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# Development of the digital oil and gas complex in Arctic areas of Russia

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**Abstract.** This article examines the issues of digital modernization of the oil and gas complex of Russia, the evolution of digital oil and gas technologies. The main results of research work in the field of creating digital technologies for preventing complications and accidents, transferring drilling data in blockchain format, monitoring the state of pipelines using magnetic tomography are briefly outlined. The digital modernization strategy is aimed at large-scale digitalization of oil and gas production facilities and lays a reliable basis for the growth of capital productivity of fields in the long term. The approach is based on improving the quality of management, analyzing the effectiveness of control actions when using an integrated model or a digital twin of the field. The integrated application of digital technologies for effective management is the basis for cost optimization, ensuring the transition to robotic control, and increasing the capital productivity ratio of key gas assets. These solutions are especially effective in regions with difficult natural and climatic conditions or undeveloped infrastructure, Arctic fields. The proposed integrated approach makes it possible to extend the periods of profitable exploitation of gas fields at the stage of declining production and complicated production conditions. By the end of 2025, the number of digital fields using technologies for processing Big Geo Data will exceed 10% of the total number of oil and gas fields in Russia.

**Key words:** Digitalization, production, drilling, Arctic, well, field, machine learning

## 1. Introduction

The purpose of this article is to study the current state of digital modernization of the oil and gas complex in Russia and the evolution of digital oil and gas technologies. The humanization of the digital oil and gas business is the implementation of the principle of the worldview, which is based on respect for people engaged in digital oil and gas production, concern for their labor protection and safety, and the belief in their great opportunities for self-improvement and the acquisition of digital skills and competencies. By digital technologies (also intelligent, integrated, smart), oil and gas specialists understand technologies and technical means based on the use of information and communication technologies and artificial intelligence methods: digital wells and fields; intellectualization of production processes, preparation and transport of products; robotic complexes for drilling and production; opticalization of the processes of collecting, transmitting and storing geoscale data; virtualization and addition of geofill reality; integration of the production chain into a single whole. The term digital technologies refer to oil and gas technologies and technical means that are created, modified and



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developed on the basis of digital oil and gas platforms (education; industrial Internet of Things – IIoT, Industry 4.0, Internet+; blockchain). Digital oil and gas technologies can be generated and implemented on the basis of information and communication, cybersecurity, fiber-optic and satellite systems (integrated operations centers, areal and borehole phased antennas); robotic complexes (drilling robotic complexes, drilling without drilling rigs, borehole tractors, reservoir nanoelectromechanical systems, nano - and bionodots; aerial drones and multicopters, underwater drones) [1-20].

From the first steps of its formation in the early 2000s, digital technologies were presented to oil and gas workers as an advanced frontier of Hi - Tech, which unpredictably combined the latest achievements in the field of artificial intelligence methods, information and communication systems for collecting, transmitting and processing large-scale data, nanobiotechnologies, high-performance computing complexes, augmented and virtual realities, etc. Oil and gas engineers sought to improve methods and methods of managing oil and gas production in real time due to rapid retraining for new digital competencies; mastering the capabilities of digital technologies; using methods of virtualization of production facilities based on the use of supercomputers and opticalization of systems for collecting, preparing and transmitting large amounts of data.

## **2. The digital modernization of oil and gas production**

The digital strategies for the development of Russian oil and gas companies, including in the Arctic, are discussed below. PJSC Gazprom has proposed the following projects for 2021-2026 years in the implementation of complex scientific and technical programs and projects of the full innovation cycle: "Development of intelligent systems for operational geological and technological monitoring, long-term planning and management of field development of Gazprom's producing enterprises (on the example of fields in Western Siberia)" and "Development and application of digital modeling technologies, creation of "digital twins" of productive reservoirs, wells, gas collection networks, gas treatment and transportation facilities". The implementation of two comprehensive scientific and technical projects of a full innovation cycle will increase annual gas production by 25 billion cubic meters of gas in 2026 and the reserves of easily extracted dry gas will increase by 5% or by 100 billion m<sup>3</sup>.

PJSC Gazprom Neft's digital development strategy was adopted on 16.09.2019 and is calculated until 2030. The main goal is the transition to new management systems, and a significant increase in the efficiency and operational safety of assets. The main digital innovations are:

- Digital oil,
- Cognitive geologist,
- Mobile driller,
- Oil control,
- distributed platform in supply,
- immersion test and
- AR glasses.

Expected effects from the implementation of the strategy: halving the time for obtaining the first oil from the fields, accelerating the implementation of large oil and gas production projects by 40%; optimizing production management costs by 10%.

In December 2017, the Board of Directors of PJSC Rosneft approved the Rosneft-2022 Strategy, focused on qualitative changes in the company's business through the introduction of advanced management approaches, new technologies and increasing the profitability of existing assets. The development of technological potential is one of the most important elements of the Rosneft – 2022 strategy. As part of the Comprehensive Plan for Accelerated Digitalization, the composition of separate programs for business blocks was approved. The implementation of these programs is carried out in close coordination with the programs for the development of basic and industrial automation. In PJSC Rosneft, the operating fund of oil wells is 60 thousand, of which 10% are high-tech, horizontal and 5% are low-productive.

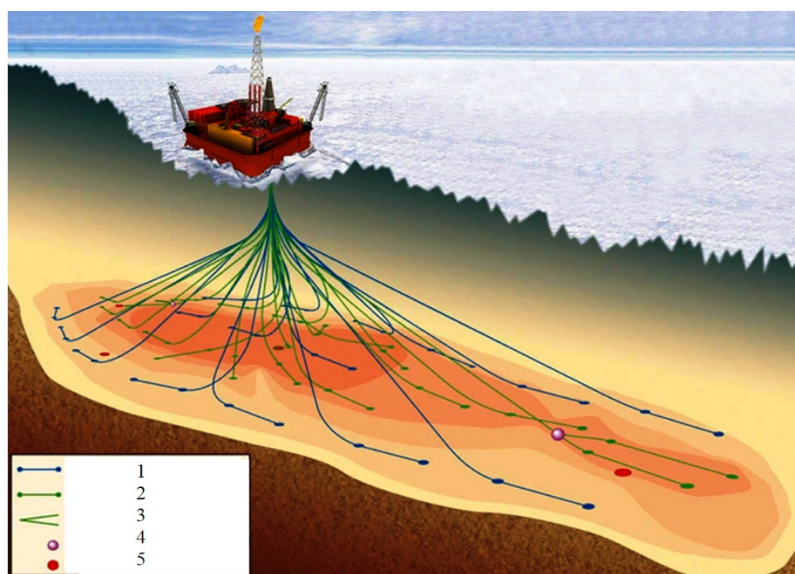
The development strategy of Rosneft-2022 is aimed at strengthening its leadership position in the global oil market by increasing efficiency in managing costs, investments and capital through the digitalization of the company. The main objectives of the company in terms of digitalization of production: increasing the competitiveness of the oil and gas business; development of digital technological competencies, an increase in oil production by 30 million tons; an increase in the capitalization of Rosneft relative to the current market value by 25-30%; 100% coverage of the main production processes with digital technologies. The company's digital modernization program includes the creation and scaling of the best solutions in terms of

- digital oil and gas field,
- digital refinery,
- digital filling station and
- digital spare parts supply chain".

On May 21, 2019, Rosneft announced the start of pilot operation of the Digital Field information system. It was implemented on the basis of the Ilishevsky field in Bashneft (a subsidiary of PJSC Rosneft). PJSC Rosneft notes that this project covers all the main processes of digitalization of oil production and logistics for the first time in the industry. The creation of our own digital platforms for the reorganization of production processes using digital counterparts of fixed assets is based on the predictive analysis of large geodata (in production-at 57 thousand wells, it is planned to control from 20 to 100 thousand parameters and the volume of Big Data will reach 60 TB per year; in oil refining-at 12 refineries, it is also planned to control from 20 to 100 thousand parameters with the volume of big data up to 60 TB per year; in the petrochemical industry, it is planned to control from 13 to 30 thousand parameters with a volume of big data up to 20 TB of data per year at 10 plants). It is planned to complete the complete replacement of foreign software related to the exploration and production of hydrocarbons with its own developments by 2025. To implement the strategic objectives of digitalization, Rosneft has created a Digital Transformation Center and a digital cluster of Sibintek, which are key mechanisms for implementing digital programs. Implementation of the digital development strategy "Rosneft-2022" will allow increasing the share of highly productive horizontal and multilateral wells in the existing oil well stock up to 40% (or up to 24 thousand wells); production from wells with horizontal termination to 30% of total oil production; industrial drilling speed by 12-15% and reduce the average cost of well construction by 6-8%.

### **3. The Prirazlomnoye offshore oil field.**

The Prirazlomnoye oil field is the only field on the Arctic shelf of Russia where oil production is carried out. On March 15, 1993, JSC "Rosshelf" received a license for the search, evaluation and production of oil at the Prirazlomnoye field. To participate in the development of the Prirazlomnoye field in 1994, the Institute of Oil and Gas Problems of the Russian Academy of Sciences, foreign partners - the Australian company "VNR Petroleum" and the German company "Wintershall" were involved. From 1993 to 2015, IPNG RAS prepared and participated in five technological schemes for the development of the Prirazlomnoye field. In December 2013 The Prirazlomnoye field was put into development. The following innovative solutions were used to develop the Prirazlomnoye field in ice conditions on the Arctic shelf: a method of maintaining reservoir pressure based on horizontal injection wells from the beginning of development and horizontal production wells, including one bionic or two lateral ones (see Figure 1) [17, 19].



**Figure 1.** The system of well placement at the Pirazlomnoye oil field. Source: Gazpromdobycha Shelf LLC.

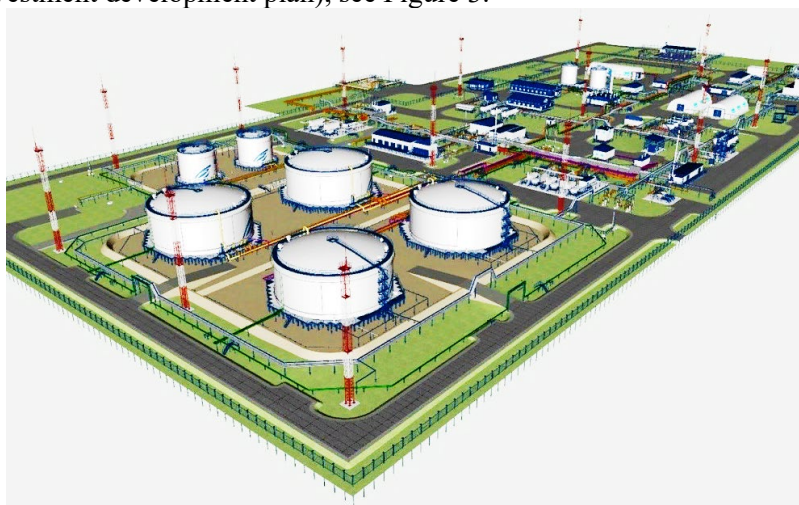
Opening the annual Russian Oil and Gas IT Summit "Intellectual Field", organized by ENSO, on March 29, 2018 in Moscow, we noted that 2018 can be considered the year of the beginning of the quantization of the oil and gas business. At the III International Conference "Arctic: Offshore Projects and Sustainable Development of Regions" ("Arctic-2018") held on February 20-21, 2018 in Moscow at the Chamber of Commerce and Industry of the Russian Federation Kondrashov Z. K. (Research Institute "Scale") presented an industrial technology of a secure fiber-optic communication system with a remote Arctic mining platform, based on quantum cryptography technology ([2, 9,11, 13, 15 and 16]), which uses the existing telecommunications infrastructure (see Figure 2).



**Figure 2.** A secure fiber-optic communication system based on quantum cryptography technology with a remote marine platform . Source: Research Institute "Scale".

Scientific and technological progress is marked by the emergence of vectors of digitalization of oil and gas facilities: wells, fields, surface structures (for example, 4D, 5D and 6D models of structures of the Novoport enclosure). The Novoport field is a large oil and gas condensate field on the Yamal Peninsula. The development of the field is carried out by a subsidiary of PJSC Gazpromneft – LLC Gazpromneft-Yamal. The deposit is located 30 km from the coast of the Gulf of Ob. Recoverable

reserves of oil and condensate of categories C1 and C2 amount to more than 250 million tons, as well as more than 320 billion cubic meters of gas. In 2017, the Novoport field produced 5.5 million tons of oil. The initial stage in building a digital model, as a rule, is laser scanning of complex production systems. The use of digital technologies allows monitoring the quality of the contractor's work and promptly tracking deviations from the construction work schedule. The real-time management system for construction and installation works of oil and gas facilities includes virtual modeling of the construction process; analysis of the sequence of work on the project; monitoring of the real progress of work; identification of spatio-temporal collisions and monitoring of the performance of weekly and daily tasks of the customer. Digitalization of construction and installation works at oil and gas facilities includes the construction of a 4D model (integration of the information model with the SMR schedule); 5D models (integration of the model with procurement and supply plans) and 6D models (integration of the model with the investment development plan), see Figure 3.



**Figure 3.** Digital model of the central oil collection point. Source: Gazpromneft-Yamal LLC.

PJSC Lukoil adopted a digital development strategy in 2018, and it is designed until 2027. The main goal of the strategy is to increase the efficiency of the company through the digitalization of business processes. During the implementation of the program, it is planned to introduce the following innovations and technologies:

- Digital operator,
- Sphere 3D,
- Digital oil and gas field and
- Digital Oil Refinery.

As expected, during the implementation of the digital strategy, the following results will be obtained: The following innovations and technologies will be introduced: Digital operator, 3D sphere, Digital oil and gas field and Digital oil refinery", which will rise production by 2-3%; reduce costs and losses by 5-10%, repair costs by 15-20% and increase labor productivity. Digital technologies developed at PJSC Lukoil include:

- in the Center of integrated operations-digital personnel and digital workspace; robotization of routine operations; predictive maintenance of equipment; management of large geodata; predictive analytics; mobile services; ensuring cybersecurity and the functioning of a single digital platform;
- in the field of exploration and production is a smart field to implement digital production optimization; digital twins' fields; digital architecture; digital information management and field development; intelligent digital drilling and industrial safety;
- in the field of processing and marketing of commercial products: end-to-end digital management of production processes; application of methods of machine learning; intelligent



monitoring system; digital marketing customer management and integrated asset management system.

Table 1 shows the main objectives of the digital modernization programs of PJSC Gazpromneft and PJSC Lukoil.

**Table 1.** The main objectives of the digital modernization programs of PJSC Gazpromneft and PJSC Lukoil

Company	Strategy	Goals	Trends	Digital products	Efficiency
Gazpromneft	2018 - 2030	Digital technologies	AI, VR, AR Petrobotics	Digital oil cognitive geologist	Acceleration of field commissioning up to 40%
Lukoil	2018 - 2027	Digitalization of business processes	Neural networks	Digital field digital operator	Increasing production up to 3%

#### 4. Conclusions

In 2022, innovative technologies will continue to be successfully used in digital oil and gas production. The new waves of technological evolution are becoming more numerous and diverse than ever. Among the innovative technologies, we can highlight the quantization of the collection and transmission of BigGeoData via secure fiber-optic channels, the digital oil and gas university [13, 15, 16], artificial intelligence methods [15], petrorobotics [2, 9, 13], predictive analytics [9, 13], the oil and gas wireless and satellite Internet of things. These new technologies have been experimentally tested and are mature enough to provide opportunities for improving the efficiency of the digital oil and gas business.

The functioning of digital oil and gas production throughout its life cycle as a complex cyber-technical system forms a fundamentally new paradigm of oil and gas business [2], namely, accelerated capitalization and effective economic development of oil and gas companies; high-quality satisfaction of demand for oil, gas and petroleum products without intermediaries in real time.

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