Controlling of the digital transformation oil and gas industry

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Abstract. The global challenges of the Russian oil and gas complex intensify the search for effective development directions both in the near and long term. One of these ways is digitalization. The development and implementation of digital technologies in technological processes and business processes helps to increase the competitiveness of oil and gas enterprises in the domestic and global energy markets. To increase the synergy effect and the rate of implementation of digital technologies, it is necessary to conduct development within a single concept and with optimal management of development and implementation processes within the entire oil and gas industry, and not locally for individual companies. The paper shows the features of digitalization of the oil and gas industry in Russia, analyzes the conditions for effective digital transformation, formulates the prospects for digital development of the oil and gas complex, taking into account breakthrough technologies, and develops a block diagram of a management system for the development and implementation of digital technologies.

1 Features of digitalization of the oil and gas industry.

The main global challenges for the development of the Russian oil and gas complex are:
• sanctions restrictions;
• liquefied natural gas production and transportation system;
• environmental requirements;
• decarbonization of the economy;
• conditions of the Paris climate agreement, etc..

The oil and gas complex (OGC) is one of the most technologically advanced in the industrial market. Since the 2000s, the largest global and Russian oil and gas corporations have been developing and implementing digital technologies in technological processes and business processes, which helps to increase their competitiveness in the global energy market.

A priority direction for the development of the oil and gas industry in Russia in the face of sanctions restrictions, growing competition and market volatility has become the development and implementation of advanced digital technologies and data-based management.

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The development and implementation of digital technologies is an important part of the 4th industrial revolution, the main trends of which include: robotization of production; cognitive technologies; digital twins; virtual and augmented reality; big data; artificial intelligence; unmanned aerial vehicles; 3D printing and the Internet of things. The use of these technologies in the company's processes from exploration and production to the marketing of finished products significantly increases their efficiency.

Digitization in a broad sense is the innovative development of technology and technology with the optimization of technological and business processes, as well as management decisions based on breakthrough digital technologies.

Digital transformation in the oil and gas industry is understood as a continuous process of improving and optimizing the business models of enterprises for the effective management of cyber-physical systems and information resources.

Cyber-physical systems are digital counterparts of physical assets: factories, wells, fields, etc.

The relevance of the digital transformation of the oil and gas industry is due to the depletion of some of the largest fields, a decrease in the resource base and increased competition in the global energy markets.

By 2035, according to experts, the implementation of the concept of digital transformation of the oil and gas industry can give an effect of 200-280 billion rubles. per year, and the total - more than 700 billion rubles. per year with a reduction in the commissioning of facilities by 40% [1-3].

The development of oil and gas markets is significantly influenced by key scientific and technical areas (end-to-end technologies), a list of which is given in the program "Digital Economy of the Russian Federation": components of robotics and sensors; neurotechnologies and artificial intelligence; virtual and augmented reality technologies; big data; new production technologies; industrial internet; wireless communication technologies; distributed ledger systems; quantum technologies.

End-to-end technologies can simultaneously cover several industries.

In the oil and gas industry, the following are widely used: big data; industrial internet of things; robots; digital twins; smart materials (including nano-coatings and smart liquids); 3D printing; distributed registry (blockchain) and artificial intelligence.

Given the active introduction of end-to-end digital technologies in the oil and gas industry, the digital oil and gas complex should include the following basic elements: digital geological exploration in real time, digital field, digital pipeline, digital oil refinery (refinery) and an integrated management system with digital economy and logistics (Fig. 1).

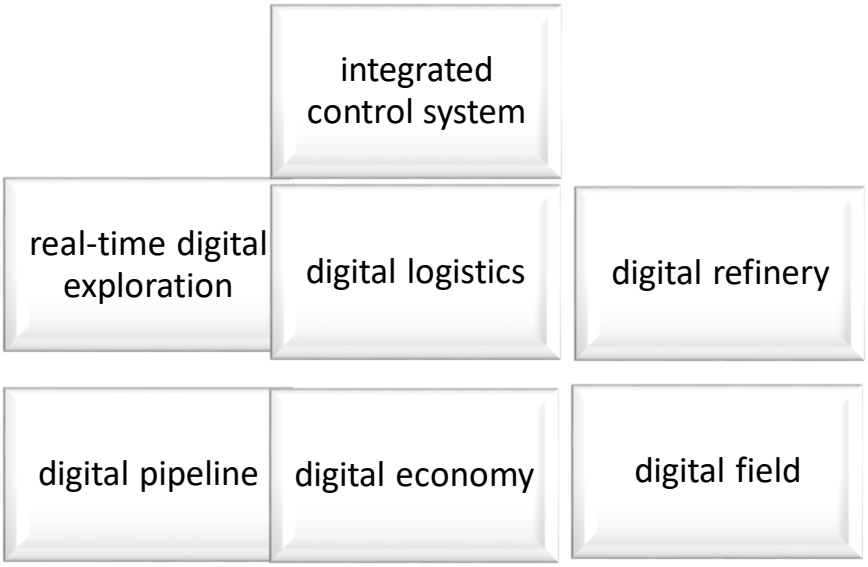

Fig. 1. Digital oil and gas complex

To promote priority digital transformation projects in the oil and gas industry, the Ministry of Energy has formed a working group "Digital Transformation of the Oil and Gas Industry".

The priority tasks are: import substitution, legal regulation, infrastructure and public administration, staffing, for the effective solution of which key areas for the implementation of digital transformation were formulated: global energy markets; public administration and import substitution.

2 Conditions for effective digital transformation

The digitalization of production processes increases the power output of equipment and wells, streamlines maintenance and scheduled repairs, optimizes trading operations, increases oil production, reduces the cost of extracted resources and increases the economic efficiency of business segments.

Promising innovative technologies used in the oil and gas industry are shown in fig.2.

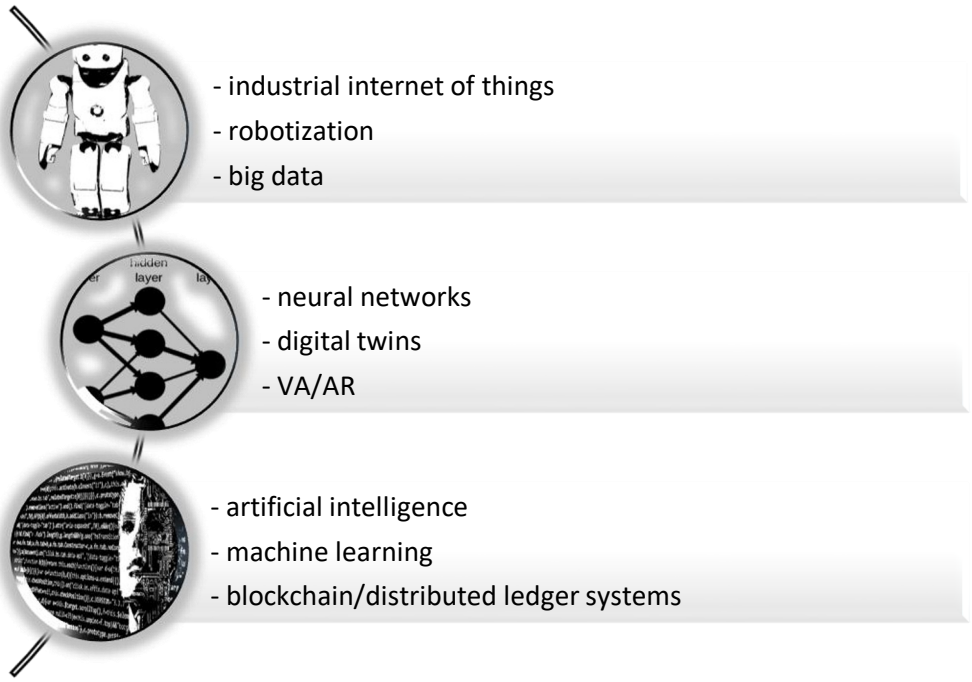

Fig. 2. Innovative technologies in the oil and gas industry

Today, the need is growing not just for innovative technologies, but for "smart" technologies, the effectiveness of which is shown in Fig. 3 [3-5].

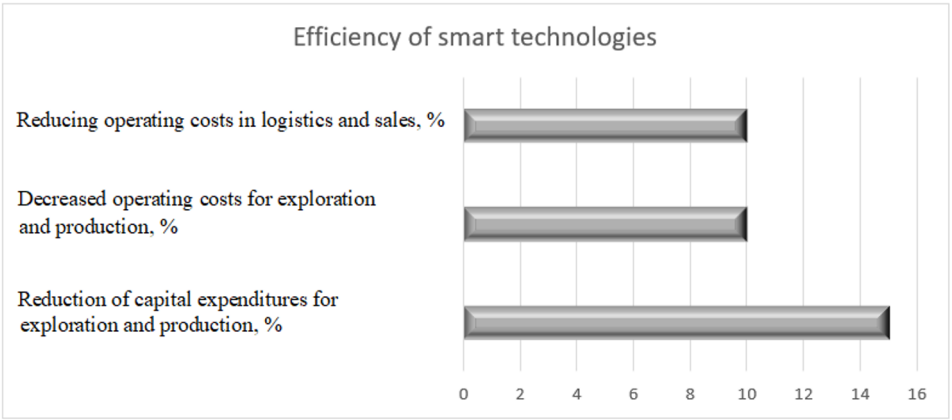

Fig. 3. Efficiency of smart technologies

At the same time, global oil recovery can increase from 30 to 50%.

Under the "intelligent" technology in the technological processes of the oil and gas industry, it is customary to understand an automatic control system with continuous optimization of the integral model of the object and the process control model.

Promising "intelligent" oil and gas technologies are: unmanned platforms, robotics for drilling, wireless systems, etc.

The main factors of saving "intelligent" technologies are shown in Fig. 4 [6-8].

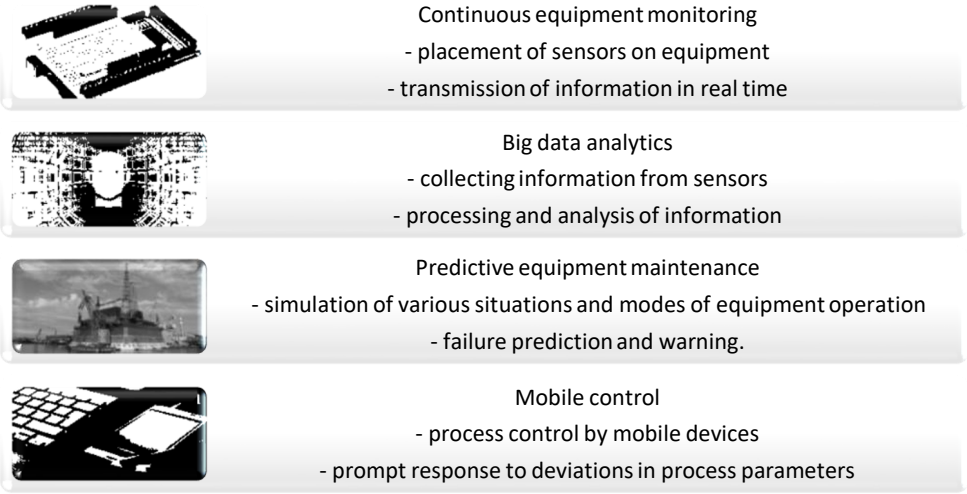

Fig. 4. Factors of saving "intelligent" technologies

The conditions for effective digital transformation of oil and gas enterprises are:
1. Digital process platforms.
2. Digital control systems.
3. Competent staff.
4. Innovative incubators.
5. Regulatory rationale.

3 Directions for the implementation of digital transformation

The world leaders in digital transformation in the oil and gas industry are Shell, BP, Chevron, where the effect of digital transformation reaches 20% of operating profit, which is higher than Russian companies (up to 5%) due to an earlier start in this direction and more investment. For example, at Aker BP, digital technologies were envisaged from the very beginning when forming a business as an integral part of core business [9-11].

World leaders are actively working with digital technologies, including:
• subsoil users: BP, Chevron, ExxonMobil, Equinor, Repsol, Shell, Sinopec, Saudi Aramco, Eni, ADNOC, and TotalEnergies;
• oilfield service providers: Baker Hughes, Weatherford, Schlumberger, Halliburton;
• digital solution developers: Facebook, Fieldbit, Magic Leap, Microsoft, Unity, FutureOn, Google, Amazon, 3gig, Blue River Analytics, ChaiOne and HUVR.

The main areas of cooperation between oil and gas subsoil users and IT companies and projects for the use of digital technologies are presented in Table 1.

Table 1. Digital technology projects of oil and gas companies

Subsoil users	**Cooperation**	**Projects**
Total	IBM	predictive analytics to improve drilling accuracy
	Amazon	using cloud services to accelerate

		digital transformation
	Microsoft	using Azure to accelerate digital transformation
Chevron	Microsoft	using Azure to receive large volumes of data in real time and process it
BP	Microsoft	digital twins of production facilities for production optimization based on the APEX modeling system
Repsol	IBM, Accenture, Turing, Google, Salesforce, Microsoft,	digitalization of processes based on the ARiA platform developed within the company; Big Data, IoT, data visualization and artificial intelligence
Equinor	Microsoft	Echo digital twin for operations in the North Sea
Eni	Microsoft	digital solutions based on artificial intelligence and VR for simulation of operations, decision support and automation of drilling operations

Source: Compiled by the author based on [1]

In the plans of oil and gas companies until 2025, it remains relevant to increase the cost of digital transformation by more than 7% and the cost of automation - up to $25 billion.

At the same time, it should be noted that the main directions of digital transformation in the global oil and gas industry market coincide, and Russian companies - market leaders are already at a level above the industry average in terms of digital development.

Leading companies in the oil and gas industry use digital products from a standard set, but developing or adapting to their production: Digital Twins, Digital Field, Digital Supply Chain, Digital Filling Station, Digital Worker , Digital Trading, Digital Staff, Digital Factory, Robotization and Digital Ecosystem.

Gazprom Neft PJSC implements the Digital Transformation Strategy in 12 priority programs aimed at meeting the business objectives of Strategy 2030.

Taking into account the unified structure, the programs are combined into groups:

- production optimization programs along the value chain;
- production programs for functional improvement;
- programs of corporate functions;
- programs for improving occupational safety;
- programs that support elements of digital transformation.

Optimization of production processes is implemented along the entire chain from geological exploration to the sale of petroleum products. For example, when conducting exploration work through the use of innovative technologies based on computer-aided design, big data, multidimensional modeling, the introduction of virtual reality and video analytics.

For the integrated management of the efficiency of the enterprise, a production control center (MCC) was created, where digital twins successfully operate, maintaining optimal operating modes of the entire complex. The company launched the world's first digital Arctic logistics management system.

But digital transformation at Gazprom Neft PJSC is focused not only on production, but covers almost all departments, including the optimization of the work of the financial and economic service, and personnel management systems with a digital twin of an employee.

The digital transformation of the Tatneft Group is being implemented in 9 business areas and includes 70 programs and about 250 IT solutions integrated into a single digital platform.

For example, at the Romashkinskoye field, production costs decreased by 30% with the introduction of a new digital model.

The use of digital twins in drilling made it possible to increase production and increase the flow rate of unprofitable wells by several times.

In the context of the global trend towards complete carbon neutrality and decarbonization by 2050, in order to increase long-term sustainability in the industry segment, one of the company's steps was the decision to develop the petrochemical business.

Thus, a dynamic production model has already been created at the Taneco refinery to improve the efficiency and development of the enterprise.

The implementation of digital transformation at Lukoil is proceeding in the following promising areas:

• robotization;
• digital twins;
• optimization of personnel work;
• ecosystem.

Robots make it possible to increase labor productivity, increase staff creativity and optimize the number of employees through cognitive technologies and automation of routine processes.

The introduction of digital twins optimizes costs and improves the quality of managerial decision-making by increasing the efficiency of production and production.

Optimization of personnel work is achieved by combining equipment data, work processes and personnel conditions.

Augmented and virtual reality reduce the cost of training and advanced training of company specialists.

The digital ecosystem of suppliers and contractors, partners, representatives of state-owned companies, customers and transport companies reduces the time required for the execution of processes and reduces transaction costs.

Digital Transformation of Rosneft" are implemented in the following areas of digitalization: refineries, fields, supply chains, filling stations, personnel and trading. When introducing digital technologies, Rosneft optimizes the technological processes of exploration and production using geomechanical and physicochemical modeling technologies.

Smart wells and fields are being actively implemented by almost all major oil and gas companies.

A smart field is an integrated set of hardware and software that improves the energy efficiency of equipment and technological processes and allows you to manage an oil reservoir in order to increase hydrocarbon production, reduce energy costs, reduce the number of equipment failures and operating costs, as well as reduce emissions of carbon dioxide into the atmosphere.

Smart (intelligent) wells and fields combine the use of digital twins, big data, the Internet of things, intelligent technologies and optimize production by adjusting operating modes based on real information about the situation at the bottomhole.

It should be noted that the set of implemented elements of intelligent and digital technologies is optimized according to the parameters of the field being developed, which leads to a reduction in the cost of operating the field by up to 20%. The advantages of smart deposits (in %) are shown in Figure 5. [12-15]

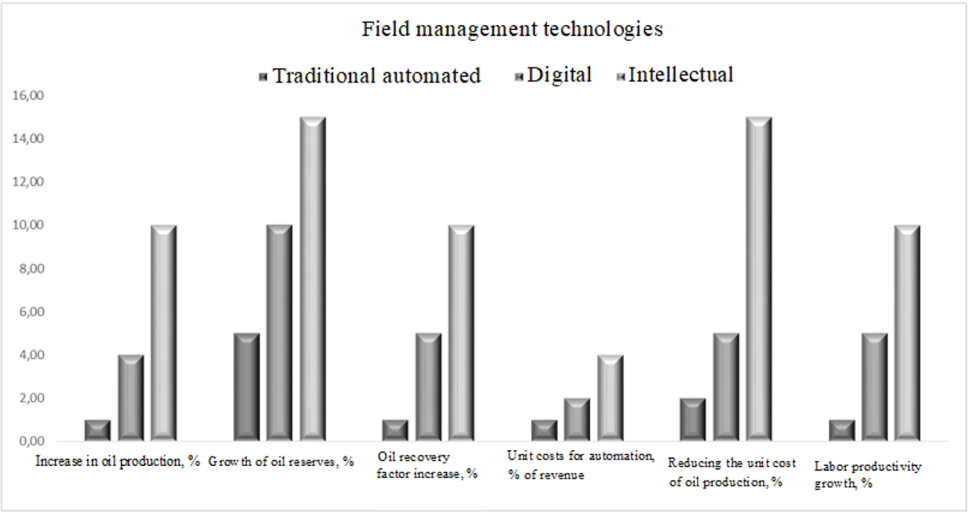

Fig. 5. Benefits of smart deposits

The digital transformation of Russian oil and gas companies can reduce costs by 20% and increase labor productivity by 10% [16-18].

4 Prospects for the digital development of the oil and gas complex.

Digitalization of the oil and gas industry in the short and medium term will increase the efficient production of light, low-viscosity oil and extend the life of large fields, as well as intensify the development of hard-to-recover reserves and unconventional oil and gas resources [19-21]

In the medium and long term, it becomes significant to develop hard-to-recover reserves based on the systemic digitalization of enterprise processes and the managed transformation of the oil and gas industry to maintain a leading position in the energy markets and stable development of the country's oil and gas complex.

In the digitalization of the oil and gas complex, in order to obtain breakthrough results, a national multi-industry production and research platform is needed with the integration of unique scientific knowledge, the necessary practical geological experience and data, as well as modern laboratory facilities and equipment. At the same time, it should be noted that the priority element in this system is the personnel, their social conditions and motivation [22-24]

The digital development trend of the oil and gas industry is shown in Figure 6.

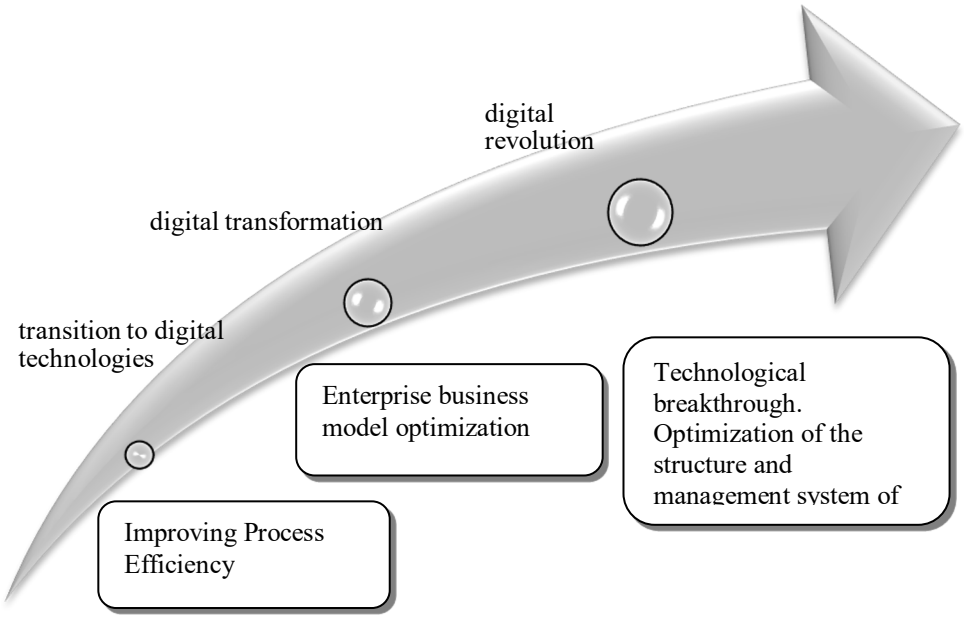

Fig. 6. Trend of digital development of the oil and gas industry

Optimization of the structure and management system of the industry involves the creation of an effective end-to-end management of the industry based on intelligent technologies [25-27].

In the coming decades, digital technologies will make energy systems multiplicative, intelligent, efficient, reliable, sustainable and environmentally friendly.

It is breakthrough production technologies based on new physical principles that will determine the further development of the oil and gas complex and be a catalyst for the "digital" revolution [28-30].

This means that there will be breakthrough technologies based on new physical principles that will easily cope with the collection, storage and processing of a huge amount of data, which is still problematic today. Based on this, the basic approach to managing oil and gas industry facilities as data management will move to a new level of intelligent integrated management of large systems with minimization of the human factor [31-33].

5 Management of digital development of the oil and gas complex

As part of the "Digital Economy of the Russian Federation", with a implementation period of up to 2025, measures have been taken to motivate and stimulate the digital development of the country in five areas: regulation, personnel, research, infrastructure and security, but they do not take into account the industry specifics of the oil and gas complex [34-36]. For the optimal and adapted transformation of the oil and gas industry, the authors proposed a scheme for the effective management of the digital development of the oil and gas complex (Fig. 7.).

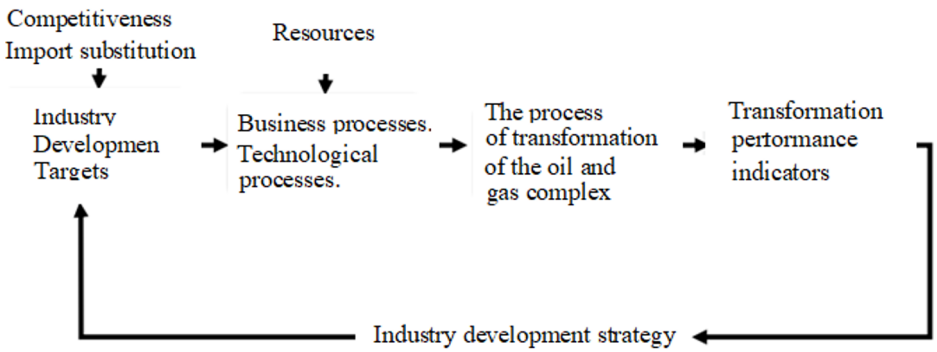

Fig. 7. Scheme for managing the digital development of the oil and gas complex

6 Conclusion

Taking into account the global challenges of Russia, the main conditions for the effective development of the oil and gas industry are the widespread digitalization of processes and the digital transformation of business structures of enterprises in the short and medium term. Rapid progress in this direction is due to the depletion of some of the largest deposits, a decrease in the resource base and increased competition in the energy markets, as well as an understandable and rapid effect of new technologies [37-39].

Already by 2035, the effect of the implementation of the digital transformation program for the oil and gas complex may amount to 200–280 billion rubles. per year, and the total - more than 700 billion rubles. in year [40-41].

In the long term, for the stable development of the country's oil and gas complex, as well as maintaining a leading position in the world energy markets, it becomes significant to develop hard-to-recover reserves based on the systemic digitalization of enterprise processes and the controlled transformation of the oil and gas industry.

And it is breakthrough production technologies based on new physical principles that will determine the further development of the oil and gas complex and be a catalyst for the “digital” revolution.

For the optimal transformation of the oil and gas industry based on the active introduction of digital technologies, the authors proposed a scheme for the effective management of the digital development of the oil and gas complex.

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