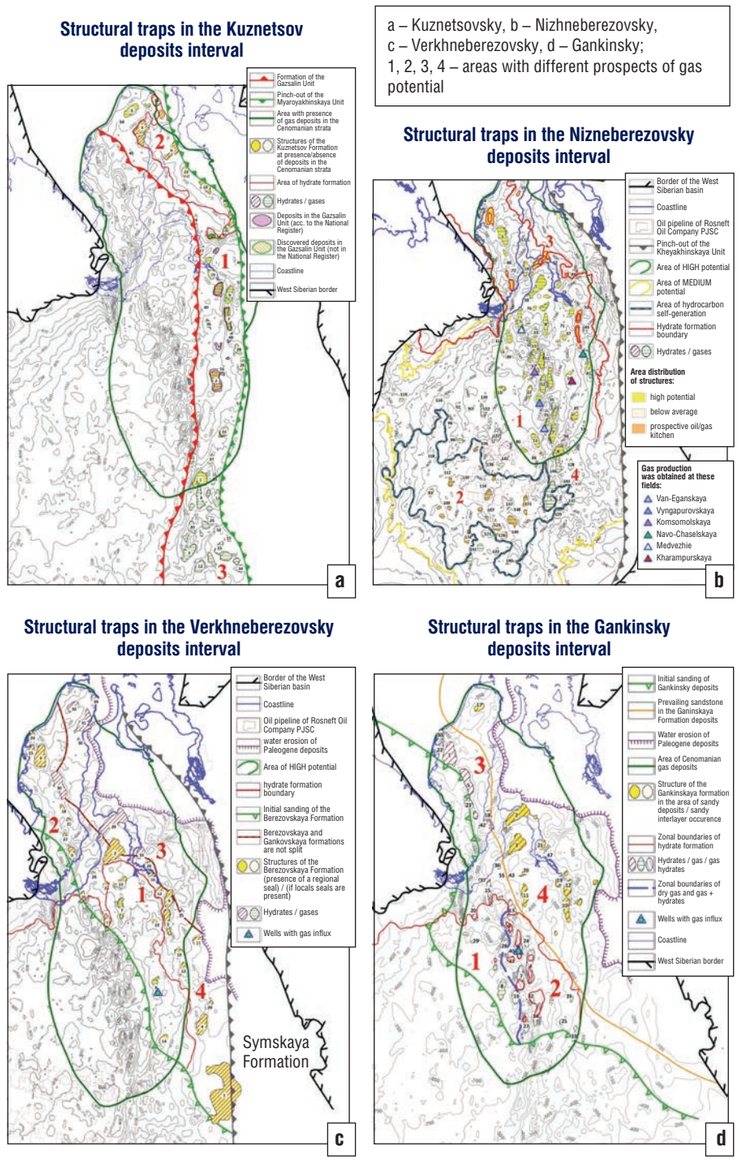


FIGURE 6. Structural Maps and Horizon Traps

a – Kuznetsovsky, b – Nizhneberezovsky, c – Verkhneberezovsky, d – Gankinsky; 1, 2, 3, 4 – areas with different prospects of gas potential



marl of the Gankinsky formation. The appearance of reservoirs is associated with an increase in sediment thickness in the northeast direction and clay replacement with aleurolites, starting from the top. Seal is the clays of the lower part of the Talitsky (Tibeysalinsky) formation.

Structural imaging was completed for each SS, shale lines of reservoirs and sanding lines of regional seals were mapped.

When zoning the prospects of structural traps of the sequences, common criteria were used (Figure 4):

- Cenomanian sediment productivity (green outline)
- At a depth of less than 350 m, deposits were not evaluated (deposits thinning, absence of selas – yellow outline).
- The boundaries of the reservoir distribution, the termination of the tracking of regional seals;
- The distribution of gas hydrates (east of the plain red line).

Resource potential assessment results:

Kuznetsovsky reservoir

The state register of mineral reserves lists reserves in 14 deposits. All identified deposits are located in the area with the gas-bearing Cenomanian. Starting from the Messoyakha shaft and further north, deposits are favorable for the existence of gas hydrates. The resource potential is estimated at 1 trillion m^3 in gas deposits and up to 1.5 trillion m^3 in gas hydrate deposits.

Nizhneberezovsky reservoir

Current study phase. The state register lists reserves at the Medvezhy and Kharampur deposits. The total resource potential estimate is 5.5–9.5 trillion m^3, with up to 2 trillion m^3 of gas in gas hydrate state.

Verkhneberezovsky reservoir

Relatively insignificant in size gas reserve in bed VB1. discovered at the Kharampur deposit. The gas inflow amounted to 40 thousand m^3/day.

The resource potential of the sequence is estimated at 1.3–2.7 trillion cubic meters, with more than 95% in the zone of gas hydrates stability.

Gankinsky reservoir

In the Gankinsky formation, gas shows are found in the Yamsoveyskaya, Verkhnerechenskaya, Gubkinsky and other fields. Producing zones are identified by electrical logging and confirmed by testing at the Gubkinsky deposit.

Gankinsky horizon resource potential is estimated at 1.5–2.5 trillion m^3, with more than 95% of the resources in the zone of gas hydrates stability.

New productive facilities in the Vendian sedimentary sequence of the Srednebotuobinsky deposit (Siberian platform)

Practice shows that at the late stage of exploration, significant hydrocarbon resources are detected in non-anticlinal type traps, which are often confined to geological bodies that were previously considered unproductive. The detection and mapping of such objects, characterised by a complex structure and, usually, by small size, is very difficult due to the lack of reliable search features. The conditions of paleotectonic and paleogeographic development of the territory of the Siberian Platform led to the formation of hydrocarbon traps of various genetic types associated with zones of stratigraphic and lithological thinning of productive deposits, with barrier reefs, with secondary reservoirs in carbonate strata, with hydrodynamic and capillary screens, gas hydrate zones.

New productive reservoirs

In the course of exploration work carried out in recent years at the Srednebotuobinsky deposit, a number of previously unknown oil and gas objects were discovered. In such a way, a natural gas inflow with a flow rate of 200 thousand m^3/day was obtained from the basal unit of the Ustunsky formation underlying the Preobrazhensky horizon. During testing a marking clay-carbonate unit of the Kursovskaya formation, which was previously considered unproductive, an oil inflow with stratum water was obtained with a flow rate of 18.7 m^3/day. Signs of the existence of hydrocarbon traps are noted in the Verkhnebyukskaya subformation. The discovered hydrocarbon deposits structurally differ from those previously discovered within the Nepsko-Botuobinsky petroleum region, therefore, their further study is necessary.

Basal unit of the Uspunskaya formation

The productivity of the unit was first established in 2017 based on the results of drilling a 115P borehole, in which an inflow of gas with a flow rate of more than 200 thousand m^3/day was obtained during the test.

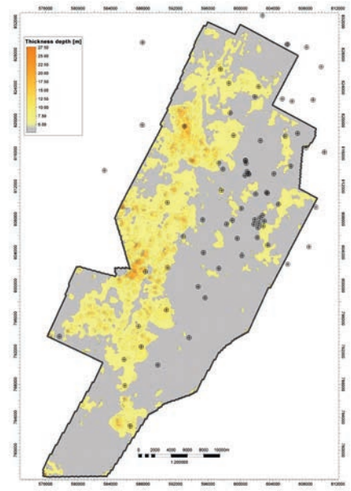
The basal unit transgressively lies on the eroded surface of the Verkhnebyukskaya formation (predanilovsky stratigraphic unconformity). The bed is confined to the bottom of the Uspunskaya formation and is represented on most part of the area with clay-carbonate differentials. In the western part of the deposit, in the section of a number of wells, terrigenous, mainly clay deposits, probably representing the filling fascia of the incised valley, are noted. In the section of wells 115P and 94, the erosion channel is filled with quartz sandstone.

According to A.P. Vilesov interval of the basal horizon in well 115B corresponds to the stage of formation of the Nizhneuspunsky sequence. Deposits of the incised valley – channel sandstones and clay-aleuritic sediments of the floodland – lie at its bottom; they accumulated at the transgressive stage of the formation of the sequence. The incised valley formed at the low standing stage of relative sea level (LST). The terrigenous deposits of the channel filling overlap with the carbonates of the shallow sublittoral and littoral stages of the highstand of relative sea level.

As part of the interpretation of the seismic data, an AVA analysis was performed in the interval of the basal horizon, and the found result was that the thickness of the terrigenous part of the channel mainly affects the amplitude of reflection from this horizon.

The spatial distribution of the terrigenous part is predicted by the exponential dependence of the total thickness of the basal horizon on the complex parameter FluidFactor, taking into account the parameters R0 (intercept) and G (gradient), with a correlation coefficient of 0.75. Then, according to the obtained dependence, a map of the total thickness of the basal horizon was calculated (Figure 1).

FIGURE 7. Map of the basal horizon total thickness



As a result of the prediction, a number of promising stratigraphic type traps associated with sandy deposits filling erosive channels were identified.

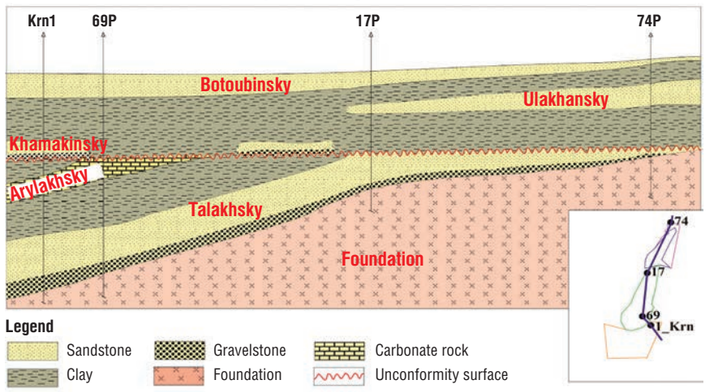
Arylakhsky horizon

According to the results of drilling exploratory well 110P in 2016, the productivity of a clay-carbonate unit was discovered in the upper part of the Kursovskaya formation. When testing this interval using clay-acid treatment, a mixed flow of oil and produced water was obtained with a flow rate of 18.7 m^3/day. The bed was called Arylakhsky in honor of the unit of the same name, singled out by P.N. Kolosov as part of the Kursovskaya formation.

According to A.P. Vilesov and A.V. Plyusnina, the bed is formed by the alternation of dolomites, marls and mudstones. It is a bedding marker and is important for the correlation of sections of the Kursovskaya formation in the study area. Previously, the object was considered to have no signs of hydrocarbons.

The Arylakhsky horizon lies below the regional stratigraphic unconformity within the Kursovskaya formation (pre-Late Tyr erosion surface). The existence of this stratigraphic unconformity

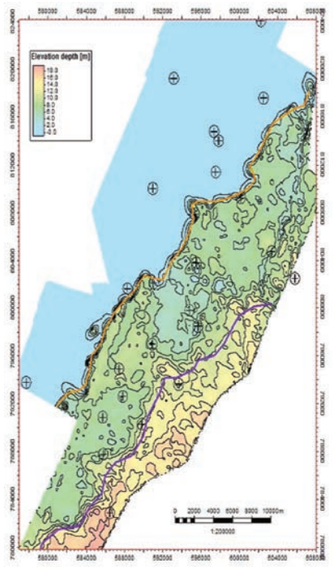
FIGURE 8. Principal geological section of the Kursovskaya formation of the Srednebotubinsky deposit



is justified in the work of Lebedev M.V., Moiseev S.A., Fomina A.M., etc. called "A stratigraphic diagram of Vendian terrigenous deposits of the northeast of the Nepsko-Botuobinsky anteclise."

During the period of pre-Late-Tyr erosion, the Nizhnepsky deposits, including the Arylakhsky horizon, eroded. The erosion intensity increased in the northwest direction, up to the complete denudation of individual stratigraphic levels (Figure 2).

FIGURE 9. Map of the total thickness of the Arylakhsky horizon



The presence of a reservoir in the Arylakhsky horizon is presumably related to the processes of hypergenesis in the area where the rocks reach the erosive paleo-surface. In the core, taken from the Arylakhsky horizon immediately below the erosion paleo-surface (well 116R), interlayers of dolomite are unevenly cavernous-porous, non-uniformly oil saturated by fractures. The core taken in the zone not affected by paleohypergenesis is represented by mudstones and dense dolomites (well Krn 1).

According to the dynamic analysis data, the conditional lines of the beginning and complete erosion of the Arylakhsky horizon were mapped. Figure 3 shows a map of the total thicknesses, where the beginning of the bed resecting with the erosion surface is clearly visible – in the central part (purple line) and full thinning in the northwest (yellow line).

Thus, the region of the likely occurrence of the reservoir in the Arylakhsky horizon can be contoured with the boundaries of the bed outcrop on the erosive paleo-surface (erosion area). The litho-stratigraphic traps associated with the Arylakhsky horizon are a new field of exploration in the area.

Verkhnebyukskaya subformation

Clay-sulphate-carbonate rocks of the upper part of the Byukskaya formation accordingly superpose the lower part, represented by sandstones of the Botuobinsky horizon. Earlier, deposits of the Verkhnebyuksky subformation within the Botuobinsky zone were considered unproductive. But according to the data of the history of the exploration of old exploratory wells, as well as the core data of new wells, there are clear signs of the existence of unexplored hydrocarbon deposits in this interval.

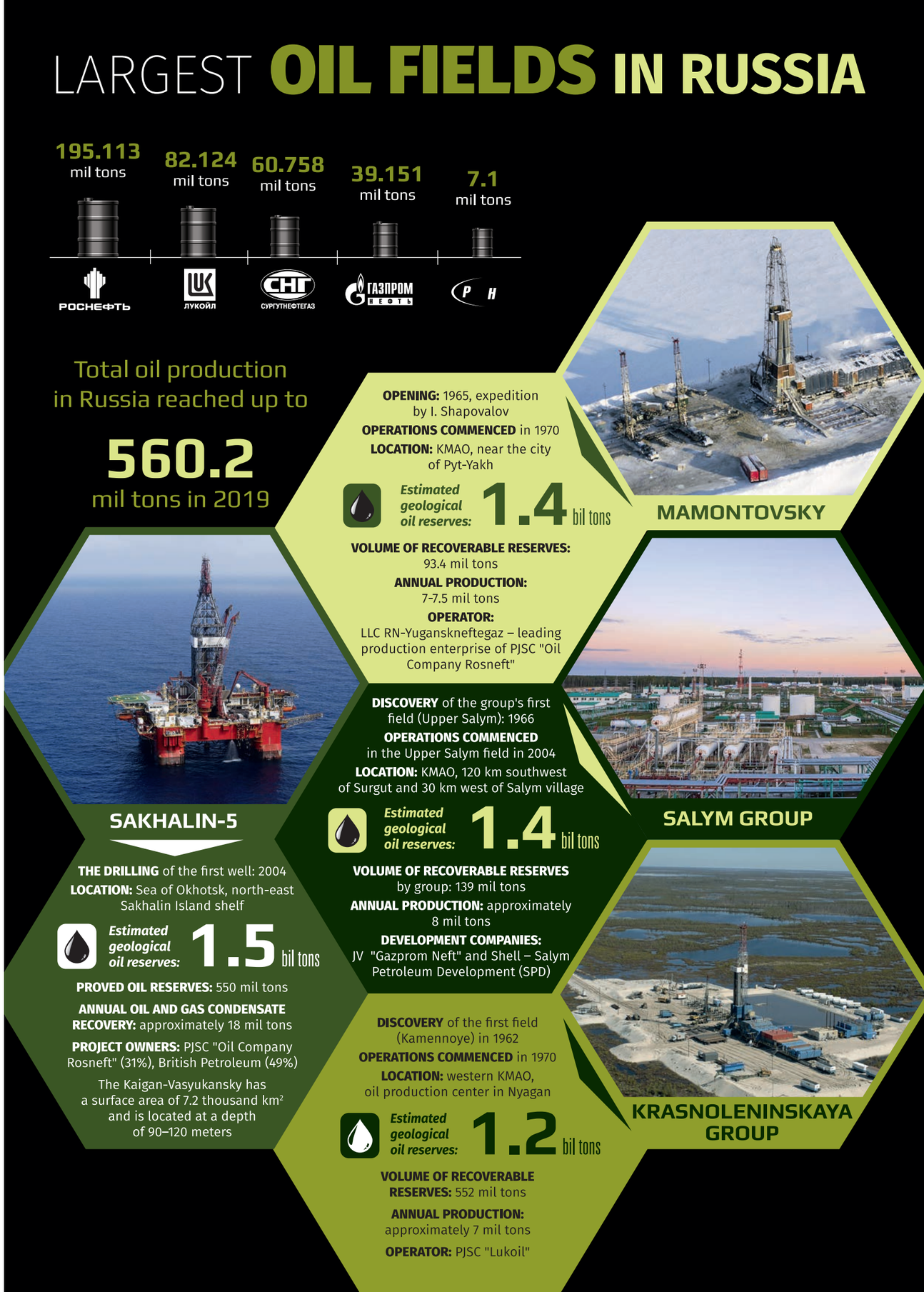
So while drilling exploratory well 18 in the middle part of the Verkhnebyuksky subformation, intensive absorption of drilling fluid up to 60 m³/h and abundant oil presence were noted. Based on well logging data, a bed reservoir with a porosity of up to 17% is clearly distinguished. With the passage of the described interval in well 86 an intense absorption with gas presence, which turned into controlled eruption, was recorded. Similar mud losses were also observed in well 5, located in the northern part of the deposit. According to core data from well 116P, lithogenetic fractures filled with bitumen are observed in dolomites of the lower part of the subformation.

The prospects of the Verkhnebyukskaya subformation are related to the fissure-cavernous type of the reservoir and are localised in the northern and central parts of the deposit.

Conclusion

Increasing the hydrocarbon resource potential is one of the key priorities of the Company. With the depletion of hydrocarbon reserves concentrated in the main reservoirs of the Srednebotuobinsky deposit, replenishment of hydrocarbon reserves is possible by connecting new promising facilities.

Hydrocarbon deposits similar to those discovered in the Uspunskaya, Byukskaya formations and the Arylakhsky horizon can also be found in other deposits of the Nepsko-Botuobinsky petroleum region. In this regard, the geological structure of the identified objects requires in-depth study.

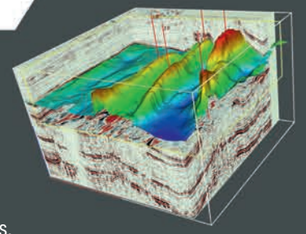


10 TECHNOLOGIES IN EXPLORATION

Geological exploration is an important aspect in the oil and gas sector. It provides survey and preparations for commercial development of new fields and clearly defines prospects of existing ones. Novel and advanced high-tech digital solutions are actively being integrated into geological exploration, as well as other segments of the oil and gas industry. On the other hand, tried and tested methods are being improved and developed further. In our jubilee issue, we would like to talk about the most interesting, promising and relevant geological exploration methods for Russia

The need for digital models

The oil and gas industry has reached a state of development, where simply obtaining data on geological exploration is no longer sufficient; the information collected needs to be analyzed and interpreted. This raises the question of generalization of the obtained dataset, with the need to look at it from a different angle and to identify patterns and relationships. The growing importance of digital models, that generalize the collected data and allow their effective analysis, including the use of Big Data technologies and artificial intelligence, increases because of the rising share of HRR. As new information becomes available, digital models become more accurate and thorough, allowing further exploration of new areas to be identified and reducing the time and cost of geological explorations



The 4th dimension

Geomodeling reaches new scales, including the possibility to develop 3D and 4D models. In seismic surveys, 3D surveys easily replace the usual two-dimensional image, giving a three-dimensional image of a cut of the Earth's crust. Further on, the fourth dimension — time — gave us an impetus to develop 4D seismic exploration

More density!

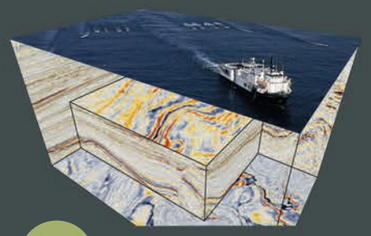
The use of azimuthal seismic surveys with an increased density of data acquisition is becoming more widespread in geological exploration. In comparison to classic seismic survey methods, this method allows seismic observations with a density 25 times higher, as well as more accurate data acquisition. Seismic surveys conducted efficiently will enable the company to avoid additional costs: in subsequent stages of the well construction drilling location will be defined more precisely

Seismic surveying offshore

The shelf, along with HRR, is the resource that will maintain the required level of oil production in Russia, in the medium- and long-term perspective. Current geological surveys of offshore shelfs, primarily in the Arctic, are still relatively low, but in recent years seismic exploration on the shelf has become increasingly active. Russian seismic vessels are being modernized and equipped with the most up-to-date technology along with the acquisition of newer vessels. The Russian seismic fleet can expect a dramatic upgrade after the full-scale launch of The Zvezda Shipbuilding Complex

Caring for nature

Care for the environment is becoming a production requirement. A good example is the "green seismic" technology, which reduces the swath width for installing sensors by using lighter equipment and preserves significant areas of forestry from being cut down. The use of wireless systems optimizes the production cycle by accelerating the installation of seismic receivers in a complicated landscape. This approach allows us to reduce the environmental footprint and perform record-breaking seismic surveys



Under water, but not on shelf

Over 12% of Russia's territory is covered by water. Hydrocarbon deposits are often located under the surface of rivers, lakes and reservoirs, making their study very difficult. Water to land bridges impose increased requirements on seismic exploration, particularly on the choice of conditions of wave reception. The fact that seismic exploration is carried out on land, in the water reservoir and in the transition zones simultaneously, raises the complexity of the operation. When working in reservoirs it is necessary to engage special vessels, which virtually equates this seismic survey with that of the marine. Foreign companies involved in Russian projects require such work

Time to drill

In the coming years, we should expect an increase in exploratory drilling in the Arctic. Current Western sanctions against Russian Arctic offshore projects compel to use mainly Russian offshore drilling rigs. However, their fleets are rather limited, so the return of the Bavenite drilling vessel to Russian waters after many years of work in foreign projects is a good sign. Then again, we can expect a significant contribution to the renewal and the expansion of the Russian fleet of drilling rigs through The Zvezda Shipbuilding Complex. Proposed regulatory amendments may also stimulate exploration drilling on the Arctic shelf, increasing the access to subsoil users in the region

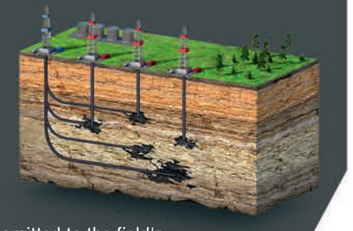
Both remotely and indirectly

Russian oil and gas companies are actively experimenting with non-seismic exploration methods that allow them to obtain indirect information on the presence of hydrocarbon deposits in the subsoil. For example, an on-site geochemical survey helps determine the geographic location of oil-saturated zones by capturing hydrocarbon gas molecules. A sorbent placed in shallow wells practically near the surface is used for this. Prospective oil and gas bearing zones in the Okhotsk Sea have been explored using the helium survey method, which consists primarily of measuring helium concentrations in the bottom layer of water from boreholes drilled in the ice. The use of drones in geological exploration is also becoming more widespread. Drones have been tested in multi-level magnetometer surveys, proving worthy alternatives to aircrafts and helicopters, traditionally used to measure the geomagnetic field over the surface. These methods alone do not provide an accurate summary, however, they do help increase the efficiency of geological surveys and optimize costs during the most critical stages of early development in a new project

Subsoils in figures

The majority of geological exploration methods in one way or another give us an idea of the subsoil structure, but only by physically studying core samples can we get an accurate picture of the subsoil and learn history of the Earth. A comprehensive study of a core sample is virtually the only method that provides reliable information about properties and composition of the subsoil and ensures that remote studies are objectively validated and interpreted. As a result, leading Russian oil and gas corporations are creating storage facilities for core samples and are adopting digital core technologies. By creating a digital model of a core sample, we can expedite and simplify the process of obtaining data, primarily on HRR, as well as model various processes in the subsoil with high levels of accuracy. At this stage, the digital core technology is more of a tool, but it enables us to improve the quality and reliability of determining the properties of collector rocks and reduce uncertainty in the results of laboratory studies, which is already a significant step forward

Dual-purpose wells



Exploratory wells are not limited to explorations alone, they can also be used to select technological solutions for production drilling. After the completion of horizontal drilling and hydraulic fracturing, exploration wells are put into trial operations. This enables us to select techniques and explore the geological cuts (e.g. completion methods), that can be transmitted to the field's operating fund, and approach the commercial development stage with the most efficient development option. Simultaneously, arrangements are being made to organize the business process involving the construction of wells, which may be replicated in new gas-producing regions

DO SEDIMENTARY BASINS IN RUSSIA HAVE SHALE GAS?

THIS PAPER CONSIDERS THE ISSUES OF SHALE HYDROCARBONS FORMATION, OIL AND GAS, IN THE BAZHENOV FORMATION, AND IN OTHER MARINE-GENESIS HIGH-CARBON FORMATIONS OF SEDIMENTARY DEPOSITS IN RUSSIA. THE SUCCESSION OF SHALE OIL AND SHALE GAS GENERATION WAS EMPHASISED. THE REQUIRED GENETIC CONDITIONS FOR THE FORMING OF SHALE GAS FIELDS IN IMPERVIOUS CLAY-SHALE ROCKS WERE SUBSTANTIATED. WE REACHED THE CONCLUSION THAT THE OVERALL PROSPECTIVITY OF THE NORTHERN EURASIA DEPOSITS FOR THE SHALE GAS FORMATION AND EXPLORATION IS POOR

UDC 553.981

Ключевые слова: *shale gas, Bazhenov formation, West Siberia, ontogenesis, deposits, reserves, resources, generation, prospects, recovery.*

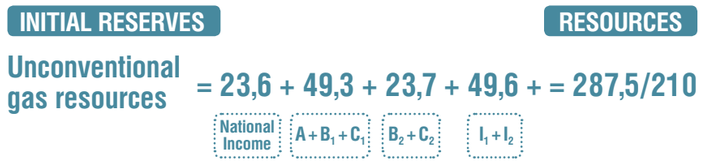
...First clay begets oil,
and in its turn it later begets shale gas

Viktor Skorobogatov
Chief Scientist,
Gazprom Vniigaz LLC,
Doctor of Geological
Mineralogical Sciences

For quite a long time, since 2010, the author of this paper has come across multiple papers, which contain various – and apparently unproven – assessments of shale gas in the Russian subsoil... The concerns of the US, China, Argentina and some other countries are understandable: they have exhausted initial reserves and inferred resources of regular (coventional) free gas in normal gas-containing formations (of the gas, natural gas liquid, sodium hydrocarbonate, unconventional, etc. types), or the subsoil in these countries was initially poor with gas, so they had to explore, survey and develop resources of unconventional "dense gas" – in dense former reservoirs with low permeability (with the permeability below 0.1 mD), of coal gas – in coal-bearing formations and in coal, and of shale, gas-hydrate gas (dense gas, shale gas, combustible gases). But does Russia – the great gas-producing state – have to study and develop to large extent unconventional gas resources now and/or in the near future, before 2030? I guess, it has to. However, this will be with a long-range goal in mind, for the prospect after 2040, and the main concern will be the gas in dense low-permeability reservoirs.

Within Northern Eurasia, which is the land of Russia and the surrounding Arctic, Far East and inland seas, we know 30 sedimentary basins of sub-basins. Twelve of them are either large or the largest ones (mega-basins – West Siberian, Barents-Kara shelf basins), and they include oil- and gas-bearing mega-provinces, provinces and

SCHEME



** official/author's and corporate estimation*

regions with the same names. For the initial and current reserves, initial and forecast resources of the conventional free gas, Russia is the global leader. The structure of initial potential conventional resources of free gas accumulated in the subsoil (by 01.01.2019) is as follows (Scheme).

Without giving specifics to the size of free gas resources, we should emphasise the following: even with sober estimations, the real size of non-discovered gas resources in reservoirs exceeds 100 trillion m³. At present, Russia can produce not 725 billion m³ (national production in 2018), but significantly more – 900/950/100 billion m³, and the growth of gas production can happen quickly and easily if there are proper conditions in the world and regional gas markets (West + Central Europe, Asia-Pacific Region, etc.).

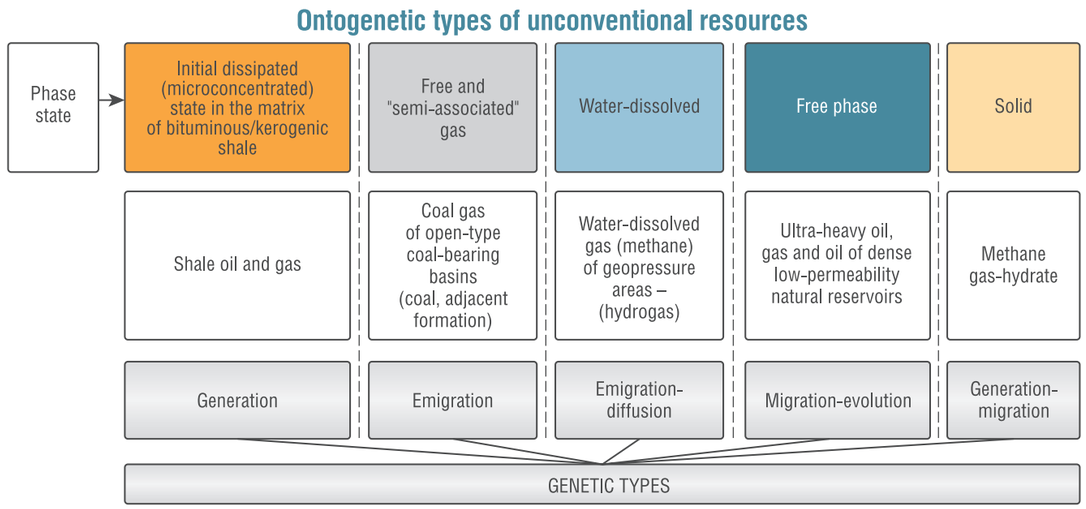
With the internal (national) consumption of 460–500 billion m³ (until 2030 and later on), all "surplus" gas recovered can be imported – to the Western and Eastern geostrategic directions. For example, in 2018 such an "excess" amounted to more than 250 billion m³. When the "second gas front" opens in the Far East (China, North Korea, South Korea, Japan) in 2020–2021, gas export from Russia will quickly exceed 300 billion m³ within a short period of time. This makes the US liquefied natural gas, which is mainly shale gas, stay far behind since within the near decade gas export from the US will hardly reach the amount of 100 billion m³ (in the natural, physical state): the country has high internal demand for gas even with export from Canada. However, let us come back to Russian shale gas.

For several decades the author has been working on the problem of oil and gas ontogenesis in sedimentary deposits. Subjects of his studies are classic bitumen-generating (oil-source) rocks in sedimentary deposits of Russia: the Bazhenov formation (the Volga Stage) in West Siberia, the Domanic formation (the Upper Devonian) in the Volga-Ural province, and to less extent the Kuonam formation in the East of East Siberia (the Cambrian) and the Kumsk formation in the Eastern Pre-Caucasian region (the Cenozoic). Research results are published here [1–9]. Along with the colleagues from Gazprom VNIIGAZ LLC, V.A. Kuzminov, V.A. Istomin, E.V. Perlova, L.S. Salina, V.S.Yakushev, all types of unconventional gas resources have been studied since late 80-s. It is beyond all doubts that the subsoil of a number of Russia sedimentary deposits is rich with shale oil, which estimated reserve only for West Siberia is within the range from 10 to 20 billion tons (however the reserves of regular Bazhenov-origin oil are still below 1 billion tons). In the central regions of the West-Siberian petroleum megaprovince (Khanty-Mansiysk Autonomous Okrug), production during the recent years has been at the level of 700–750 thousand tons/year which still cannot overcome the level of 1 million tons due to a number of reasons. Still it is the recovery of customary oil from a non-customary reservoir fractured in the volume of highly-bituminous rocks of the Bazhenov formation; production of shale oil is not present yet. By the way, according to the author's assessment, the ultimate potential resources of customary oil in the Bazhenov formation and its analogues in West Siberia are 2.5–3.0 billion tons, and this value must be considered along with the shale oil resources. According to the assessment by a number of researchers in the field of exploration and production, by 2040 the production of Bazhenov-origin oil can reach 35–50 million tons, and by 2050 it will be 80–100 million tons, due to the existing and future advanced technologies of "oil-bitumoids/bitumen oil" extraction from the Bazhenov formation. The latter values are over-optimistic, however, they are realistic basing on the large amount of organic oil-like substances dissipated in the Bazhenov formation volume over the area of 250–300 thousand km² (in central regions of the West-Siberian petroleum megaprovince). By the way, the USA produce not ultimately shale oil [2], but more likely combined oil in terms of its genesis and occurrence conditions. The real classic shale oil is known in Russia only – namely, in the Bazhenov formation in central-western regions of the West-Siberian petroleum megaprovince (Salym, Krasnoleninsk, Priob, etc.) [2, 10, 11, etc.]. So, let us be consistent. Let us begin with myths.

Myths about shale gas in Russia

This is the feature of petroleum geology as a science. It has plenty of scientific myths in all areas, such as the oil and gas genesis, and the shale gas issue.

FIGURE 1. Types of unconventional sources for natural gas obtaining/resources (as per phase state and genesis/ontogenesis)



Myth No.1: shale gas is widely spread in the subsoil of Northern Eurasia sedimentary basins [12].

Myth No.2: shale gas resources in Russia are vast.

Myth No.3: commercial shale gas production is possible in the foreseeable future. It is criticised in a number of papers [2, 13, etc.].

Let us consider the genetic conditions favourable for the formation of vast geological resources of shale gas fields in Northern Eurasia.

Ubiquity and overall distribution of various gases are evident, including hydrocarbon gases and oil-like substances of various density, geochemical types, genesis and level of maturity in The Earth's crust [2]. From its surface (wetlands, rivers, lakes, seas, from the solid surface of sedimentation basins) to very low depths (7–9 km and more), organic movable and non-movable compounds (OMC) are distributed in all organo-fluid-mineral systems in dissipated and concentrated forms (reserves of hydrocarbons, coal, combustible shale and more rare carbon shale, apart from red-color rocks where gas and oil quickly disappear within the scale of geological time, as they get oxidised).

"Shale hydrocarbons" is not a fully correct term, though in a number of cases bounding clay-siliceous-carbonate impermeable rocks can be enriched with organic compounds, reach a combustible/bituminous shale condition (with the content of sapropelic organic matter as dispersed organic matter from 12–15% to 22–25%, and even 30% in certain interlayers).

Among other "conventional" gases, shale gas is the leader in what concerns the amount of conducted scientific, experimental, technical and technological studies, and modern industrial importance in a number of countries [12, 14, and many others], notwithstanding the fact that it is a genetic "heir" of

FIGURE 2. hydrocarbon gas and bitumoid generation within the range of "mature" and late organic matter catagenesis (m^3, % of weight per 1 t)

R^0	Organic matter	
	Liptinite-humus dispersed organic matter	Sapropelic dispersed organic matter in terrigenous subsoils
0.85	200/4.7	45/19.2
0.90	204/5.0	60/22.0
1.00	210/6.0	70/24.0
1.05	214/6.5	80/26.0
1.10	217/7.0* (start of bitumoid and oil destruction in reservoirs)	90/28.0
1.15	220/5.0	100/30.0
1.20	228/3.0	250/20.0
1.25	237/2.5	**320/15.0**
1.30	245/2.0	**370/10.0**
1.35	258/1.0	**400/7.0**
1.50	300/1.0	**450/3.0**
2.00	320/0.5	**500/2.0**
2.50	330/–	**550/0.5**
3.00	335/–	**570/–**
3.40	340/–	620/–

Shale oil

Interval of intense fracture of rock and oil bitumoids in reservoirs

Shale gas generation inside shale strata

* adopted on the basis of natural factors, calculations and experimental data

shale oil (oil-bitumoids) in the volume of producing strata with sea and lake genesis. The point is that on the whole shale gas is more frequent in many sedimentary basins and all over the world than shale oil.

Comparison of genetically various types of unconventional gas in highly-transformed terrigenous, including coal-bearing strata (with R^0 over 1.2%) is shown in Figure 1.

Thus, hydrocarbon gases, and primarily methane, is generationally ubiquitous; oil is catagenetically and spatially restricted by the "oil window", both in the concentrated form (deposits in reservoir rocks), and in dissipated form ("oil-bitumoids/bitumen oil" and shale oil in especially favourable geothermal and geochemical, i.e. in generational conditions).

The experience of studying ontogenetic processes in subsoils of various-age sedimentary deposits around the world shows the specific nature of oil and gas shale fields, depending on the generational, emigrational, and evolutionary conditions inside clay-sapropelic formations/generators, with their progressive submerging to moderate and big depths in more and more severe thermal-catagenetic conditions [2, 6, 8, 15, 16].

Issues of oil and gas ontogenesis in various geological, geochronothermabaric and geochemical conditions are considered in detail in other author's papers [3, 4, 6, 9, etc.].

The author's calculations and conclusions on gas and bitumen generation in rocks of various types and age containing the humus organic matter – dispersed organic matter, semi-concentrated (carbonaceous shale), and concentrated (coal with the organic carbon content, Corg, over 50% of weight), sapropelic dispersed organic matter and pyroclastic organic matter, and mixed – humus-sapropelic type – clay shale/shale gas, including various admixtures of liptinite component (natural resines, flower dust, wax, etc.) are given in [2, 3, 6, etc.]. Figure 2 shows the author's calculations of hydrocarbon gas and bitumoid generation within the range of mature and late catagenesis over the oleum scale (with R^0 from 0.85 to 3.40%). Figure 2 also shows catagenetic ranges of shale oil and shale gas formation in clay strata of sea and lake genesis with significantly sapropelic organic matter.

It is significant, that at the phase of common bituminous coals (gradation MC^3_3/ MC_4), organic matters of all types promptly switch to generation (R^0 1.20–1.25%). At that in regular reservoir, the oil phase (in the from of accumulations-reservoirs) disappears within the range 1.30–1.35% [6, 15, 16], however, it remains within the volume of Bazhenov formation (up to 1.4%). At the phase of lean coal (R^0 = 2.00%) sapropelic organic matter significantly overruns humus organic matter in terms of hydrocarbon gas generation (500 and 320 m^3 respectively per one ton of "residual organic matter" at this phase). This is what was at the base of the statement on the main gas formation phase (S.G. Neruchev, E.A. Rogozina, et al.), which is, however, referred to sapropelic organic matter only (gas accumulation in reservoirs which is secondary in terms of genesis).

The conditions which support the realisation of all links in the ontogenetic chain of processes and phenomena must be present for the oil and gas hydrocarbon shale formation in traditional reservoirs:

– generation (G) – emigration (Em) (preliminary migration from generator to the reservoir rocks) – secondary migration (via permeable rocks) of real phase-specific oil and gas – accumulation + conservation – evolution of hydrocarbon shale in traps – fall (partial/full) of deposits... Thus, shale oil and shale gas are the forms (components) of OMC, generated within mother rocks – generators, which did not migrate [2]. Poor migration conditions or their absence make the majority of OMC stay within mother strata (clays, coals, claystones, polymineral complexes of strata like those in the Bazhenov formation in West Siberia).

Efficiency and the scale of spatially and temporarily conjugated generation and emigration processes determine the weights and the volumes of OMC which stay in a non-associated condition within strata-generators and compose the so-called "shale oil", or to be more exact – "oil-bitumoids/bitumen oil" and shale gas, sequentially replacing each other within the range of mesocatagenesis MC_2–MC_3 (with R^0 0.65–1.25%). At that, in the frames of hydrocarbon ontogenesis, "shale oil" is essentially a transitional substance – oil-bitumoid (bitumen oil). The more the initial content of sapropelic organic matter was, the more "noble" its content was, the more isolated the internal areas from the reservoir horizons were (preliminary sand rock reservoirs, etc.), the longer shale oil stays within the clay-shale rocks (for the absolute weight and fraction of the generation mass). The same is referred to shale gas.

From oil-source clays (argillites) 100 m thick,for example, migration of a significant amount of the most mobile components of bitumoids will take place from 10–15 m zones adjacent to the covering and underlying reservoir horizons (fractureless variant), while the central areas of strata 70–80 m thick will be weakly involved in the

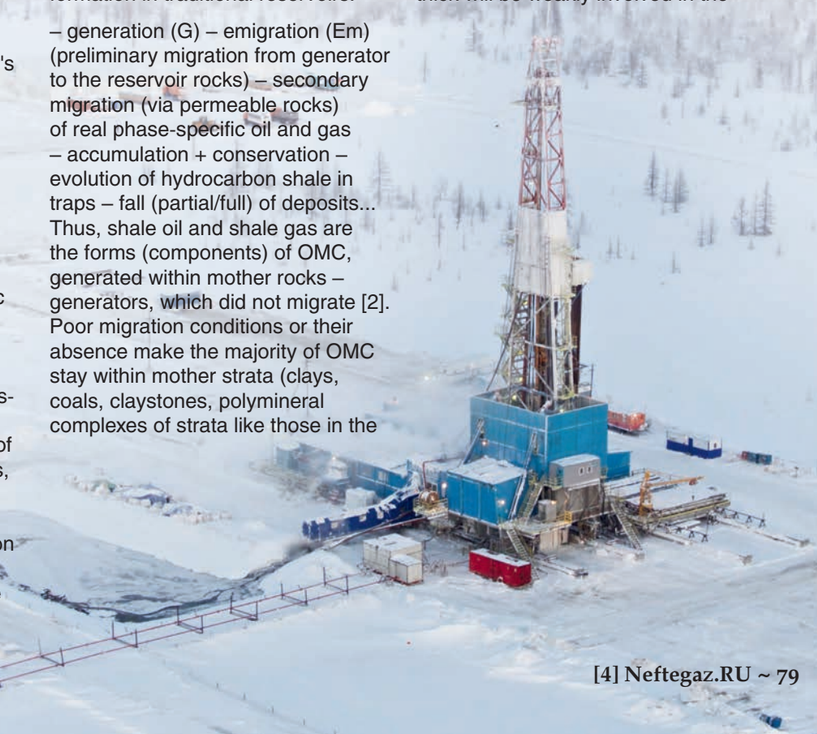
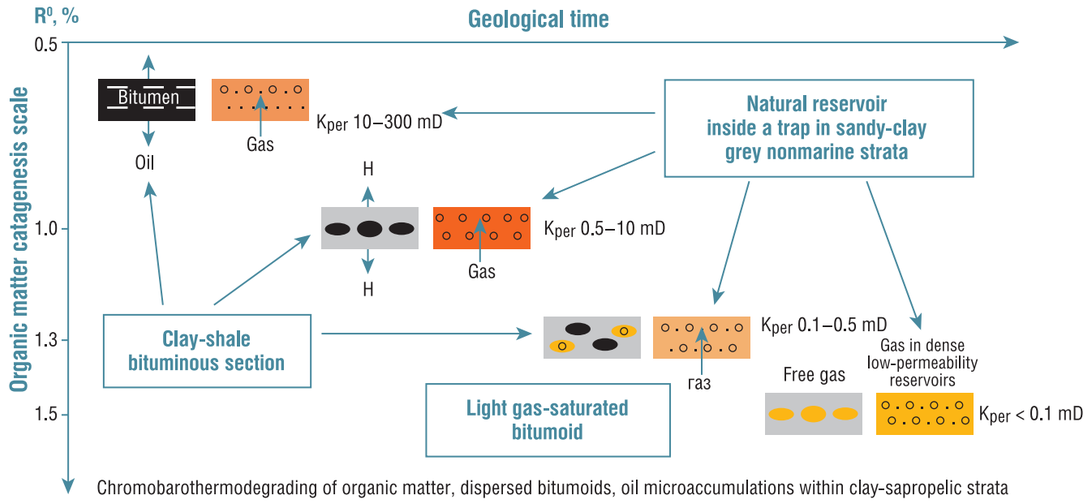


FIGURE 3. Evolution of shale gas accumulations compared with the evolution of gas deposits in dense reservoirs with low permeability in severe thermal-depth and catagenetic conditions



emigration. In a gas-source bed (dispersed organic matter) of similar thickness, the hydrocarbon gas and part of bitumoids withdrawal in gas-dissolved state (within the range of "oil window" for humus organic matter) will be realised rather actively and relatively completely even for central areas at the distance from the nearest reservoir top of 30–40 m. However, in the oil-source bed in the middle and the end of mezacatagenesis (MC_3–MC_4), along with gradual change of the oil-like substance emigration (free phase-specific into gas-dissolved one), its relative scales and distances increase, that is "yield capacity" of source strata.

Thus, within the range of the "oil window" (R^0 from 0.45–0.55 to 1.2–1.35%) with the significant generation of bitumoids in clay rocks with average and high content of dispersed organic matters of significantly sapropelic type (from 2–3% to 10% and more) to relatively thick beds, not all bitumoids pass the "preliminary migration cleaning phase" and turn into the migration-capable oil at the bed boundaries – reservoir/cover=generator interface. The remaining/nonmigrating oil (its part in the form of parautochtonous bitomioids) forms so-called "shale oil" which later transforms into shale gas. Thus, shale gas is a secondary-sapropelic gas that is spatially dispersed within generating impermeable strata of argillite-like dense clays and clay-siliceous-carbonate rocks.

As the global experience suggests, the formation of shale gas fields requires more strict ontogenetic conditions than the shale oil formation. Namely, the level of catagenesis of sapropelic/humus-sapropelic organic matter must correspond to the start of gradation MC4 (at least R^0 1.20–1.25%), the total thickness of a clay bed is 40–50 m or more at various current content of C_{org}, but at least 3% even in apocatagenesis (R^0 > 2.0%, and in the middle and the end of mesocatagenesis – at least 5%), minimum disjunctive disruption of generator strata.

In the end, the formation of efficient shale-oil fields requires the following:

- rather thick clay-bituminous "shales" (at least 20 m);
- intense bitumen generation within the organic matter catagenesis range from 0.6 to 1.1% R^0;
- minimum, or no emigration, including via fractures.

The maximum favorable conditions for the formation of shale gas fields are as follows:

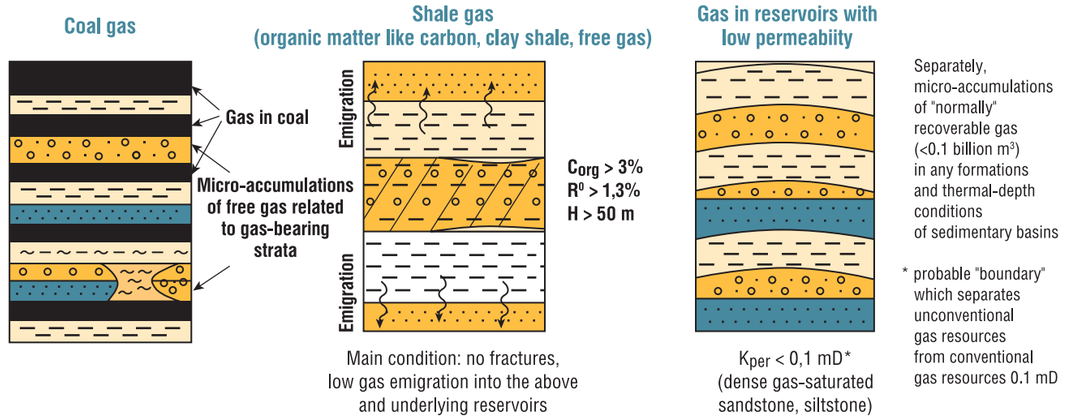
- intense secondary thermal-destructive gas generation (R^0 1.2%);
- sufficiently thick strata-generators, as well as isolating clays on the reservoir boundary (the thicker, the better, but at least 20–30 m);
- with any thickness of generating strata – low disjunctive disruption of the "generation system" (low development of strata-degasing fractures – and low areal "density" of medium- and especially high-amplitude ones).

The higher the level of disruption of generation-emigration system of sapropelic-shale strata at all phases of their development under soil, the less the amount of oil-bitumoids and shale gas that remain in them with all other conditions being equal.

The main difference between conventional and unconventional gas and oil resources is the hydrocarbon concentration level which depends on the realisation of emigration and migration potentials. Regular (= normal) gas and oil accumulations pass through long-term phases of migrations, accumulation + conservation, and finally – evolution of their accumulations inside traps [6, 9]. Dissipated forms of hydrocarbons "avoided" preliminary migration and "evolutionised" within source strata-generators.

Two forms of unconventional gas – shale gas and "dense" gas are a kind of genetic antipodes: the first one comes from bitumoids inside highly-

FIGURE 4. Forms/types of unconventional gas in terrigenic sandy-clay strata, including coal-bearing, shale strata, etc.



transformed clay strata ("shale") with significantly sapropelic dispersed organic matter/pyroclastic organic matter; the second one is a result of descending (with submersion) evolution of gas (gas condensate) accumulations in reservoirs which loose permeability as they become denser.

Genetically and often spatially they "have contact" at the end of mesocatagenesis (with R^0 1.3–2.0%) in terrigenous strata when classical reservoirs loose their permeability; and vice versa, in clay-sapropelic strata, pore-crack systems of the evolution-generation type start to form (the Bazhenov formation in West Siberia, etc.).

Evolutionary development of various types of gas accumulations in terrigenous strata is shown in Figure 3.

Comparison of various types of unconventional gas in highly-transformed terrigenous, including coal-bearing strata (with R^0 over 1.2%) is shown in Figure 4.

According to VNIGRI experts (O.M. Prishepa et al., 2013), optimum stratum parameters for shale gas fields formation are as follows:

- content of Corg more than 1%;
- sapropelic-type organic matter (II);
- "gas window", R^0 over 1.4%;
- silicon content in the rock must be over 30% with a little carbonate;
- porosity is 4–7%, permeability is less than 0.1 mD;
- thickness of clay-siliceous strata is over 45 m (for the Bazhenov formation this is a very rare phenomenon...);
- areas and sections are far from fractures and complications.

By the way, the geological-otnogenetic "necessities" for oil-bitumoid areas in the Bazhenov formation, West Siberia, with yielding reservoirs were determined by the author along with V.I. Ermolayev and S.G. Krasnov far back in 1978–1986 [3, 5, 8, etc.].

As for the formation of shale gas fields, the author's point of view in this paper is close to the specified one, apart from the values of Corg content and the level of catagenesis R^0 = 1.4% (must be more than 3–4% and not less than 1.25% respectively), while 1% is a too low content of dispersed organic matter, and the Bazhenov formation thickness is not surely 45 m. 25–30 m are sufficient.

Across the West-Siberian petroleum megaprovince, the catagenesis conditions in the Jurassic cover are severe (MC_4–MC_5), as it has been established in papers [3, 7]. They are developed on around 10% of the area: at the west of Salym and the east of Krasnoleninsk oil and gas region, in certain highly-heated areas in lows and deflections of the northern part of Nadym-Pur-Taz region, in the Kharasavey area on the land and in the Southern-Kara regions within the Priyamal shelf. However, even in the Salym oil and gas region, no inflow of free gas was obtained from wells of the Bazhenov formation intervals (medium or light gravity oil+dissolved gas). This means that even in the regions where catagenesis is very high (MC_3^1–MC_4), the Bazhenov formation is insufficiently mature to transform bitumoids and free gas into shale gas.

Sources (areas) of shale gas in the Bazhenov formation are possible in highly-heated areas only (125–140 °C or higher), where bitumoids and micro-oil start transforming into a mixture of hydrocarbone gases. Their presence is probable at the west of the Salym and at the east of the Krasnoleninsk area, where thermal anomalies have been registered. The scope of published estimations of resources in West Siberia is prominent. It should be mentioned, that shale gas resources are unlikely to be significant here. The explanation is very simple: the major formation for shale – the Bazhenov formation – was catagenetically transformed up to gradation MC_1, MC_2-start of MC_3 at a large part of the megaprovince, which means that it has not yet "switched" to large-scale secondary generation of gas. Out of the three areas with thermal anomalies – Salym, East-Krasnoleninsk and Kharasvey-Kruzenshtern (the size of shallow invasion is over 1.20% R^0) – only at the west of the Salym region the conditions for shale gas accumulation within the formation exist: in some sections, average temperature varies from 125 to

TABLE 1. Expert probability assessment of formation and areal extent of shale hydrocarbons in various-age strata of West Siberia regions

Lithostratigraphic formations	Oil and gas bearing region							
	Middle Ob (south-west, north-west)		Frolov (west/east)		Nadym-Pur-Taz region		Yamal and South-Kazakhstan Region	
	Shale oil	Free gas	Shale oil	Free gas	Shale oil	Free gas	Shale oil	Free gas
Senonian* (clay-siliceous formation)	–	–	–	–	–	++*	–	–
Apt-alb-Cenomanian	–	–	–	–	–	–	–	–
Neocomian (lower)	+	–	+/++	–	–	–	–	–
Upper Jurassic (the Bazhenov formation)	+++	+	++	+	+ (south)	–	–	+
Mid-Jurassic	–	–	+	+	++ (west)	–	–	+
Lower Jurassic (the Togura formation)	+	+	+	++/+	+	+ (west)	–	+

+++ high, ++ medium, + low, – utterly no

* secondary migration gas (from the Cenomanian age)

140 °C (R^0 is up to 1.3–1.4 %); however, inflows of condensate-like highly-saturated oil were obtained here, full degradation (disintegration) of which is hindered by abnormally high formation pressure (in the fluidal fractured-porous system). The major part of gas may have emigrated to upper and lower half-spaces (with the 10–15 m cover thickness under and above the Bazhenov formation) even without low-amplitude fractures.

It is untimely to speak about shale oil resources in the rocks of the Upper Jurrassic – Lower Neocomian age in the South-Kara region (shelf); moreover, it is incorrect from the genetic point of view due to low percentage of dissipated organic matter (less than 3 %) and its mixed content. In the north-west of the West-Siberian petroleum megaprovince, there is a remote chance of developing shale gas fields within the Bazhenov formation interval with small-thickness (8–12 m) grey clays.

However, during testing of the Bazhenov formation interval, a gas inflow with condensate was obtained from one of the wells at the Kharasavey site. There were no comments on that, as the mid-Jurassic horizons Ju_2 and Ju_3 contain GC – the deposits with abnormal (exceeding) stratum pressure up to 2.00–2.03, and there was a possibility of a gas breakthrough up the column. Along with that, the interval, where the Bazhenov formation correlate is located, is separated from the horizon Ju_2 by a thick layer of the Abalak formation grey clays (60 m), while the geothermic conditions "allow" to generate shale gas in the interlayers, rich with dissipated organic matter (2–3 % or more). Such interlayers can be found in the mid-Jurassic strata in the Bazhenov formation interval.

In the future, it may become relevant to study and search for shale gas inside rather thick clay strata of the mid- and low-Jurassic age (up to 40–70 m and more each) in the north of the megaprovince, where organic matter is highly transformed, in the South-Kara region in particular (up to catagenesis gradation MC_4–MC_5 and higher) [4].

Table 1 shows the results of probability assessment of shale hydrocarbons formation in sedimentary rocks of the West-Siberian petroleum megaprovince.

Thus, the major role of the Bazhenov formation for the assessment and industrial development of customary oil accumulations in a non-customary reservoir (conventional oil reserves and resources), as well as of shale oil in West Siberia, remains steady, which cannot be said about shale gas [2].

The estimations of recovered shale gas resources are extremely contradictory for Russian basins.

Beyond the West-Siberian petroleum megaprovince in other sedimentary basins of Northern Eurasia, the conditions for the formation of shale gas fields are still not so favorable (as of the current moment); due to this fact the assessment reliability for shale gas resources for Russia is low – significantly lower than those for shale oil [1, 2].

In Russia, the second important bitumen-generating (oil-source) formation of marine-genesis is the Domanic deposit of the Volga-Ural province of the Late Devonian-Early Carboniferous age (D_3fr-C_1t), which consists of alternating carbon and clay-siliceous rocks with rare interlayers of terrigenous sandy-clay formations.

The formations in the south of the province have variable thickness (10–90 m), locate at the depths of 2–3 km and include sapropelic (rarely mixed) dispersed organic matter in the amount from 2–5 to 20 % per rock. Many researchers of the Domanic age consider the Eagle Ford formation (USA) as an analogue, where large-scale industrial shale oil production takes place.

Along with that, the prospects of forming shale gas fields within the Volga-Ural province are estimated as minimum, and in the Caspian Depression – as undetermined. The same is true for the analogues of the Kuonam formation in the Lena-Vilyuy depression and for the north Caucasus Region.

The papers by the author et al. [1, 2, 6] show that the classic shale gas has a secondary origin. It is formed in high-carbon clay (clay-carbonate) bitumen-generating, initially oil-source formations of the Bazhenov formation in West Siberia at high stages of catagenesis (MC_4–AC_1) which correspond to coaxing, forge, non-baking coals up to semi-anthracites (with R^0 from 1.35–1.40 to 2.6–2.8 % – over the vitrinite reflection parameter – catagenesis indicator), when source rocks switch to gas generation due to continuing thermal destruction of sapropelic organic matter and earlier generated dissipated bitumoids (bitumen oil = shell oil), i.e. there is genetic connection between shale oil and shale gas. All classical oil-source formations in Northern Eurasia: Bazhenov, Domanic, Kumsk, Kuonam formations are at small and medium depths (1.0–3.5 km), they have not left the "oil window" range – they are immature in terms of gas generation. However, there was shale oil formation and they have reliable resources of bitumen oil in dissipated and micro-concentrated state (at the areas of fractures development). They contain fat gas dissolved in shale oil, but its amount is very small - the first m^3 in 1 m^3 of rock with shale oil content up to 50–70 l/m^3 (significant gas amount has already emigrated)

Shale gas fields can be connected with deep sediments of Middle and Lower Jurassic age (4–5 km and more) in the West Pre-Caucasian region. However severe thermal and depth conditions of their deposit make it difficult to study the possibilities of shale gas generation at the North Caucasus, including discovery and development of the probable shale gas location areas from the economical point of view.

Shale gas resources estimations in Russia vary from 8 to 20 trillion m^3. Note the following. Assessments of geological and recoverable resources of shale hydrocarbons carried out within the recent decade (2009–2018) on Russian sedimentary deposits, including assessments made by non-specialists unfamiliar with the sites of West Siberia, Volga-Ural province and Pre-Caucasian region [17–20], are non-reliable: this is simply a "homage to fashion" and an ambition to "establish a foothold" to make other researchers refer to such assessments. Many authors of "popular scientific" papers and monographs, without proper knowledge of how to estimate potential or even conventional oil and gas resources, easily assess the quantity of unconventional gas and oil resources including such complicated types as shale oil and especially shale gas in Russian subsoil. What is the value of such assessments? The same applies to the deductions on unconventional hydrocarbon resources of sedimentary basins in Northern Eurasia made by some foreign incompetent authors, who are unfamiliar with the structure, and have not calculated anything, but weighed up expertly.

TABLE 3. The parameters of the Marcelius shales (USA)

Depth, km	Thickness, m	C_{org}, %	R^0, %	Gas content, m^3/t
1.2–2.6	46 / 15–107	4.0 / 2.0–13.0	1.5	2–4

TABLE 2. Countries with the largest technically recoverable gas resources from shale formations (as of January 01, 2014)

No.	Countries	Amount of recovered gas, trillion m^3
1	China	31.6
2	Argentina	22.7
3	Algeria	20
4	USA*(**)	18.8 (32.9)
5	Canada	16.2
6	Mexico	15.4
7	Australia	12.4
8	Republic of South Africa	11
9	Russia	8.1
10	Brazil	6.9
Total for 10 countries 163.1 * – 177.2 **		
Total in the world 206.7* (220.7)**		

* EIA; ** ARI; *** the value is not proved by certain calculations

The shale gas status in the world is as follows. Table 2 shows the estimations of shale gas resources in ten countries with the richest gas reserves and in the world in general. Average gas-recovery ratio is 0.25, though in reality it can be significantly lower – down to 0.10–0.15. Thus, the global recovered free gas resources in 2014 were 207–221 trillion m^3. This value is significantly lower than the estimations of the ultimate potential resources of customary (conventional) natural gas for the recent years, 703–720 trillion m^3 [14].

Averaged data on the TOP10 gas-bearing shales in the USA and Canada are as follows:

- Modern average depth is 1.2–2.7 km, rarely – down to 4.0–4.1 km.
- Thickness: from 60–70 to 300 m with efficient gas saturation from 50 to 90 %.
- Dispersed organic matter content, % is 2.0–5.3 (up to10–12).
- Organic matter catagenesis level R^0 from 1.3–1.6 to 2.0–4.0 % and higher (coals of the grades K, OS, T, PA) – "gas window" for all types of organic matter).
- Gas content 1.7–10.0 m^3/7 (including Free gas 50–55%).

The parameters of the Marcelius shales (USA) are given as an example (Table 3).

This gas is in fact the residual one which did not emigrate. With the thickness more than 100 m the content of free gas would exceed 6–7 m³/t.

Apparently, conditions for the formation of shale gas fields in the majority of North America sedimentary deposits are quite favorable, in contrast, to those in Russia. As for the conventional gas, the picture is counter-narrative.

Due to genetically caused ubiquity of natural gas the conditions for the formation of shale gas fields are fulfilled for many sedimentary basins on all continents.

The countries – leaders in unconventional gas resources are as follows:

- Gas in dense reservoirs – Russia, USA, China, Canada;
- Coal gas – China, USA, Russia, Australia;
- Shale gas – China, Argentina, Algeria, USA;
- Combustible gas – Russia, Japan, Canada.

Four countries are the world leaders in terms of estimations of all types of unconventional resources: Russia, USA, China, Argentina.

Sedimentary basins which are most rich with shale gas: Preappalachian oil and gas basin, Williston (USA), Neuquén (Argentina), Sìchuān (PRC); shale oil: West Siberian, Williston, Neuquén.

Absolute monopolist and record-holder in industrial shale gas production is the USA: in 2014 they extracted 377.8 billion m³ of such gas, in 2018 it was 500 (!) billion m³. The same is true for shale oil (195.5/230 mln.t). With the total gas recovery volume in 2019 over 800 billion m³ up to 70% were for shale gas. All this takes place not out of bare necessities of life: the reserves and the resources of normal gas are almost exhausted.

Three main conditions for forming measurable accumulations of shale gas: development of marine clays with high content of highly transformed sapropelic organic matter with big thickness (at least 40–50 m) not damaged with fractures (no fractures with the amplitude more than 10–15 m). These conditions are not met in any of Russian sedimentary deposits, at least, down to the depths of 4.5–5.0 km where shale gas utilisation is unreal in the foreseeable future, as well as in the regular natural gas accumulations, at least, in terrigenous reservoirs (possibly, out of carbonates...).

Thus, Russia does not have the "big" free gas in its subsoil due to genetic reasons. Often the recovered dissipated resources are estimated by experts as 3–4 trillion m³, but it is obscure which formations they are exactly referred to, in contrast to the real shale oil resources, which can be calculated (they are calculated in papers [1, 2]), and the production is already on (though not so intense – less than 1 million t/year) in the central-east regions of West-Siberian petroleum megaprovince (Salym, Krasnoleninsk, etc.). Thus, the provided estimation of shale gas unconventional resources of 9–10 trillion m³ in a number of publications is inconsistent.

General conclusion from the provided research is the answer to the question raised in this paper: in the volume of Russian sedimentary deposits, there are no generation-conservation conditions required for the formation of vast and lengthy shale gas fields (though, there are such local conditions...), but the volume-mass "geological" shale gas resources are insignificant, the recovered ones remain non-assessed, at least they will hardly exceed 4–5 trillion m³ and at least 4 times less than the real reserves of shale oil (with the nominal ratio of 1000 m³ = 1 t).

It should be noted that the Company considers it impractical to extract shale gas over the long term, according to the results of the PJSC Gazprom Board Meeting, November 18, 2019 (RIA Novosti November 19, 2019). Similar conclusions can be found in papers [1, 13 etc.].

This is rare consensus of science and business, especially on difficult issues, in particular on shale gas in Russia. ●

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SAUDI ARABIA EXPECTED TO UNLEASH MASSIVE WORLDWIDE CRUDE OIL WAVE

The Telegraph

Ed Clowes

Saudi Aramco to maximise production to full capacity.

Global markets filled to the brim with crude oil as relations between Russia and Saudi Arabia spiral amidst failure to agree on production cuts. Putin and Trump devise action plan to lower crude oil price threshold. Oil market collapses after demand drops as commercial airlines cease flights. Experts predict negative oil prices as storage capacities run low; companies

may need to pay consumers to dispose of surplus. Republican senators blame Russia and Saudi Arabia for initiating an economic war against the U.S. American shale oil producers under threat of bankruptcy as prices drop.

GAZPROM PLANS EXPANSION TO EU VIA DAMPING

Handelsblatt

Andre Ballin

Last winter turned out warmer than expected. European storage facilities were up to 55.5% full; largest index in history. Gazprom continue sales amidst constant price fall over past months. In March, the company sold 2.46 billion m3 of gas. Two and a half times more than in the same period in 2019. However, profits have dropped significantly. The cost of gas was over $200 a year ago and $113 at the beginning of this year. Competition heats between

American LNG and Russian NOVATEK. Gazprom always stood against the spot market; sold fuel under long-term contracts. Although Gazprom reduced its price at electronic auctions. Consequently, many Gazprom customers switched to ETA. It is possible that Gazprom deliberately intensifies competition through the ETA in order to push its competitors out of the market. But this strategy holds risks for Gazprom itself. Their budget was projected at $200 per 1,000 m³. Meanwhile, expensive projects, such as the Nord Stream-2 project, remain unfinished. Experts from the Oxford Institute of Energy Research make unsettling predictions that the market will hit rock bottom this summer.

RUSSIA DELIBERATELY SPARKED A GLOBAL PETROLEUM CRISIS IN THE MARKET

RZECZPOSPOLITA

Andrei Lomanovsky

The refusal to sign the OPEC+ agreement by the Russian delegation caught everyone off guard. Russia's budget assumes a price of $40 per barrel, if prices were to decline further, the Kremlin would have to limit spending and raise taxes, which would raise public discontent. The authorities would have liked to avoid such a scenario, particularly amid the campaign to amend the constitution, which the Russian people already resent. However, Russia's current management are professionals who live and work in chaos and achieve their goals in times of crisis. Most frequently, these

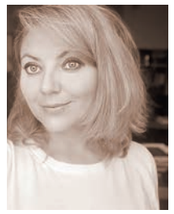
crises, such as the one today; they create on their own. The question is, what's in it for the Kremlin that they are willing to jeopardise the nations finances? Putin submitted to the persuasions of his closest associate, Igor Sechin, who stood opposed to negotiations that restricted productions. The head of Rosneft argued that only American companies producing shale oil benefit from the following measures. He believes that the United States won't be able to withstand a drop in prices below $40, while the Russians can even survive a $30 price range. Russia is displaying increasing measures to get a larger share in the market. ●

OIL AND GAS SECTOR IN RUSSIA AND THE WORLD

Current state and development perspectives

Safa Akhmetov
Doctor of Engineering, Professor

Ildar Mustafin
Candidate of Engineering Sciences, Associate Professor



Klara Stankevich
Candidate of Engineering Sciences, Associate Professor

Aidar Khanov
Doctoral student

Alexander Gantsev
Candidate of Engineering Sciences, Associate Professor

FSBEI of Higher Education "Ufa State Petroleum Technological University"

THE FOLLOWING ARTICLE ANALYZES THE POTENTIALS OF COUNTRIES INVOLVED IN THE OIL AND GAS SECTOR. ESTIMATES HAVE BEEN MADE OF OIL AND GAS RESERVES AND PRODUCTION LEVELS IN DIFFERENT COUNTRIES. CHANGES IN THE GLOBAL ENERGY BALANCE HAVE BEEN CONSIDERED, AS WELL AS, THE ROLE OF HYDROCARBONS IN THE WORLDS ENERGY SECTOR IN THE FUTURE. THE PROSPECTS OF RUSSIA HAVE BEEN ASSESSED IN THE OIL AND GAS SECTOR

UDC 553.04

KEYWORDS: *oil, gas, coal, production, reserves, minerals.*

Natural sources play a major role as energy providers. Natural energy sources include oil, natural gas, hard coal and lignite, oil shale and natural bitumen, as well as raw materials for nuclear power – uranium. All these are non-renewable sources of energy. Renewable sources of energy include sunlight, wind power, falling water, sea tides, and bio-resources.

Industries engaged in the production, logistics, and processing of various forms of fossil fuels, as well as, the processing, conversion, and distribution of various types of energy (thermal, electrical, etc.) are referred to as the energy sector. The energy sector includes fuel (oil, gas and coal), oil refining, petrochemical and energy (thermal, hydraulic and nuclear) industries.

The energy sector is the backbone of today's global economy. The level of development of the energy sector reflects on the countries' social and technological progress. It is hard to imagine our lives without fuel, energy, light, heat, communications, radio, television, transport, household appliances, etc. Without energy, the development of cybernetics, automation, computing and space technology would not be possible. Therefore, the consumption of energy and, energy resources respectively, grew consistently and particularly rapidly in the 20th century [1].

Nearly 90% of the world's natural resources of organic fossil fuels are solid – coal and lignite, anthracite, oil shale, bitumen, peat, and others. Their influence and significance – compared with liquid and gaseous fuels – prevailed up to the middle of the century and they still remain significant for the world economy. The majority of solid fossil fuels continues to be used as energy sources. The most widely used product of chemical processing of coal is coke, which remains the basis of ferrous and non-ferrous metallurgy. Whereas, a wide range of coke products are extracted from the liquid component – tar. These valuable products are dyes, varnishes, fertilizers, explosives, medicine, coal tar pitch and pitch binder, carbon electrode and graphite products, etc. [1].

Among energy sources, oil and gas play the primary role. Oil and gas are two unique and exclusive mineral resources. The petrochemical and gas products are used practically in all industrial sectors, in every type of transportation, in military and civil construction, agriculture, energy, household, and so on. A variety of chemical materials such as plastics, synthetic fibers, rubber, varnishes, dyes, detergents, mineral fertilizers and more are produced in large quantities from oil and gas. Oil and gas determine not only the economy and technological potential, but often a state policy as well [2].

However, it should be emphasized that the use of minerals for the purposes of energy has a negative impact on the environment:

- mechanical contamination of the air, water and land with solid particles (dust, ash);
- chemical, radioactive, ionic, thermal, electromagnetic, noise and other kinds of pollution;
- large water, earth, and oxygen consumption;
- global greenhouse effect, a gradual increase in the average temperature of the Earth's biosphere and the risk of an environmental disaster on the planet.

Figures 1 and 2 show the changes in the global energy balance over the time frame 1970–2040 [3].

Studying the diagrams and the forecast by Shell up to 2050 [4], we can see that coal consumption in the global energy balance will gradually decrease, whereas the demand for natural gas will increase. Consumption of renewable sources of energy will increase as well. Oil consumption will be declining slightly, and by 2040 may fall to 27%, while its share in the global energy balance will remain the largest.
It is important to highlight the increased demand for energy: in 1970 total energy consumption amounted to 4,876 mln. toe (tonne of oil equivalent),

FIGURE 1. Change in global consumption of primary energy by fuels

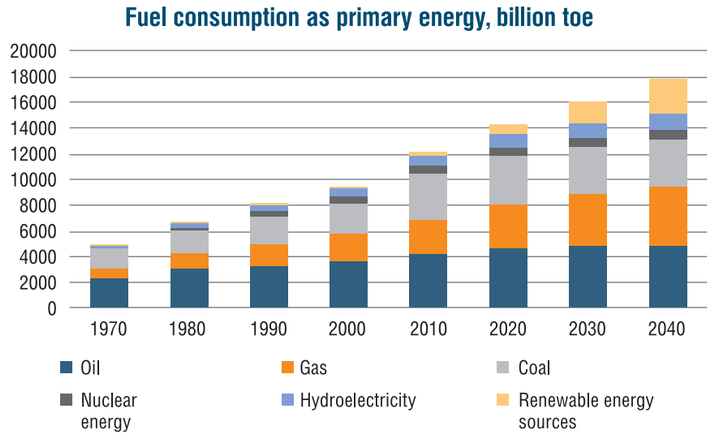
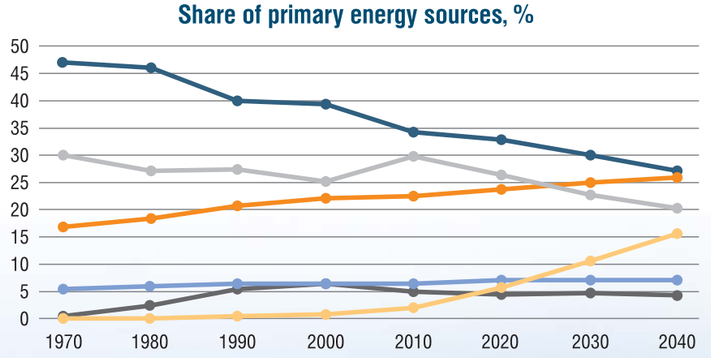


FIGURE 2. Changes in the share of primary energy sources in global consumption



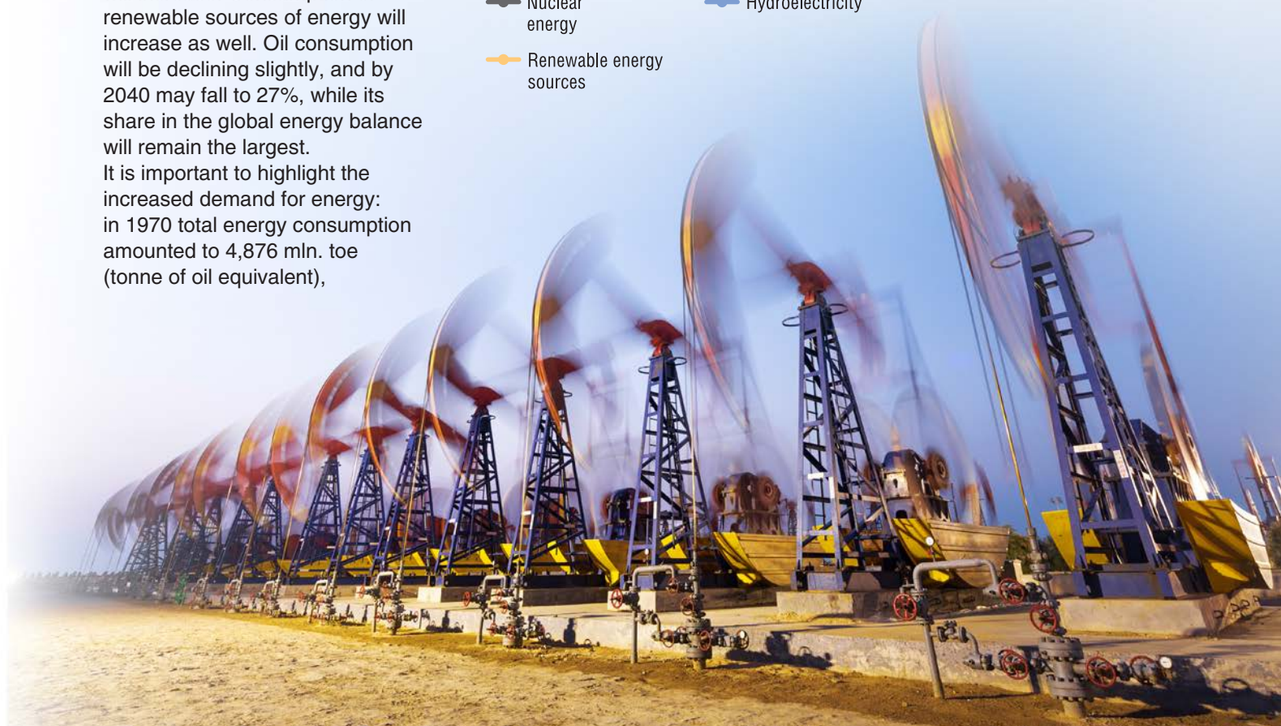


TABLE 1. Confirmed oil reserves in the countries with the largest deposits [5]

Item no.	Country	Reserves, billion barrels	Reserves, billion tons	Global share, %
1	Venezuela	300.3	48.0	17.5
2	Saudi Arabia	297.7	40.9	17.2
3	Canada	167.8	27.1	9.7
4	Iran	155.6	21.4	9.0
5	Iraq	147.2	19.9	8.5
6	Russia	106.2	14.6	6.1
7	Kuwait	101.5	14.0	5.9
8	United Arab Emirates	97.8	13.0	5.7
9	USA	61.2	7.3	3.5
10	Libiya	48.4	6.3	2.8
11	Nigeria	37.5	5.1	2.2
12	Kazakhstan	30.0	3.9	1.7
13	China	25.9	3.5	1.5
14	Qatar	25.2	2.6	1.5
15	Brazil	13.4	2.0	0.8
16	Algeria	12.2	1.5	0.7
17	Angola	8.4	1.1	0.5
18	Mexico	7.7	1.1	0.4
19	Azerbaijan	7.0	1.0	0.4
20	Ecuador	2.8	0.4	0.2
World reserves		**1,729.7**	**244.1**	**100**

TABLE 2. Level of oil production by the main oil producing countries in the world as of 2018 [5]

Item no.	Country	Production, million tons per year	Global share, %
1	USA	669.4	15.0
2	Saudi Arabia	578.3	12.9
3	Russia	563.3	12.6
4	Canada	255.5	5.7
5	Iraq	226.1	5.1
6	Iran	220.4	4.9
7	China	189.1	4.2
8	United Arab Emirates	177.7	4.0
9	Kuwait	146.8	3.3
10	Brazil	140.3	3.1
11	Mexico	102.3	2.3
12	Nigeria	98.4	2.2
13	Kazakhstan	91.2	2.0
14	Norway	83.1	1.9
15	Qatar	78.5	1.8
16	Venezuela	77.3	1.7
17	Angola	74.6	1.7
18	Algeria	65.3	1.5
19	United Kingdom	50.8	1.1
20	Oman	47.8	1.1
World production		**4,474.3**	**100**

TABLE 3. Confirmed gas reserves in the countries with the largest deposits [6]

No.	Country	Reserves, trillion m³	Global share, %
1	Russia	50.508	24.9
2	Iran	33.899	16.7
3	Qatar	23.846	11.7
4	USA	13.554	6.7
5	Turkmenistan	9.805	4.8
6	Saudi Arabia	9.069	4.5
7	United Arab Emirates	6.091	3.0
8	Nigeria	5.675	2.8
9	Venezuela	5.674	2.8
10	Algeria	4.504	2.2
11	Iraq	3.729	1.8
12	Australia	3.175	1.6
13	China	2.856	1.4
14	Indonesia	2.841	1.4
15	Malaysia	2.471	1.2
16	Egypt	2.221	1.1
17	Norway	2.210	1.1
18	Canada	2.049	1.0
19	Kazakhstan	1.885	0.9
20	Kuwait	1.784	0.9
World reserves		**203.229**	**100**

TABLE 4. Level of gas production by the world's major gas producing countries in 2018 [6]

No.	Country	Production, billion m³	Global share, %
1	USA	863.415	21.8
2	Russia	690.349	17.5
3	Iran	248.524	6.3
4	Canada	189.488	4.8
5	Qatar	181.594	4.6
6	China	150.168	3.8
7	Australia	130.535	3.3
8	Norway	126.415	3.2
9	Saudi Arabia	118.000	3.0
10	Algeria	95.898	2.4
11	Turkmenistan	80.742	2.0
12	Indonesia	69.862	1.8
13	Malaysia	63.588	1.6
14	Egypt	62.271	1.6
15	Uzbekistan	53.040	1.3
16	United Arab Emirates	47.624	1.2
17	Trinidad and Tobago	45.215	1.1
18	Nigeria	44.251	1.1
19	Netherlands	42.715	1.1
20	United Kingdom	40.658	1.0
World production		**3,951.936**	**100**

while in 2020 it reached 14,304 mln. toe, and this figure will continue to grow. Overall, most of the future energy demand will be met by minerals, just as it has in the past.

Tables 1–6 below show the latest statistics from British Petroleum on world oil and coal reserves, production volumes and the latest OPEC statistics on world reserves and gas production volumes.

The largest oil reserves in the world belong to the OPEC countries, along with Canada and Russia.

The leaders in terms of oil reserves are the Middle East. The Middle East accounts for 48.3% of the world oil reserves. Some African countries, such as Libya, Nigeria, Algeria and Angola, have relatively large oil reserves. On the American continent, apart from Venezuela and Canada, the USA, Brazil, Mexico and Ecuador have significant reserves of oil. In the Asia-Pacific region, China holds the largest oil reserves, while Indonesia, India, Malaysia, Vietnam and Australia hold much smaller reserves (2.4 billion tonnes or 19.1 billion barrels). Countries in Europe possess the smallest reserves, the leader among which is Norway (1.1 billion tons or 8.6 billion barrels). Russia is ranked sixth in terms of recoverable oil reserves.

In the CIS countries, apart from Russia, Kazakhstan has 3.9 billion tons, or 30 billion barrels, and Azerbaijan holds 1 billion tons or 7 billion barrels.

Russia, Saudi Arabia and the USA are the world's major oil producing countries.

As for gas, Russia (50.508 trillion m³), Iran (32.899 trillion m³) and Qatar (23.846 trillion m³) are leading the way.

Saudi Arabia, UAE and Kuwait, apart from Iran and Qatar, have significant gas resources in the Middle East. On the American continent, the USA, Canada, and Venezuela own substantially large gas reserves. Among African countries, Algeria, Egypt, Nigeria and Libya (1.505 trillion m³) have relatively large gas reserves.

In the Asia-Pacific region, China, Indonesia, Australia, Malaysia and India possess gas resources. In the CIS, aside from Russia and Turkmenistan, there are natural gas deposits in Azerbaijan (1.269 trillion m³), Uzbekistan (1.542 trillion m³) and Kazakhstan (1.885 trillion m³).

Currently, the USA (863.415 million m3) and Russia (690.349 million m3) are leading in terms of natural gas production volumes globally with a significant difference from other natural gas producing nations. Large volumes of natural gas are produced in Iran, Canada, China, Australia, Qatar, Norway and Saudi Arabia.

The world's industrially extracted coal reserves are estimated at 1,054.782 billion tonnes, most of

TABLE 5. World coal reserves [5]

Item no.	Countries	Hard coal, million tons	Lignite, million tons	Total, million tons	Global share, %
1	USA	220,167	30,052	250,219	23.7
2	Russia	69,634	90,730	160,364	15.2
3	Australia	70,927	76,508	147,435	14.0
4	China	130,851	7,968	138,819	13.2
5	India	96,468	4,895	101,363	9.6
6	Indonesia	26,122	10,878	37,000	3.5
7	Germany	3	36,100	36,103	3.4
8	Ukraine	32,039	2,336	34,375	3.3
9	Poland	20,542	5,937	26,479	2.5
10	Kazakhstan	25605	–	25605	2.4
11	Turkey	551	10,975	11,526	1.1
12	Republic of South Africa	9,893	–	9,893	0.9
World reserves		**734,903**	**319,879**	**1,054,782**	**100**

TABLE 6. World level of coal production in 2018 [5]

No.	Countries	Production, million toe	Global share, %
1	China	1,828.8	46.7
2	USA	364.5	9.3
3	Indonesia	323.3	8.3
4	India	308.0	7.9
5	Australia	301.1	7.7
6	Russia	220.2	5.6
7	Republic of South Africa	143.2	3.7
8	Colombia	57.9	1.5
9	Kazakhstan	50.6	1.3
10	Poland	47.5	1.2
11	Germany	37.6	1.0
12	Mongolia	34.4	0.9
World production		**3,916.8**	**100**

TABLE 7. Extractable shale oil reserves in the countries with the largest deposits

Item no.	Countries	Reserves, billion barrels	Item no.	Countries	Reserves, billion barrels
1	USA	78.2	7	Chad	16.2
2	Russia	75	8	Australia	15.6
3	China	32	9	Venezuela	13.4
4	Argentina	27	10	Mexico	13.1
5	Libiya	26	11	Kazakhstan	10.6
6	United Arab Emirates	22.6	12	Pakistan	9.1
World reserves, billion barrels			**418.9**		

TABLE 8. Extractable shale gas reserves in the countries with the largest deposits

Item no.	Countries	Reserves, trillion m^3	Item no.	Countries	Reserves, trillion m^3
1	China	31.58	7	Australia	12.16
2	Argentina	22.7	8	South Africa	11.04
3	Algeria	20.0	9	Russia	8.06
4	USA	17.63	10	Brazil	6.93
5	Canada	16.22	11	United Arab Emirates	5.81
6	Mexico	15.44	12	Venezuela	4.74
World reserves			**214.55**		

which are held by the USA, Russia, Australia, China and India. Large amounts of coal resources are also found in Germany, Ukraine, Kazakhstan, Poland and Indonesia.

China leads in coal production (46.7% of world production) by a wide margin. Among other countries that extract coal in large quantities are the USA, Indonesia, India and Australia. Coal is also mined in large quantities in Russia and South Africa.

In recent years, shale oil and gas fields have been actively developing in the USA. According to the U.S. Energy Information Administration, in 2018 the country produced 6.5 million barrels (or 886.6 thousand tons) of shale oil a day. In this article we define the term shale oil and shale gas as light oils and gases of low-permeability rocks. Tables 7 and 8 contain data on technically recoverable reserves of shale oil and shale gas, according to the information provided on the website of the U.S. Energy Information Administration [7].

As we can see in Tables 7 and 8, world shale oil and gas reserves are high. Russia and the USA have the largest shale oil resources. It is reported, that at least 80 billion barrels of shale oil have been discovered in Bahrain [8].

Argentina and Algeria hold large shale gas reserves, second only to China. Technically recoverable shale gas reserves are slightly larger than estimated natural gas reserves. The production method of shale oil and gas is more sophisticated than that of oil and gas: it is a combined technique of horizontal wells and hydraulic fracturing when high-pressure water is injected into wells with the addition of chemicals and sand. It is also important to note that in addition to extractable shale gas and oil reserves, there are many more shale oil and gas reserves that cannot be extracted using existing technology.

Throughout the years, abundant levels of oil production and oil export ensured growth of the country's economy. However, oil production is not capable of contributing to the effective development of an economy. More developed countries prefer oil refining because selling high-quality fuels generates more profit than selling crude oil. At the moment, Russia is behind Western countries on the depth of oil refining. Thus, the refining depth in the USA is about 97% and in Western Europe 95% respectively, while in Russia the actual refining depth is about 79% [9]. The low depth of refining is associated with the lack of advanced deep oil refining processes.

In addition to traditional and shale oils, there are large deposits of heavy oils and bitumen across the globe. The reserves of so-called unconventional oils are estimated to significantly exceed those of conventional oils and amount to about 70% of all hydrocarbon deposits [10]. Therefore, with gradual depletion of light and medium oil deposits, the focus will shift to unconventional oils.

According to some data there is 6.2 billion tons of high-viscosity oils in Russia [11], but it is likely that in fact the reserves are much larger. In addition, there are large deposits of bituminous sands (about 33 billion tons or 245 billion barrels), most of which are not yet accessible for extraction. Large reserves of still technologically unrecoverable natural bitumen are available in the diamond/gold bearing Lena-Anabar Basin Province (about 28.5 billion tons or 212 billion barrels) [12].

Another potentially viable hydrocarbon resource is bituminous shale. Oil from bituminous shale is obtained by means of thermally treating kerogen, the organic part of shale. Deposits of bituminous shale in the country are estimated at 39.4 billion tons or 248 billion barrels, and world deposits accessible for extraction estimated at 430 billion tons [12].

These oils are characterized by increased density, viscosity, coking capacity, increased content of resinous and asphaltene compounds, and hetero compounds, particularly sulphurous compounds. Such a complex occurrence of these oils, as well as their complex composition require new technologies for their production and transportation to be developed. Processing of such raw materials requires modernization of existing oil refineries and equipping them with modern facilities to efficiently treat heavy materials and obtain high quality fuels. Certain countries, such as Canada, have been effectively processing bituminous sands for the last 20 years [13], and the proportion of bituminous sands in Canadian production will amount to 75% by 2030 [14].

Thus, for at least the next several decades, oil and gas will remain the world's main energy source. Russia possesses abundant oil and gas reserves, as well as unconventional oils, such as heavy crude, bitumen and shale oils, which provide the country with a secure energy supply and a strong economy. In order to fully utilize the country's oil and gas potential, it is necessary to improve the oil refining process. Creation of new facilities, as well as modernization of existing refining facilities will make the oil industry resistant to the deteriorating quality of composition and hydrocarbon bearing raw materials. Implementation of modern oil refining processes will allow to produce high-quality motor fuels and lubricating oils, which will benefit the economy considerably more than the production and export of hydrocarbons. ●

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THE **DEEPEST** OIL WELLS IN THE **WORLD**

OP-11 WELL
RUSSIA

12,345 m,
EQUIVALENT TO

A BUILDING WITH A HEIGHT OF 3,514 FLOORS

3,514
3,471
3,421
3,381
3,351
3,321
3,291

COMPANY
Exxon O&G Limited

LOCATION
Russia's Far Eastern shelf, Odoptu, one of the three fields of the "Sakhalin-1" project

The well was drilled in **60 days**

TECHNOLOGY
a drilling rig named "Yastreb" - entirely sealed, adapted for operations in extreme winter conditions.

High-speed drilling technologies and integrated drilling quality control developed by the company were used

BD-04A WELL
QATAR

12,289 m,
EQUIVALENT TO
83
PYRAMIDS OF GIZA

83
80
70
60
50
40
30
20
10

COMPANY
Maersk Oil (Total Group)

LOCATION
Al Shaheen Oil Basin, Qatar

The well was drilled in **36 days**

TECHNOLOGY
Transocean GSF Rig 127

"THE KOLSKAYA SUPERDEEP" (SG-3)
USSR

12,262 m,
EQUIVALENT TO
15
BURJ-KHALIFA SKYSCRAPERS OF DUBAI

15
10
5

The Kolskaya Superdeep Geological Exploration Expedition (in 1992 it was transformed into the "Kolskaya Superdeep research centre")

LOCATION:
Murmansk region, north-eastern part of the Baltic Shield

The well was drilled intermittently, from **1970** to **1991**

TECHNOLOGY:
"Uralmash-4E" and "Uralmash-15000" drilling rigs

THE BERTHA ROGERS WELL
USA

9,583 m, EQUIVALENT TO
THE AVERAGE FLIGHT HEIGHT
OF AN AIRCRAFT

COMPANY:
GHK

LOCATION:
Washita County, Oklahoma, USA

It took **502 days** to drill the well

Operations had to be stopped when the sinkers came across molten sulphur deposits

WELL HAUPTBOHRUNG
GERMANY

9,101 m,
EQUIVALENT TO
THE DISTANCE FROM MOSCOW
TO THE CITY OF BYALA, BULGARIA

The German continental deep drilling program

LOCATION:
mountains of Bavaria

The Hauptbohrung was drilled from 1990 to 1994, it had to be suspended due to technological difficulties. The territory is now home to a research laboratory and a museum

TECHNOLOGY:
to carry out the works, a tower (83 meters high) and a drilling rig with a capacity of 800 tons were built

THE BADEN UNIT WELL
USA

9,159 m, **311 m** DEEPER THAN THE EVEREST

8,848 m
311 m

COMPANY: Lone Star

LOCATION:
close to Anadarko

Its development began in **1970** and lasted **545 days**

In total, the well took **1,700 tons** of cement and 150 diamond bits to bore

It cost the company **6 million USD**, total

THE "SAATLINSKAYA" (SG-1)
USSR

8,324 m,
EQUIVALENT TO
238
NOTRE-DAME DE PARIS CATHEDRALS

35 m

Superdeep Drilling Program of the USSR Ministry of Geology

LOCATION:
Kurin Valley, Azerbaijan

According to data from the SG-1 a geophysical model of the Earth's crust was planned on being built. Construction began in 1977 and was stopped due to technical reasons in 1982

TECHNOLOGY: "Uralmash-15000" drilling rig

INTENSIFICATION OF HIGH-VISCOSITY OIL PRODUCTION

PUTTING HIGH-VISCOSITY OIL DEPOSITS INTO DEVELOPMENT AND ENSURING PROFITABLE PRODUCTION VOLUMES IS AN URGENT TASK FOR OIL AND GAS COMPANIES BOTH IN THE RUSSIAN FEDERATION AND ABROAD. AT THE SAME TIME, THE DYNAMICS OF INVOLVEMENT IN THE DEVELOPMENT OF HARD-TO-RECOVER AND UNCONVENTIONAL HYDROCARBON RESERVES HAVE INCREASED. WHAT TECHNOLOGIES DO RUSSIAN SCIENTISTS OFFER TO INTENSIFY THE PRODUCTION OF HIGH-VISCOSITY OIL?

KEYWORDS: *high-viscosity oil, production intensification, solvent reagents, hard-to-recover reserves, geological and technical measures.*

Pavel Roschin
Chief Project Engineer, Specialized Institute for Development of High-Viscosity Oil Fields SamaraNIPIneft OOO

Ivan Kireev
Key Project Chief Manager, Specialized Institute for Development of High-Viscosity Oil Fields SamaraNIPIneft OOO

Sergey Demin
Deputy General Director for Geology and Development SamaraNIPIneft OOO

In 2017, representatives of the Ministry of Energy of the Russian Federation indicated a share of 65% HRT in the amount of total oil reserves [1].

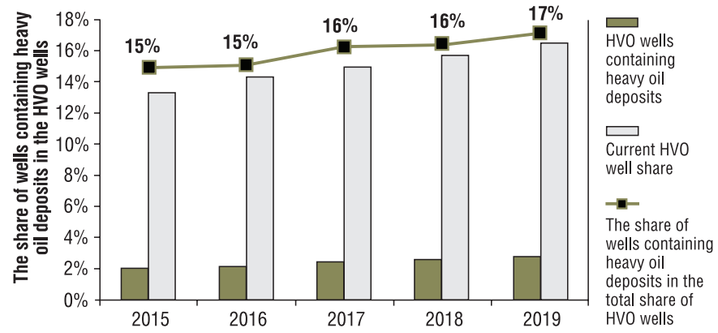
According to a report by British Petroleum (BP Statistical Review of World Energy 2019), there is an increasing tendency of hydrocarbon production in the world. At the same time, a major advantage for mining companies will be the use of local infrastructure and personnel in well-equipped old oil and gas producing provinces to ensure efficient production, transportation and processing of products.

A promising area of maintaining production levels in the oil and gas regions is the development of high-viscosity oil (HVO) fields. However, for the effective extraction of such raw materials, it is necessary to adapt classic and develop new technologies in response to a number of technological challenges [7, 8]. First of all, the production of HVO is complicated by the high viscosity of the product, the abnormal rheological properties due to the high content of asphaltenes, resins and paraffins in the oil [2, 5, 6, 9–11]. This complicates oil influx rate from the pay bed to the development wells, and its transportation through infield pipelines. HVO tends to form complex asphaltene-tar-paraffin deposits (heavy oil deposits) both in the formation pay zone and on downhole equipment as well as production tubing.

The high content of resins and asphaltenes, which are natural stabilizers of oil-water emulsions, leads to complications in the processes of bringing high-viscosity oil to marketable quality. According to the results of the analysis of Samaraneftegas JSC's number of wells at HVO facilities from 2015 to 2019, there is an increase in the share of HVO wells containing heavy oil deposits (Figure 1).

Based on the analysis of data on the chemical composition of oil, heavy oil deposits and production conditions, it is proposed to use hydrocarbon solvent reagents to comprehensively increase

FIGURE 1. Increase in the share of wells containing heavy oil deposits in the total number of wells at HVO facilities in Samaraneftegaz JSC



a number of technological processes aimed at intensification of the production of HVO. The affinity of the chemical composition of oil and solvents, ease of production use, and the possibility of laboratory tests using a minimum set of equipment make it possible to recommend such reagents for implementation under conditions of economic profitability.

Currently, a large number of different technologies are used to intensify oil production. The most common geological and technical measure (GTM) is the traditional acid treatment (AT) of the formation pay zone. The low cost of conducting such a geological and technical measure is ensured by the possibility of using standard equipment, the simplicity of the operation, the predicted efficiency. Despite the apparent simplicity of implementation, ATs require a careful approach to the choice of composition and technology. For example, the effectiveness may depend on the duration of exposure of the acid composition in the formation pay zone until the subsequent development of the well [4]. When choosing acid treatments as a way to intensify production in wells operating facilities with HVO, a number of possible complications should be taken into account: the formation of persistent and viscous acidic emulsions of AC with oil, the risk of heavy oil deposition in the formation pay zone, etc. These processes can have a negative impact on the final result, complicate the development and subsequent operation of the producing well.

One of the easiest ways to increase the efficiency of AT in HVO facilities is to pre-inject the solvent bank into the formation pay zone before the acid treatment itself. By conducting laboratory tests for the objects of the Volga-Ural oil-and-gas province, it was found that the use of a pre-selected solvent reagent allows cleaning the formation pay zone rock surface from heavy oil deposits to ensure a more complete AT reaction, to increase the efficiency of well development after completion of the GTM due to the effective separation of the emulsion "acidic composition – high-viscosity oil." Evaluation of the compatibility of the acid composition and HVO can be carried out as follows: oil and acid composition are poured in equal volumes into a container, then mixed for half an hour to simulate the most unfavorable interaction of fluids in the formation pay zone. A similar process is carried out with a number of other samples, but with the addition of a solvent reagent in oil. Then the containers are closed with lids and placed in a heating cabinet with a set temperature equal to the formation temperature. Assessment of the quality of separation of mixtures is carried out after 5 and 30 minutes when the containers are in the heating cabinet at formation temperature, then the mixture is poured onto a sieve with holes of 0.152 mm. If the fluids are compatible with each other, then after they pass through the mixture there shouldn't remain any sediment or emulsions on the surface of the sieve. When adding an oil-compatible solvent-reagent, no precipitate should be observed on the surface of the sieve, it is also possible to note a clear separation of the phases of the oil and the acid composition, which indicates the absence of an emulsion (Figure 2).

FIGURE 2. How the solvent affects the efficiency of "acid-oil" emulsion separation

- **with the addition of surfactant species**
- **with the addition of a solvent**

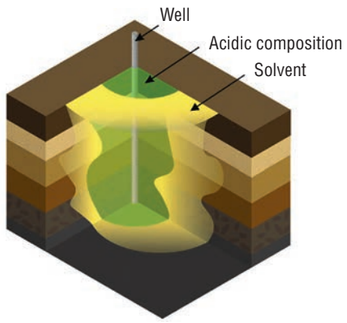
- **with the addition of surfactant species**
- **without the addition of a solvent**

Despite the fact that a number of acidic compositions were tested in commodity form, with surfactant species already added to them, not one of them was compatible with a sample of high-viscosity oil. The addition of a hydrocarbon solvent reagent ensured the efficient passage of the emulsion through a sieve. Thus, conducting such test allows you to quickly evaluate options for improving the technology of acid treatment of a formation pay zone in fields with high-viscosity oil.

Figure 3 shows the distribution of the solvent and acidic composition in the formation pay zone during an operation in a production well.

An important task in the operation of HVO deposits is to ensure the optimal operating mode of deep-well pumping equipment, as well as preventing the formation of heavy oil deposits, lowering the

FIGURE 3. Scheme of the treatment of the formation pay zone by sequential injection of solvent and acidic composition



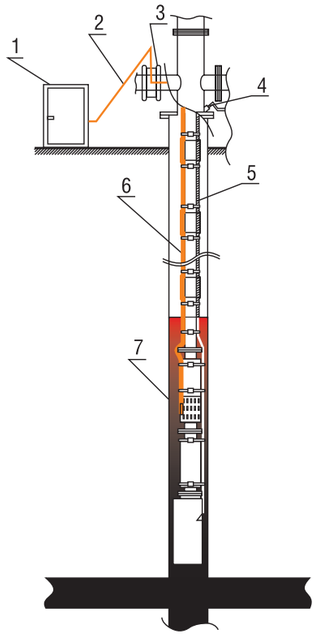
viscosity of HVO, etc. Practical experience shows that the use of solvent reagents makes it possible to efficiently control the rheological properties of high-viscosity oil throughout its production and transportation – from the producing well bottom to the time of delivery of the HVO for processing.

One of the most effective methods for introducing a solvent into the HVO is dosing at a pump suction through a capillary tube (Figure 4). To do this, reagent dosing units are placed on the day surface, usually in a block-complex design, and a capillary tube is lowered into the well to the pump suction basket. This method of feeding the reagent has several advantages. Firstly, the solvent mixes well with HVO, the viscosity of the well produce decreases, because of that the load on the pump drive is significantly reduced (usually, it's an electric motor in various models). Secondly, modern reagent dosing units allow precise control of the feeding volume. Additionally, the likelihood of the formation of heavy oil deposits on production tubing, fountain fittings and field communications on the surface is reduced, and pressure in the flow lines is reduced as well. Due to this, the overhaul period of the well is significantly increased, there are no periodic shutdowns of the well due to engine overload.

Preliminary laboratory tests are carried out to select the most effective and solvent-compatible reagent solvent. One of the easiest ways to pre-evaluate a reagent is to conduct a compatibility test. The solvent and oil are mixed at a concentration of 80% and 20%, respectively, and then poured onto a filter installed in a funnel. An oil compatible solvent does not precipitate any heavy oil deposit sediments.

As seen on the presented figure, solvent A showed poor mixing properties with HVO and left a sediment on the filter, solvent B passed through the filter without leaving a sediment on it. Thus, the solvent B is compatible with oil, which allows us to recommend it for further testing and application at the well. It should be noted that there are a number of technologies where the process of deasphalting of high-viscosity oil is initiated purposefully both in formation conditions and on the surface, however, they are not considered in the framework of this work.

FIGURE 4. Scheme of reagent feeding for electric centrifugal pump suction



1 – dosing unit; 2 – onshore pipeline; 3 – input device through the lateral branch of the fountain fittings; 4 – input device through the cable input of the fountain fittings; 5 – power cable of the ESP system; 6 – downhole capillary tube; 7 – spray valve

FIGURE 5. An example of a test to assess the compatibility of solvents with oil (checking the presence of sediment on the filters) and a visual assessment of mixing properties

Despite the similar chemical composition, different solvents have different effects on the rheological properties of high-viscosity oil. Figure 6 presents the results of laboratory studies evaluating the effectiveness of reducing the viscosity of an HVO sample with the addition of reagents in a volume concentration of 3%.

The graph shows that the solvents have different efficiencies of lowering the viscosity of HVO. In this case, solvent No.1 showed the lowest efficiency and cannot be recommended for use in production.

The use of hydrocarbon solvents in complex technologies for thermochemical treatments of the formation pay zone is of great interest (Figure 7). This approach allows you to increase the intake capacity and the injection rate due to the most effective dissolution of asphalt, resin, and paraffin materials and an additional decrease in oil viscosity in formation pay zone. Thus, the chemical effect of the solvent and the subsequent thermal effect of steam have a synergistic effect on the additional production of HVO [3].

Figure 9 presents the results of hydrodynamic modeling of the use of complex thermochemical formation zone treatment with

FIGURE 6. An example of the results of testing reagent solvents to lower the viscosity of HVO (volume concentration of 3%)

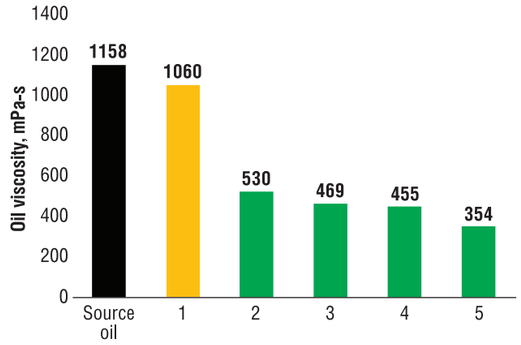
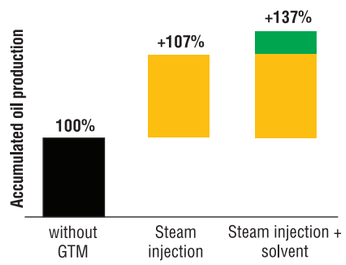


FIGURE 7. The process of treating the formation pay zone of a vertical well formation with solvent and steam at a high-viscosity oil facility

FIGURE 8. Example of modeling results of the use of complex technology for treating the formation zone of a vertical well with solvent and steam at a high-viscosity oil facility (oil saturated thickness 14 m, oil viscosity under formation conditions 400 mPa·s, pre-injection of aromatic solvent reagent bank)



solvent and steam at one of the HVO fields of the Volga-Ural oil and gas province.

What follows is that the use of a hydrocarbon solvent in combination with heat treatment of the formation pay zone with steam will allow to take advantage of the chemical and thermal effects.

Based on the material on the above methods of using solvent reagents in the processes of intensification of production of high-viscosity oil, it is possible to draw the following conclusions:

- Selection and justification of the use of solvents are impossible without preliminary laboratory studies for each high viscosity oil field. It is necessary to carefully study the compatibility of a hydrocarbon solvent with high-viscosity oil, as well as with other reagents used, for example, to avoid lowering the permeability of the formation pay zone due to organic deposits appearing.
- The justified use of such reagents in classical technologies for the oil production intensification can improve the results and increase the potential of various geological and technical measures. The injection of the solvent bank before the acid treatment allows to increase the efficiency of the acidic composition and accelerate well development. The feeding of a reagent to deep pump suction allows to control the rheological properties of the produced HVO and, as a result, increase the flow rate of the well and reduce the load on the pump motor. The preliminary injection of reagent solvent bank during the complex thermochemical treatment of the well allows to increase oil production compared to the classical formation pay zone with steam.
- Hydrocarbon solvent reagents are produced by a large number of petrochemical enterprises and are readily available on the market. The simplicity of introducing solvent reagents into a number of technological processes to intensify the production of high viscosity oil using standard equipment makes it possible to consider options for their prompt implementation in production. ●

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10 TECHNOLOGIES IN THE OILFIELD SERVICE

Russia is rich in hydrocarbon reserves. However, lately, the quality of their deposits are incrementally declining. Re-opened fields are scaling down, oilfields that continue their operations are gradually depleting, and more complex methods are being consistently relied upon to extract difficult deposits. Two prospects have been determined for the future development of the sector – shelf drilling and hard-to-recover reserves (HtRR), unfortunately, it may take some time before they can be exploited, at the moment it is necessary to support production in the regions where an infrastructure has been established. These factors determine the importance of oilfield services, that are becoming more complex by the day as they are faced with challenges thrown by the industry. Oilfield services have a vast portfolio, that are closely interrelated between one another, however, we can distinguish technologies and solutions that have become flagship and further development of the sector would be impossible without them

Harder and harder!

A significant part of the oilfield services market is production drilling, where the biggest challenge is the complexity of the wells construction. Over the past 10 years, horizontal wells have been accounting for an increasing share of total production drilling in Russia. In some oil production regions, such as Eastern Siberia and Yamal, horizontal wells have become the primary method of the fields developments. Well configurations are becoming more sophisticated as the share of multilateral and multihole wells grows, the Fishbone process spreads when multiple offshoots are diverted from one horizontal wellbore, and wells are drilled with greater deviations from the vertical. Previously, technically incapable wells are being engaged, drilling horizontally inclined wells such as those on the Chaivo field of the Sakhalin-1 project, on the northern tip of the Chaivo field and Tsentralno-Olginskaya-1 on the Taimyr

Production intensification – more than HF

Methods of increasing oil recovery (IOR) and intensification of production are not limited to hydraulic fracking operations. It comprises of a wide range of methods, including thermal, chemical, gas, hydrodynamic, physical methods and their combinations. The key prospects for IOR development in Russia are associated with thermal methods, which are already enabling production of high-viscosity oil in the Timan-Pechora and Volga-Urals oil and gas bearing provinces. Promising prospects for the development of the Bazhenov formation are associated with the use of thermal-gas IORs, which rely on the injection of oxygen into the formation and its transformation into effective displacing agents, due to low-temperature intra-plast oxidation processes. A key aspect for further implementation of IOR is the degree of its tax burden. Over recent years, measures have been taken to stimulate this sector particularly by launching pilot projects on already mature fields

Fracturing production

Today, its hard to imagine a horizontal well which hasn't undergone hydraulic fracturing (HF). Hydraulic fracking operations allow the flow of oil to the well by injecting a mixture of liquid and a special propping agent (proppant) into the formation at high pressure to form cracks in the network. The quantity of stages in hydraulic fracking is increasing. If some 3 years ago, it reached 6–7 stages, whereas today, we can read up on about 20 to 30 stages of HF. Mixtures for HF are becoming more sophisticated. Along with traditional guar gum, polymer solution, hydrocarbon gels, acid compositions, stable foams and so on are used

Overworking tubing units, and more

Ageing of the well stock and decline in production rates, stimulate further increase in the number of well workovers and their complications Among the most popular well workover operations are those related to maintaining or increasing production volumes, such as well injection and development, preparation for hydraulic fracking and post-fracking development, bottom-hole zone treatment, etc. Coiled tubing, which uses coiled tubing (CT) units, is becoming a promising technological solution for well overworking. Coiled tubing allows injecting fluids into the well at any time, regardless of the position or direction of the equipment

Let there be mechanisation!

Factors that account for the growth of production drilling volumes, number of wells and increase of HRR contribute to the development of a mechanised production market in Russia. In comparison between 2 principal pumps – ESPU (electrical submersible pump unit) and BHP (bottom hole pump), the former successfully prevails. Where ESPU well shares continuously grow, while BHP units decline in their positions. While HRR well productions increase, ultra-small well pumps are being integrated. In sectors of mechanised production, and in the sector of oilfield services in general, we can increasingly observe the results of import substitution. For instance, one significant technological leap in mechanised mining was the production launch of Russian valve engines

Geophysics is our everything

The exploitation of increasingly complex hydrocarbon reserves and the construction of complex wells allows us to unlock the entire potential of geophysical well logging (GWL). GWL methods allow to characterise well logs, lithology, reservoir parameters and other characteristics, to obtain data on subsoil structures and their conditions. The introduction of industrial sanctions in 2014 posed a major challenge, when global leaders of the sector decreased their activity in Russia, and domestic companies had to find their own solutions for complex facilities such as horizontal wells, HRR and shelfing. The most sought after GWL, today, is GWL during overwork, drilling and hydraulic fracking. In addition, extensive research is being carried out on sidetracking. Localisation, substitution of imported geophysical equipment and improved software for data interpretation have become powerful factors for the development of GWL in Russia

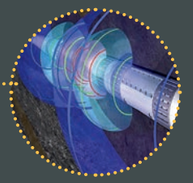
Meeting demand

The increasing volume of production drilling has ensured consistent development of the well cementing market in Russia over the last 10 years. While at the same time, customers' requirements for fastening of production columns increases, which calls for more expensive service and materials. As a result, operations become more expensive, which is also affected by the increased share of high-tech drilling in gross volumes

The recipe matters

Growth of drilling depths, increased risks of complications, tougher requirements to the quality of penetration and efficiency of productive rock exploitation, all this determines the importance of selecting the right composition of drilling fluids. The drilling solution provides for cost efficiency, effectiveness and safer drilling, that is why, extensive studies and tests are carried out on its compositions and properties. Hydrocarbon-based drilling fluids and their environmentally friendly alternative solutions have been gaining increasing popularity in Russia lately. This could potentially contribute to the development of new trends, such as the use of surfactants and emulsifiers

An accurate picture



Depending on the complexity of the well, respectively, the more accurately data on its actual trajectory should be assessed and further trajectories should be predicted. This is aided by telemetry systems (MWD) and logging during drilling (LWD), which have evolved in response to the areal extent of horizontal drilling and the increasing complexity of its conditions. MWD/LWD operations are mainly used in horizontal drilling as well as sidetracking. The market for LWD is slightly inferior to MWD, as logging operations are not as common in Eastern Siberia due to magmatites. MWD/LWD technologies are gaining popularity, towards the development of navigation sensors and software, expansion of data transmission channels, increasing the number of registered drilling parameters and improving reliability

Smart finish

The completion of a well involves a comprehensive set of operations that is required to start initial productions, so as new technologies develop, smart solutions are increasingly being used to optimise the process. Automated downhole equipment provides for continuous collection and transmission to the surface of data on production parameters or fluid injection into the reservoir in real time, maintaining separate production records for individual reservoirs, as well as regulating water injection into formations in injection wells. The implementation of these so-called "smart well" systems, is due to increased attention to HRR, development of remote and offshore fields, and development of small-scale technologies. The introduction of fully intelligent solutions has so far been limited to these situations, but many companies use downhole monitoring system in wells, that include pressure and temperature gauges, distributed temperature profiling, and downhole flow meters

BIOCHEMICAL ACTIVITY ANALYSIS

at control of soil reclamation process

Rauf V. Galiulin
Doctor of Science (Geography), Leading Scientific Worker of Institute of Basic Biological Problems of Russian Academy of Sciences

Vladimir N. Bashkin
Doctor of Science (Biology), Professor, Chief Scientific Worker of «Gazprom VNIIGAZ» LLC and Institute of Physicochemical and Biological Problems of Soil Science of Russian Academy of Sciences

Roza A. Galiulina
Scientific Worker of Institute of Basic Biological Problems of Russian Academy of Sciences

BIOCHEMICAL ACTIVITY ANALYSIS, I.E., CATALASE AND DEHYDROGENASE ENZYME ACTIVITIES ANALYSIS WAS USED AS CONTROL, I.E., AT EFFECTIVENESS ASSESSMENT OF RECLAMATION PROCESS OF MECHANICALLY DISTURBED SOILS IN THE IMPACTED ECOSYSTEMS OF A GAS PRODUCTION COMPANY IN THE TAZ PENINSULA (THE YAMALO-NENETS AUTONOMOUS DISTRICT, NORTH OF WEST SIBERIA, RUSSIA). REGENERATION OF A VEGETATION COVER AS SELF-RESTORATION OF THE DISTURBED SOILS WAS DIAGNOSED BY THE CATALASE ACTIVITY ANALYSIS, AND EFFICIENCY OF PEAT BASED RECLAMATION OF DISTURBED SOILS WAS DIAGNOSED BY THE DEHYDROGENASE ACTIVITY ANALYSIS

UDC 631.4:502.76+577.15

KEYWORDS: *mechanically disturbed soil, reclamation, regeneration of vegetation cover, peat, control, activity of catalase and dehydrogenase.*

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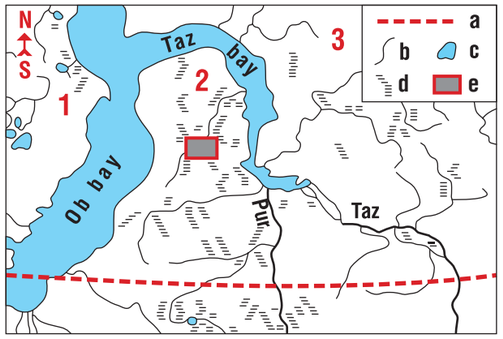
Introduction

From the geoecological point of view, process of soil reclamation represents the restoration of its fertility lost due to various reasons to which it is possible to refer productive activity of the gas industry in the conditions of the Far North. This activity consists of conducting exploration works, arrangement and development of new fields, gas and gas condensate production and their preparation for transport. Very often this is accompanied with mechanical impacts on a soil-vegetation cover when tundra soils partially or completely lose a vegetation cover and an organogenic layer, and the mineral horizons come to a day surface. Nevertheless the soil has self-restoration in the form of regeneration of a vegetation cover, originally settling by the different types of perennial cereal grasses association not characteristic of the natural communities which subsequently are forced out by native for a tundra zone - mosses and lichens. However in the conditions of severe climate of the tundra about self-restoration of mechanically disturbed soils it will be possible surely to judge only decades later after the beginning of this process [1, 2]. It has been also shown that a local peat can by applied for stimulating the reclamation of mechanically disturbed soils in the northern impacted ecosystems. Accordingly, we need the express assessment of this process effectiveness *in situ* conditions.

Peat applying for mechanically disturbed soil reclamation is due to some reasons. First, this organogenic material consists both of partly decayed plant remains and specific products of their degradation, humus and humic acids, which are characterized by the high content of nutrients, especially nitrogen, up to 3.5%. Secondary, peat possesses a certain pool of various physiological groups of the microorganisms

FIGURE 1. Map-scheme of the territory under study



1 – The Yamal peninsula;
2 – The Taz peninsula (68°09' N, 76°02' E);
3 – The Gydan peninsula;
a – The North Polar Circle,
b – rivers,
c – lakes,
d - swamps,
e – plot of mechanically disturbed tundra soil for reclamation

(ammonifiers-aerobes, sporous bacteria, oligonitrofila, fungi, nitrifiers, denitrifiers, butyric-acid bacteria etc.) participating in degradation of peat organic substance that makes available nutrient elements for plants [3].

As for key indicators of reclamation process, it is possible to refer activity of soil enzymes. This indicator differs in high sensitivity and expressivity, sufficient accuracy and stability of indices in comparison with the existing methods of microbiological analysis [4].

The specified geoenvironmental problem solved on the example of the mechanically disturbed tundra soils of the Taz peninsula (Yamalo-Nenets autonomous district, north of West Siberia, Russia) as region of productive activity of 100% subsidiary company of «Gazprom» PJSC – «Gazprom Dobycha Yamburg» LLC. As known the Taz peninsula is in the north of the West Siberian Plain between the Ob bay in the west and the Taz bay in the east (Fig. 1). The territory of the peninsula is on a relief flat, it is covered with lakes and swamps and has vegetation characteristic of the tundra. Historically this area also is used by local population for pasturable reindeer breeding. Researches of the last years showed existence of a problem of mechanically disturbed tundra soils on the Taz peninsula as a result of productive activity of «Gazprom Dobycha Yamburg» LLC [5].

In this regard the main objective of work consisted in stimulation of the reclamation of mechanically disturbed tundra soils from the Taz peninsula by means of local peat use and an express assessment of this process effectiveness in the conditions *in vitro* with use a catalase and dehydrogenase enzyme activities as control of the soil reclamation process.

Materials and methods

Representative average samples (0–6 cm layer) of two mechanically disturbed tundra soils as the consolidated sand on granulometric composition were selected in the Taz peninsula on sites around the location of installations of the complex gas preparation providing a collection and processing of natural gas and gas condensate according to requirements of industry and state standards. On one site the vegetation cover was absent; on other site the fragmentary regeneration of a vegetation cover in the form of certain species of perennial cereal grasses association, as well as mosses was noted. Preliminary analyses showed that the content of organic carbon (C) in soil without vegetation cover was 0.2%, and with a vegetation cover – 0.9%. In experiences for soil reclamation, the local peat with 54% ash-content added to the soil in the ratio 1:4 (peat:soil). As a standard of peaty-gleezem typical tundra soil (0–10 cm layer) with 39% ash-content was used [6]. The short physicochemical characteristic of the studied samples of soils and peat is given in Table 1.

TABLE 1. Physicochemical characteristic of different soils and peat samples from the Taz peninsula

Sample	Density, g/cm^3	Capillary moisture capacity, %	Full moisture capacity, %	pH_{water}
Peaty-gleezem typical tundra soil	0.4	216	315	5.1
Peat	0.4	216	420	5.4
Disturbed soil without vegetation cover	1.7	25	32	5.9
Disturbed soil without vegetation cover and peat addition (peat:soil, 1:4)	1.0	66	80	5.1
Disturbed soil with vegetation cover	1.5	37	43	5.1
Disturbed soil with vegetation cover and peat addition (peat:soil, 1:4)	0.9	78	102	5.3

For assessment of the soil reclamation effectiveness, 50 g samples without addition and with peat addition, humidified to 70% of a full moisture capacity incubated in Petri's cups in the thermostat at a temperature 30°C. In dynamics, i.e., on 5, 10, 20 and 30 days a catalase and dehydrogenase activity of samples from various experimental variants was analyzed by means of the gasometer and spectrophotometer methods, accordingly, presented in work [5].

Results and discussion

It is known that from the studied enzymes the catalase initiates degradation reaction of the hydrogen peroxide (H_2O_2) to water (H_2O) and oxygen (O_2), which is formed in the course of breath of soil organisms and as a result of various biochemical reactions of organic substances oxidation. The catalase activity of soils can be considered not only as an indicator of functional activity of microflora, but also testifies to a safety of enzymes in postmortal plant material [7]. As for the dehydrogenase, its role consists in dehydrogenation reaction catalysis, i.e. hydrogen splitting off, of the organic substances (carbohydrates, alcohols and organic acids) arriving with the vegetation remains. The regression analysis has revealed a high positive associativity (determination coefficient, $r^2 = 0.90–0.98$) of catalase and dehydrogenase activities as linear function that consists in transfer of the hydrogen (H_2) splitting off by dehydrogenase to air oxygen with formation of water and (or) hydrogen peroxide which subsequent degradation is carried out by a catalase.

The data of Table 2 show that closest to catalase activity of peaty-gleezem typical tundra soil (taken for 100%), was the corresponding activity of disturbed soil with a vegetation cover, which during observation made 62–75% that is higher than activity even of the peat used for soil reclamation.

It allows to draw a conclusion on a significant contribution of plants to soil biochemical activity through postmortal plant material, owing to the enzymes remaining in this matter. Apparently regeneration of a vegetation cover as self-restoration of the disturbed soil was diagnosed by increase in catalase activity. The other picture was observed in case of dehydrogenase activity. So, for the entire period of observation, peat addition significantly increased the dehydrogenase activity of disturbed soil without vegetation cover and, especially with a vegetation cover. Apparently effectiveness of the disturbed soils reclamation by means of peat addition was diagnosed by increase in dehydrogenase activity. As for dehydrogenase activity of peat, it not only reached the corresponding activity of peaty-gleezem typical tundra soil, but also in the first 5 days was 29% higher.

TABLE 2. Dynamics of enzyme activity of the mechanically disturbed soils from the Taz peninsula at their reclamation by means of peat

Sample	Catalase activity / Dehydrogenase activity, % from activity of peaty-gleezem typical tundra soil			
	Day			
	5	10	20	30
Peat	44 / 129	40 / 100	54 / 97	64 / 101
Disturbed soil without vegetation cover	25 / 9	20 / 7	23 / 8	27 / 6
Disturbed soil without vegetation cover and peat addition (peat:soil, 1:4)	25 / 33	20 / 24	23 / 19	27 / 24
Disturbed soil with vegetation cover	75 / 19	73 / 14	62 / 15	73 / 12
Disturbed soil with vegetation cover and peat addition (peat:soil, 1:4)	38 / 71	40 / 59	62 / 60	55 / 41

As the proof of adequacy of dehydrogenase activity use in the time of assessment of the disturbed soils reclamation effectiveness by means of peat addition, the results of correlation and regression analysis of experimental data are served. So, calculation of the coefficient of correlation (r) indicating the direction and degree of an associativity in signs variability has shown existence of strong essential correlation dependence between a dehydrogenase activity and density of various samples ($r = -0.95$), a dehydrogenase activity and capillary moisture capacity ($r = 0.95$), and also a dehydrogenase activity and full moisture capacity ($r = 0.95$). The corresponding formulas of correlation dependence, i.e., the equations of linear regression allow judging how the productive sign (y) quantitatively changes at change of a factorial sign (x) on a unit of measure had the following appearance:

$$y = 76.9 – 44.4x;$$
$$y = 2.74 + 0.28x;$$
$$y = 7.71 + 0.15x.$$

As it has appeared, the less density of samples and respectively more their capillary and full moisture capacity determined substantially by an organic component of the used samples, the dehydrogenase activity is higher. It is confirmed by data of previous works [7, 8], where increase in dehydrogenase activity with increase of humidity in various soils was noted. The leading value of humidity in soil dehydrogenase activity is connected with the fact that moisture defines a normal physiological state of the microorganisms and plants producing enzymes in the soil and also supports enzymes and their substrata (carbohydrates, alcohols and organic acids) in a reactionary state.

Conclusion

Thus, biochemical activity analysis, i.e., catalase and dehydrogenase enzyme activity analysis were used as control, i.e., at assessment of reclamation effectiveness of the mechanically disturbed tundra soils from the Taz peninsula. The relevant results of *in vitro* experiments that were aimed to local peat application showed that catalase and a dehydrogenase activity analysis are fitting for express assessment of reclamation process. From our point of view, such *in vitro* experiments are the basis for the formation of biogeochemical technology for the reclamation of mechanically disturbed tundra soils [9].

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OFFSHORE INTEGRATED LNG TERMINAL

Guseynov Ch.S
D.Sc. in engineering, Professor, Automation and Design Department for Offshore Oil and Gas Facilities, Gubkin Russian State University of Oil and Gas (NRU), Scientific Researcher at the Oil and Gas Institute of RAS

UDC 629.1

THIS PAPER PRESENTS THE POSSIBILITY OF CREATING A NEW OFFSHORE STORAGE TERMINAL FOR LIQUEFIED NATURAL GAS AND A WAY TO REDUCE THE COST OF PRODUCING LIQUID AIR AS A REFRIGERANT FOR LIQUEFACTION OF NATURAL GAS

KEYWORDS: *natural gas, liquefaction, refrigerant, liquid air, liquefied natural gas.*

Since the time when natural gas became one of the main sources of energy in the world and the problem of its delivery to consumers by pipelines began to clearly restrain its production, gas liquefaction has become the universal solution. At present numerous technologies all over the world are used for its liquefaction. Nevertheless, the search for new technologies for liquefying natural gas (LNG) continues, and we are also taking part in it [1,2], thereby contributing to the successful diversification of gas delivery methods to consumers. It should be noted that our developments are primarily intended for the development of deep-sea long-term freezing waters of the Arctic Ocean, since traditional ice-resistant platforms, designed primarily for depths of up to 50-60m, will not withstand ice impacts; furthermore, no modern technology is designed for use in underwater conditions in order to produce and liquefy natural gas [3].

FACTS

50-60 m

Depth of wells, for which traditional ice-resistant platforms are mainly intended

The improvement of one of our proposals for LNG production technology can certainly be implemented under the conditions of underwater natural gas production and will contribute to the efficiency of natural gas production [4]. In this respect, one of the most important components of our underwater gas liquefaction technology is the cost of the refrigerant used. In our proposed method of gas liquefaction, the main goal pursued is cost reduction and the only refrigerant is liquid air (LA), which is supplied against the countercurrent flow of natural gas extracted from productive formations. Liquefied natural gas (LNG) obtained this way must be stored in isothermal reservoirs, from which the accumulated LNG is periodically pumped to a gas tanker thereby delivering gas to the consumer. It should be noted that the delivered LNG is pumped to special reservoirs, LNG storage facilities, from where it is re-gasified if necessary for distribution into gas pipelines.

We propose to “utilize” its cold at the stage of LNG regasification, subjecting it to pumping in the countercurrent flow with forced air, which can be cooled to about minus 145-150°C, that is, the length of the cooling path must be such as to achieve the above temperature range, next, the air cooled in this manner is subjected to further cooling in order to achieve liquefaction using traditional air liquefaction technology.

The proposed method of regasification of LNG gives us a double benefit, namely: we save the energy needed to heat LNG and cool the air to the above-mentioned temperatures as much as possible, and then we continue to further cool the pre-cooled air transforming it to a liquid state, i.e. at the final stage of air liquefaction we utilise traditional technology for air liquefaction.

In this regard, we consider it necessary to pay particular attention to the underused opportunities of LNG as a refrigerant after it is delivered to the destination port: when it is discharged, there is the possibility (in the countercurrent flow) to cool the injected air to approximately the above-mentioned temperatures, and then to bring the already cooled air in such a manner into a liquid state using the traditional method; and then pump this liquid air into a tank freed from LNG, with the tank “washed” (purged) beforehand with degassed liquid nitrogen in order to avoid the formation of an explosive gas-air mixture. This type of procedure should be carried out sequentially: tank by tank, as the delivered LNG is being released from each tank. Naturally, such a solution can significantly reduce the already low cost of liquid air (in comparison with the traditionally used multi-mixture refrigerants obtained specifically for these purposes from natural gas, which, undoubtedly, increases the cost of the target process itself). It should also be noted that the new technology for liquefying natural gas will not structurally alter the usual appearance of the tanker itself, and the only thing that will be added to the dispensing operations is the mandatory purge of all tanks with degassed liquid nitrogen in order to avoid the formation of explosive vapour concentrations of gas-air mixtures (which will require the installation

of a specially designated tank for storing liquid nitrogen with equipment for its degassing before the procedure for the scheduled purge of the remaining gas tank of the LNG carrier).

The traditional offshore terminal will also be functionally modified to implement a new liquefaction technology, namely: it will be necessary to install the following:

- a reservoir for storage (and gradual accumulation) of liquid air;
- a compressor/powerful blower (for pumping air into the track of the pre-cooled air to be liquefied);
- a unit for production of liquid air (pre-cooled air);
- a pumping station (for pumping liquid air into the tanker);
- a countercurrent heat exchanger/evaporator ("pipe in pipe" type);
- a unit for production of liquid nitrogen from liquid air.

Thus, the application of the proposed technology for liquefying natural gas through multi-stage heat transfer in the countercurrent flow with forced (pressurised) air with LNG will require additional construction corresponding to the above-mentioned units and operations at the receiving offshore complex.

The costs for the acquisition and installation of the listed equipment of the offshore integrated terminal (OIT) will naturally increase; however, the final cost of liquid air will be significantly lower than the total cost of multi-mixture refrigerants (taking into account the different types of containers for their storage, various compressors for transmission and more complex closed systems for liquefying natural gas [4]. Furthermore, the total cost of energy needed to heat regasified LNG in countercurrent flow with hot air will increase slightly, while the method we propose will certainly be much simpler than existing ones in modern LNG plants.

All other functions of the receiving terminal will not practically change, and, in our opinion, this makes a compelling argument for the construction of new (regular) plants using our method.

Essentially, construction takes place twice (firstly, in the underwater field (see [2]), and secondly in OIT), we use the cold of both refrigerants: in the field – the cold of liquid air, and in OIT – cold of LNG, which, taking into account the small size of the heat transfer process creates the advantage of our proposed innovation.

In general terms, the following elements should be included in OIT:

- a complex for the production of methanol (when using methanol as an inhibitor for hydrate formation) from methane with storage and filling into the tanker (as an option, it can also be used for receiving, storage and loading into the tanker);
- a methanol regeneration unit, including a complex for disposal of treated inhibitor solutions not subjected to regeneration;
- a unit for the production of liquid air and regasification of LNG, which allows to produce the necessary volumes of liquid air both with the use of the cold of LNG and without it;
- a complex for the preparation and supply of sales gas into the main gas pipeline;
- a terminal for loading LNG into railway and road cisterns.
- a facility for storage and offloading of liquid air into the tanker;
- an installation for the production of liquid nitrogen (LN), a storage container and a delivery system to the tanker;
- a depot for supply and repair;
- support systems (control, automation, control and emergency protection, power supply system, regular and emergency lighting system, communication system, etc.);
- a central control point for all these operations.

FACTS

Up to

-145–150 °C

Temperature to which the forced air is cooled, which can be used during LNG regasification stage

It is worth noting that such an approach seems reasonable provided that there is sufficient energy for the production of liquid air. A rational solution in this case is the placement of OIT in an area where adequate power capacities are present, and the production of liquid air would be carried out during periods of minimum daily power loads at minimum tariffs, which will also allow for the production of liquid air with maximum efficiency, simultaneously balancing energy consumption in the power system.

In regard to gas fields in the Barents Sea region, the first proposed OIT could be located in one of the deep-water ports of the Kola Peninsula

provided that there are railways and roads and no network restrictions in terms of electric power supply. Such possibilities could be implemented on the Kola Peninsula, both in the Kola Bay and in other ports of the Arctic.

It is clear that in this case an adequate natural gas consumption market is necessary in the offshore complex region, otherwise such a market should be formed, for instance, by building a gas-chemical complex. The disadvantage of this approach is the lack of flexibility inherent in LNG as a commodity for the spot market, when LNG on the tanker can potentially be delivered to any point in the world provided that an appropriate receiving terminal is available. At the same time, the savings during production of liquid air using the cold of LNG can completely counter-balance this drawback, and in cases where the advantage of spot supply becomes obvious in terms of price parameters, this method allows liquid air to be produced without using the cold of LNG. Moreover, in both cases, underwater field and the offshore complex should have a single management system and operate as a unified technological complex in order to avoid organisational, technological or commercial disruptions during the production process.

Conclusions

The technological method for developing offshore gas fields with underwater LNG production using liquid air seems to be very promising, especially in the Arctic.

FACTS

Up to

1.5 times

Efficiency of project increased when using LNG cooling capability for the production of liquid air on the offshore complex

The use of the cooling capacity of LNG for the production of liquid air on the offshore complex significantly (up to 1.5 times) increases the overall efficiency of the project, provided that there is a gas market in the region where OIT is located.

The construction of OIT using the proposed technology allows to create a flexible and highly efficient system: Gas extraction – Production – LNG – sale of LNG and/or degassed LNG in the region. ●

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ENERGY VECTORS OF KAZAKHSTAN

Murat Zhurebekov
The First Deputy Minister of Energy of the Republic of Kazakhstan

KAZAKHSTAN'S RECOVERABLE OIL RESERVES ARE ESTIMATED AT 4.1 BILLION TONS WHILE PROJECTIONS OF GAS CONDENSATE RESERVES ARE AT 300 MILLION TONS RESPECTIVELY. MEANWHILE, HYDROCARBON RESERVES MAY DOUBLE THANKS TO EXPLORATIONS OF THE DEEP HORIZONS OF THE CASPIAN LOWLAND. IT IS HARDLY SURPRISING, THAT THE OIL AND GAS INDUSTRY IS THE ECONOMIC LEADER OF THE REPUBLIC. WHAT ARE THE SOME OF THE MAJOR CHALLENGES FACED BY THE INDUSTRY AND HOW ARE THEY BEING RESOLVED AT A STATE LEVEL? WHERE WILL CRUDE OIL BE SOURCED AFTER THE DEPLETION OF THE PRIMARY RESERVES OF THE REPUBLIC? WHAT PRIVILEGES HAVE THE AUTHORITIES PREPARED TO GRANT AND WHO WILL DEVELOP HTRR? THE FIRST DEPUTY MINISTER OF ENERGY OF THE REPUBLIC OF KAZAKHSTAN, MURAT ZHUREBEKOV ANSWERS THESE QUESTIONS

KEYWORDS: *Republic of Kazakhstan, hard-to-recover reserves, Tengiz, Karachaganak, Kashagan.*

– Murat Utemisovich, what are the main issues faced by the Minister of Energy in the Republic of Kazakhstan? Which key tasks does the Ministry address?

– It is necessary to focus on more important areas, whilst preserving all the planned production indicators in the fuel and energy sector achieved in 2019.

Generally, the priorities are clear. During an extended board meeting, which was held on February 25 this year, we reviewed the results of the Ministry of Energy for 2019 and the industry's objectives for 2020. The volume of oil production in 2019 reached a record level in the history of the oil and gas industry – 90.5 million tons. This year's oil production is expected to reach 90 million tons.

In conjunction with the Committee of Geology and Subsurface Use of the Ministry of Ecology, Geology and Natural Resources, JSC "NC "KazMunayGas" and KMG "Engineering" are working to develop a geological exploration program for the period of 2021–2025.

The Government has approved the following Concept of the State program. Dynamics growth on investment projects was also observed in 2019. Above all else, these are such major projects as Tengiz, Kashagan and Karachaganak.

Production from the three major projects was 55.2 million tons (102.2% by 2018 (54 million tons) and 103.2% against the planned target (53.5 million tons). The target for 2020 is 55.7 million tons.

Tengiz future expansion project is also being developed. Currently, over 230 domestic service companies are involved in the development of steel structures and other construction works.

In line with the future expansion project / wellhead pressure management project (PBPUD), Tengizshevroil is planning to increase production by 12 million tons annually.

FACTS

39.8
billion barrels
proven reserves of oil and gas condensate in Kazakhstan

70 years
the period of oil and gas production in the country while maintaining the current production level

Kashagan has achieved a stable production of 400 thousand barrels per day, thanks to a major overhaul in 2019 and the transfer of two production wells to the injection well stock. Further production expansion projects are well underway at an active pace.

Kashagan's effective oil volume in 2019 was 14.1 million tons, or 106.8% compared to 2018.

In 2020, the reserves are expected to yield 15.5 million tons of oil and 10 billion m3 of gas.

The efforts are also taken to support the production regiment in the Karachaganak deposit.

In order to maintain production at levels of 10–11 million tons per year, phase 2M production regiment maintenance projects (lift production restrictions on gas, 4th gas injecting compressor) are being implemented. Projects aimed at maintaining the production regiment will enable the production of 18.5 million tons of liquid hydrocarbons by the end of the FPSA period, with total investments of $1,678 million.

After the completion of Phase 2M projects, the Karachaganak Expansion Project (KEP-1) is planned to be implemented to further support liquefied hydrocarbons production. For this purpose, it will be necessary to install 2 new gas injection compressors (in 2023 and 2025).

One of the Ministry's top priorities is the development of the gas sector and gasification.

As you are aware, in December 2018, along with the participation of the nation's leader (Yelbasy) the "Saryarka" gas transmission pipeline project was initiated. Today the pipleline is fully operational. It was launched on December 27th, 2019. Developments in the following sectors will be resumed.

The petrochemical industry is expected to undergo a lot of work, to meet project requirements such as the production of polypropylene with the capacity of 500 thousand tons per year, worth $1.9 billion and polyethylene with the capacity of 1.25 million tons per year.

In the electric power sector, the volume of electricity generation amounted to 106.0 billion kWh or 99.3% by 2018 (106.8 billion kWh). The plan for 2020 is 105.2 billion kWh. Electricity consumption reached 105.1 billion kWh, or 102% by 2018 (103.2 billion kWh), which indicates a complete coverage of the country's economic needs in electricity.

Renewable energy still remains a top priority. 21 RES facilities were launched last year. The total number of investments attracted into RES projects amounted to 613 million USD.

A lot of effort was put into attracting investments. For this purpose international auctions were conducted. In 2020, the Republic of Kazakhstan is expecting amendments in its legislation pertaining to clauses that involve the use and support of renewable energy sources and electricity.

– It is no secret that the main hydrocarbons production in Kazakhstan is located in the three largest fields: Tengiz, Karachaganak and Kashagan. When these enormous reserves are exhausted, which prospective areas will be targeted by the authority?

– Tengiz field has sufficient reserves to last for 34 years, Kashagan for 147 years and Karachaganak for 44 years. Subject to production rates of 2019 (based on data of the Geological committee of the Ministry of Ecology, Geology and Natural Resources of Kazakhstan on the balance of recoverable reserves by categories as of January 1st, 2019).

The future growth of oil production in the country will be achieved by commissioning offshore fields as well.

In addition, efforts are currently under way to develop proposals that encourage the stimulation of highly high-yield oil and gas fields that are in stages of late development.

Today the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan jointly with the Ministry of Energy and JSC "NC "KazMunayGas" are developing the "Geological exploration program for 2021–2025". This program will be aimed at conducting regional geological and geophysical research, identifying potential oil and gas prospects, and increasing the degree of exploration of these areas as a basis to attract future private investments.

FACTS

1.8%
of global reserves are oil reserves in Kazakhstan

15
sedimentation basins, where more than 65% of the country's recoverable oil reserves are concentrated, are located in Kazakhstan

– The Ministry of energy of Kazakhstan is developing a number of tax incentives for mature fields and fields with hard-to-recover reserves. Please tell us more, about some of the benefits and incentives, as well as the methods of determining the effectiveness of the state support measures in the oil production industry. What are the necessary measures to enhance the development of new hydrocarbon deposits?

– In accordance with the instructions given by the President of Kazakhstan during a meeting dedicated to the development of the oil and gas industry in the country which took place on September 5th, 2019, work is underway to study the issues of further stimulation of high-yield and late stage oil and gas fields.

Ongoing works are being carried out in the following areas:

- analysis of existing tax regime for subsoil users in Kazakhstan to identify provisions that discourage investments in high-yield and late stage oil and gas fields;
- studying foreign experience in implementing incentive measures to maintain the production plateau in fields of late development by introducing new technologies.

– Does Kazakhstan face any difficulties in fulfilling its obligations under the OPEC+ Agreement? Will you deviate from the plan, given the high level of production at the Kashagan field? What effect do you expect from OPEC+'s decision to exclude condensate from the quota-setting mechanism under the production cut-off agreement?

Kazakhstan's current obligations under OPEC+ are 1,843 thousand barrels per day until the end of March 2020 (57 thousand barrels less than in November 2018).

We expect that Kazakhstan will meet its obligations over the period.

KEY INDUSTRY EVENTS
UNDER ONE ROOF

MINISTRY OF ENERGY OF THE RUSSIAN FEDERATION · MINPROMTORG RUSSIA · CCI of RF · RSPP · Russian Gas Society · UNION OF OIL & GAS PRODUCERS OF RUSSIA · VDMA Process Plant and Equipment · EXPOCENTRE · Messe Düsseldorf

ECONOMIC GROWTH POINTS:

Russian-Swiss partnership as a mechanism for forming the sixth technological order

UDC 339

THE BASIS OF ANY BUSINESS IS MUTUALLY BENEFICIAL COOPERATION. IT IS IMPOSSIBLE TO DEVELOP GLOBAL INDUSTRIES, WHICH, IN PARTICULAR, IS THE OIL AND GAS INDUSTRY, WITHOUT RELIABLE PARTNERS. WITH WHOM ARE RUSSIAN COMPANIES BUILDING BUSINESS RELATIONSHIPS THAT CONTRIBUTE TO ECONOMIC GROWTH?

Keywords: *Swiss Business Hub Russia, Russian-Swiss partnership, oil and gas industry, small and medium-sized businesses, investment climate.*

Lorenz Widmer
Head of Swiss Business Hub Russia, economist

– Mr. Widmer, what does the Swiss Business Hub in Russia do? What tasks do you set for your establishment regarding the development of partnership between the two countries?

– The Swiss Business Hub Russia is the Moscow representative office of Switzerland Global Enterprise (S-GE), the official organization for promoting international trade and investment. The center is part of the Swiss Embassy and promotes the development of exports of goods and services to Russia, as well as popularizing ideas and promoting business opportunities in Switzerland.

Swiss Business Hub Russia (at the Embassy of Switzerland in Moscow) provides services for small and medium-sized businesses from Switzerland and Liechtenstein to expand their presence in the Russian market. The center also provides support for Russian companies interested in opening their own subsidiaries in Switzerland or in finding Swiss business partners

Bilateral economic relations between our countries are developing successfully, but I am convinced that the partnership potential is not fully realized, so we set ourselves the task of developing it further. To do this, we provide information about business opportunities and help establish contacts.

– And in what industries can this potential be more revealed? What is interesting in Russia?

– Traditionally, Swiss companies successfully operate in industries such as pharmaceuticals, engineering, electronic goods and tools, and, of course, in the field of consumer goods.

I want to note that in addition to the well-known Swiss global leaders, there are a large number of small and medium-sized players, as a rule, occupying a narrow niche in which they often claim technological leadership. I think that such companies are especially attractive to potential Russian partners. As a practice, they are very open and ready to search for the optimal format of cooperation jointly.

– How well, in your opinion, has the investment climate formed in Russia?

– In recent years, undoubtedly, many areas of business life in Russia have become more professional. The framework created by the state for business has become clearer and interaction with state authorities is more convenient. That is, for example, evidenced by the improved World Bank “ease of doing business” indicator. Speaking about investments, the main challenge

The chemical industry is one of the most important sectors of the Swiss economy

is the weakness of some public institutions, especially those related to private property and the courts. This is the point of view expressed by our customers – representatives of small and medium-sized businesses.

– What Swiss companies do business in Russia today in the oil and gas sector and related industries? What successful joint projects could you talk about?

– Swiss companies successfully supply technology and specialized chemicals to the Russian oil and gas sector. Examples of such technologies include equipment and solutions for separation processes in the petrochemicals, compressors and gas treatment units, mechanical engineering parts for sinking such as gearshifts for high capacity, parts for the construction of oil and gas pipelines, including seamless joints. Finally, Switzerland produces tools, including for working in explosive atmospheres.

Alongside to world-famous companies such as ABB or Sulzer, small high-tech and highly specialized companies work in this sector, which only market experts know about. Enerproject SA, a manufacturer of gas compressor equipment from the Canton of Ticino, implements projects in Russia together with its partner, the company ENERGAS. A recent example of their collaboration is equipping the Grozny TPP with three Enerproject compressor units. Swiss equipment, launch and maintenance were provided by Russian specialists of ENERGAS Group.

– Which features of the work of Swiss companies in Russia could you highlight? And what are the features of the work of Russian companies in Switzerland?

– As for the Swiss companies in Russia, then, probably, the main difficulty at the primary stage is the search for a suitable and reliable partner. Much depends on this, and this moment should be carefully worked out. The Swiss Business Hub center very often supports Swiss companies that are taking their first steps in the Russian market in this direction.

If we talk about the work of Russian companies in Switzerland, the situation is fundamentally different in that most often Switzerland is not considered as a separate market. Russian companies that open their business in Switzerland have global or at least European ambitions. They see Switzerland as a platform through which a wide variety of markets are conquered. Such a strategy can, for example, be observed in Russian IT companies.

– What concerns stop Swiss companies from developing business in Russia?

– At the moment, it is very difficult to talk about fears, because it all depends on the depth of the global crisis, which is just unfolding now and which will not blow over Russia. Leaving aside the current

The most powerful Enerproject screw compressor units in Russia provide fuel gas for turbines of the Grozny TPP

Low pressure booster compressor station on the basis of Enerproject units pumps low-pressure associated gas at the Varandey field of LUKOIL-Komi

crisis, in recent years, many companies that are our customers, are closely monitoring which development model Russia will choose in the future. This refers to categories such as nationalization of business or openness /autarchy. In any case, the Swiss business will continue to work in the Russian market, but the cooperation models will depend on these strategic decisions.

– It is no secret that Russian enterprises need European technologies, but the technologies are not produced for sale, they are developed in research centres within companies "for their own consumption". In your opinion, how willing are Swiss companies to share these technologies with Russian enterprises?

– I am convinced that there are interesting prospects for cooperation with Swiss small and medium-sized businesses. If we talk about the development of technology, then Russian enterprises have, roughly speaking, two ways: either to develop their technologies themselves or to acquire ready-made technologies through partnership with a major foreign player.If we talk about the development of technology, then Russian enterprises have, roughly speaking, two ways: either to develop their technologies themselves or to acquire ready-made technologies through partnership with a major foreign player. The first path is a process that requires a significant amount of time; the second path indicates a certain loss of control. However, there is a third way, which is for the company to develop its own technologies, but at the same time resort to specialized engineering companies that can help speed up the process. I know that this is performed in other sectors, and I suppose that this also applies to the oil and gas industry.

In the autumn, from October 26 to 30, we will assemble a group of Swiss companies on a business mission in the oil and gas industry to Moscow and Astrakhan. We have already received a very positive response from our companies, and we are convinced that the business mission will take place in an exciting composition. This will be our specific contribution to the development of partnerships this year!

– In your opinion, does the impact of sanctions only affect Russian companies against which the prohibitive measures are directed, or do they also affect European partners of Russia?

– First of all, it is important to understand that Switzerland does not apply the sanctions of either the European Union or the United States. Our neutral position is that we have taken specific measures so that our territory is not used to circumvent the sanctions.

As for the influence of Western sanctions and Russian counter-sanctions on Swiss business, it naturally exists, in the sense that any restrictions prevent the development of the economic activity.

– What, in your opinion, are the prospects for cooperation between Russia and Switzerland in the oil and gas industry? Tell us about the plans of the Swiss Business Hub for the development of partnerships in the near future.

– As I said above, Swiss companies are successfully operating in the oil and gas industry in Russia, including large corporations and smaller enterprises. Some of these companies have already localized at least part of the production in Russia, while others are only gaining pace. We definitely see the potential for further development, so this year we invested in a small study of the Russian oil and gas industry in terms of potential for Swiss enterprises. We want to use this study primarily for Swiss small and medium-sized businesses.

The Swiss Business Hub promotes international trade and investment, including through the organization of Swiss pavilions at exhibitions. ●

WHAT Neftegaz.RU WROTE ABOUT 10 YEARS AGO…

Private oil and gas companies are welcoming shelf drilling

In 2010, the Ministry of Energy of the Russian Federation announced that it is prepared to discuss its plans with non-government agencies on the topic of shelf drilling. According to the acting legislation on subsoil use, only two state owned companies are allowed to operate on the shelf – Gazprom and Rosneft. Whereas the Ministry of natural resources believes this is not sufficient.

• Comment
Neftegaz.RU

In March 2020, The State Duma passed a legislation on incentives for investors working in the Arctic. Foreign enterprises and commercial organisations registered in the Arctic Zone will be able to become residents of the Arctic Zone.
The residents are entitled to tax incentives, such as a zero-rate over the span of 10 years, as low as 5% on production over the span of 15 years; a zero MET rate for 12 years on liquefied gas production and gas chemistry, a zero MET rate within the first 12 years with a gradual transition to a full rate from the 13th year up to 17th year for new oil provinces in the Eastern Arctic. By passing this bill, the government hopes to attract 7 trillion rubles in private investments into the Arctic by 2030.

Buryatia will be given gas

The president of the republic of Buryatia is determined to continue the gasification of the region. V. Nagovitsyn announced this on April 26, 2010, addressing the National Khural of the Republic in his annual message. The Head of the Republic mentioned that "gasification is planned to be carried out in 2010-2011 by increasing liquefied gas supplies from Gazproms' plants via railroads to Onokhoi station (Transsib)".

• Comment
Neftegaz.RU

In 2020 the Government of the Republic of Buryatia and Gazprom LNG Technologies will study the potential to gasify the region using LNG. The respective Parties have already outlined a comprehensive action plan to implement the project, covering all phases from geological

exploration to acquire funding for the construction of the liquefaction facility. The major issue in regards to gasification revolves around Buryatia's demand for it. Low levels of gas consumption have previously halted the implementation of gasification in the region. Authorities of the republic have repeatedly raised the issue of gasification in recent years, which would enable them to abandon the use of coal and mazut boilers that are harmful to the environment.

Russia will supply the world with more oil

The International Energy Agency has revised its projections to increase oil production by non-OPEC countries for 2010. According to a new estimate published by them earlier today, an additional 600 thousand bpd will enter the world market in 2010.

• Comment
Neftegaz.RU

In 2020, Russia is still committed to supplying the world with more oil, however, OPEC is no longer prepared for it. Countries under the OPEC+ agreement could not come to an understanding in Vienna in March 2020, to proliferate the agreement beyond the first quarter of this year. Russia refused to cut its productions to 1.5 million bpd in the first quarter and to 500 thousand bpd in the second. As a result, from April 1, 2020 all participating parties to the OPEC+ agreement will be free from restrictions on oil production. Increased oil production and exports, as well as price reductions and discounts have already been announced by Saudi Arabia, UAE, Kuwait and Iraq. The disruption of the OPEC+ agreement resulted in the destabilisation of the oil market and a steep fall in oil prices. Technical difficulties were among the main reasons why Russia refused to reduce its oil production. ●

Speakers of the conference oil cargo transportation Market

G. Averyanov

The participants of the Market of transportations of oil cargoes

Participants of the conference Mechanized mining-2020

The construction site of the Amur gas processing plant

Visitors to the INTERLAKOKRASKA exhibition

I. Matskevich, V. Grib

Participants of the exhibition INTERLAKOKRASKA-2020

Participants of the exhibition INTERLAKOKRASKA-2020

A. Motorin

Members of the Presidium of the conference oil cargo transportation Market

Participant of the «Aviation Fuel 2019» conference

Participants of the exhibition INTERLAKOKRASKA-2020

Installation of a buffer tank for storing helium at the Amur GPP

Participants of the conference

F. Kerimov and colleagues

Sekavar employees

Participants of Metallexpo 2019

Speakers of the conference oil cargo transportation Market

Fourth, the Leasing Strategy conference leaders. Fighting for new markets

Sulzer hot track parts recovery center. Press tour. Yekaterinburg

A. Skorochkin

Exhibitor of the exhibition INTERLAKOKRASKA-2020

Ataya stand at the INTERLAKOKRASKA exhibition

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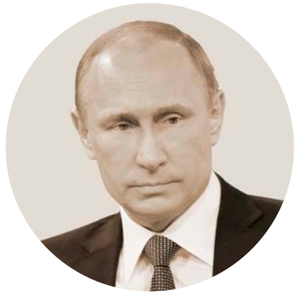
Alexander LUKASHENKO

“Oil prices are decreasing to the benefit of Belarus”



Vladimir PUTIN

“Let us refrain from our Russian manner of taking chances”

Donald TRUMP

“Today, oil prices are what I dreamed they would be”

Volodymyr ZELENSKY

“How can we speak of imports, if countries that we import from won't let us into their markets”

Pitirim SOROKIN

“We are not competing with anyone. We are not chasing round figures, and we are not after ratings. In 2020, we will produce additional 10 million tons”

Sergey SOBYANIN

“We are prepared to deliver wood and coal at subsidised prices to rural areas to assist with heating and convenience”

Sergei IVANOV

“People are the second resource to oil”

Leonid FEDUN

“Over the weekend, for the first time in 17 years, oil prices have dropped below 25 USD per barrel, which is catastrophic for Russia”

Joseph STALIN

“You cannot fight a war without oil, the side that has the ultimate advantage in the oil industry has the higher chance of winning in the upcoming war”

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