Oil and gas engineering in the activities of PJSC LUKOIL

Elena Sentishcheva*, *Marina* Parchomchuk, *Violetta* Kuzmina, and *Angelina* Zelenina
Southwest State University., 94, 50 Let Oktyabrya Street, Kursk, 305040, Russia

Abstract. This article describes the concept of oil and gas engineering as one of the fundamental in the modern economy, which combines scientific and production aspects. The authors analyze the development of the oil and gas sector of the economy in terms of engineering operations, considered on the activities of one of the largest Russian oil companies, the second largest oil production in Russia - PJSC LUKOIL. The following methods are used: critical analysis of literature, classification, synthesis, grouping, comparison and generalization of corporate documents of industry companies, information and analytical materials of international and Russian statistical services, relevant ministries and organizations, scientific publications on the topic of research. Based on the results obtained, the following conclusions can be drawn: currently, engineering activities in the oil and gas sector play an important role, allowing to solve the problem of providing oil and gas enterprises with critical components, as well as to realize the scientific and technical potential of Russian organizations. Despite the limited capabilities, oil and gas companies resort to technological and research and development, which leads to increased productivity without the introduction of new and improved equipment.

1 Introduction

Oil and gas engineering is a field of activity within which all kinds of issues arising at all stages of the development of hydrocarbon deposits, including drilling wells, with their subsequent processing, take place. Engineering as a service line has begun to penetrate into many areas of human activity, not only in regional markets, but also in international ones. Hydrocarbon production has also become more complicated in comparison with the second half of the twentieth century due to their difficulty and exhaustion (with the exception of production in the Persian Gulf countries). And naturally, oil and gas engineering appears in the service market with the growth of scientific and technological progress. Scientific research in the domestic literature can be divided into several groups: oilfield services market research [1], geophysical services market research [2], the use of intelligent technologies in the oil and gas sector at the field development stage [3, 4], the impact of scientific research on the efficiency of oil and gas companies [5]. However, a unified approach to the study of oil and gas engineering has not been formed in the Russian literature.

* Corresponding author: elenasentischeva@yandex.ru

Nowadays oil and gas complexes use the so-called reverse engineering as the fastest way to ensure the replacement of imported equipment, which is especially important in the context of sanctions pressure on the oil and gas industry in 2022 and 2023. Russian enterprises realize that the stability of hydrocarbon production processes today depends precisely on reverse engineering. Centers for this type of engineering have already been established on the basis of leading enterprises and service companies that serve them: Gazprom Neft, LUKOIL, Tatneft, Baker Hughes, Schlumberger, Tagras Holding.

The Center of Competence for Import Substitution in the Fuel and Energy Sector of the Agency for Technological Development was established in Russia, this center supports projects for reverse engineering, and by the moment 14 projects have been supported with almost 900 million rubles, and 11 new projects are planned to be supported. These projects relate to the import substitution of equipment for geological exploration, drilling and exploration of wells, components for gas-piston power plants used in hydrocarbon production sites. Before the sanctions were imposed, Russian companies used at least 80% of Western equipment for exploration and production of hydrocarbons. At the moment, direct import is impossible, and parallel import is too long and uncertain, and enterprises cannot afford the risk of remaining without equipment and components [6]. However, nowadays oil and gas companies have also focused their efforts strictly on direct engineering aimed at improving the quality and quantity of extracted raw materials using the achievements of scientific and technological progress.

2 Materials and methods

The methodological tools of the research include scientific methods of critical analysis of literature, classification, synthesis, grouping, comparison and generalization of corporate documents of industry companies, information and analytical materials of international and Russian statistical services, relevant ministries and organizations, scientific publications on the research topic.

3 Results and discussion

The oil and gas complex is one of the key sectors of the economy of the Russian Federation, as due to its resource-oriented orientation, it creates the basis for its functioning and forms prospects for further development. According to the results of 2022, the oil and gas sector accounts for up to 18.1% of the GDP of the Russian Federation, 41.7% of federal budget revenues, as well as 42% of exports, and therefore it can rightfully be considered the main source of growth of the national economy. The importance of the Russian oil and gas complex remains high both at the global and national levels, as it meets the needs for energy resources in foreign and domestic markets and forms the basis of the energy and technological sovereignty of the state.

In 2022 the recovery of the Russian oilfield services market was interrupted by anti-Russian sanctions pressure from the European Union and the United States, which led to a decrease in the market volume to $ 20 billion (-17%). The immediate reason for such a significant decline is, according to experts, the concentration of high-tech services from foreign partners and the high dependence of Russian companies on imported equipment [7]. In Russia the suspension of the activities of the Big Four oilfield services companies (Halliburton, Schlumberger, Baker Hughes and Weatherford) has created risks of non-fulfillment of the required number of well operations, which could potentially lead to a drop in production.

The analysis of the Russian oil and gas service market revealed the vulnerability of Russian contractors in providing a range of services related to hydraulic fracturing (FRACKING) technologies (the share of Western companies is 52%), measurements and research during drilling (LWD/MWD) (56% of imports), and offshore field development technologies remain the most dependent, in particular, floating drilling rigs (90%), offshore mining equipment (80%), offshore seismic exploration (70%) and support vessels (80%) [8].

PJSC LUKOIL is one of the few Russian companies in this industry that actively implements modern technologies using engineering in this industry in order to maximize the extraction of hydrocarbons. This is done from the point of view of the need and development of technical and technological processes in production, as well as the optimization of the work of the company's employees. And as a result of the introduction of achievements in oil and gas engineering, this is both an increase in the operational efficiency of the enterprise, and a reduction in costs in the process of geological development of deposits and extraction of hydrocarbons, as well as the creation of new products in the market of this industry.

PJSC LUKOIL produces hydrocarbons in 8 countries of the world, in Russia - on the territory of the Yamalo-Nenets Autonomous Okrug (NAO), the Komi Republic and the Kaliningrad Region, the Perm Territory and the Republic of Tatarstan, Khanty-Mansiysk Autonomous Okrug – Yugra (KhMAO-Yugra), Volgograd, Astrakhan regions, the Republic of Kalmykia.

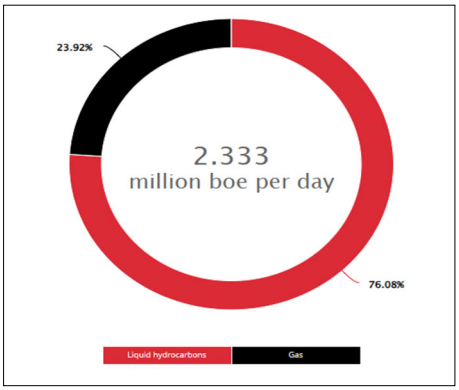

Fig. 1. Hydrocarbon production in 2022 [9].

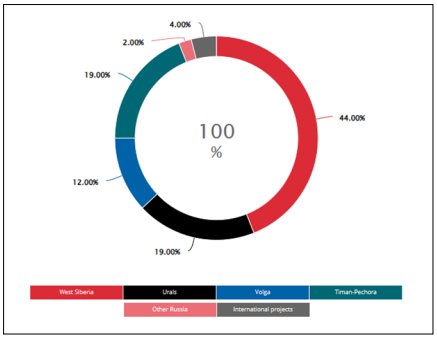

Fig. 2. Oil production structure in 2022 (excluding the West Qurna-2 project) [9].

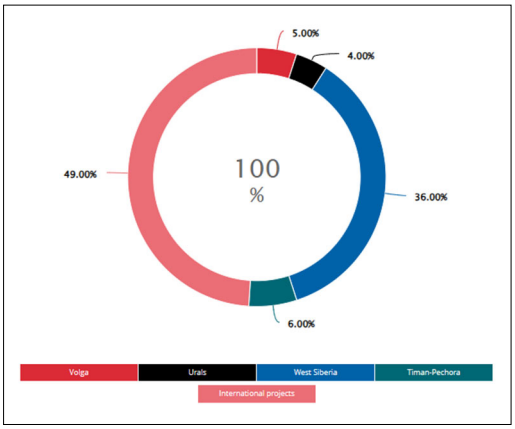

Fig. 3. Gas production structure in 2022 [9].

At the stage of geological exploration, the achievements of oil and gas engineering are successfully applied, which allows us to speak about the success of exploration drilling, which in this company is 76%, and throughout the Russian Federation - 84%. These data mean that PJSC LUKOIL is actually one of the leaders of Russian companies in this industry and a considerable merit in this is in attracting technological developments of oil and gas engineering.

One of the company's technological priorities is the development of high-viscosity oil production. Technological developments in this area are used in production in the Yareg and Usinsk fields. Unlike other fields, they use technologies of areal steam-thermal effects and steam-cyclic effects on the oil-bearing reservoir. This is an innovative patented development of PJSC LUKOIL. At the Yaregskoye field, the company's specialists use thermoshack technology, while at the Lyaelskoye field, they actively and successfully apply the technology of oncoming thermogravitation drainage of the formation. The Usinskoye field is actually a testing ground for the development of technologies for areal steam–thermal effects and steam-cyclic effects on the formation, since the deposits of this field are located at a depth of 1200 - 1600 m., and this deposit is confined to carbonate deposits of the middle and upper carboniferous and lower Permian types.

These examples indicate that LUKOIL Group will apply engineering developments such as physical, chemical, hydrodynamic and thermal methods of influencing oil-bearing or productive formations. It is important for the company to achieve high oil recovery of the reservoir, and therefore, first there is an analysis of prepared mini-projects in which, based on forecasting the structure of the reservoir, its structure, a decision is made on drilling, it is also possible to drill second shafts when this is justified by the presence of an inactive well fund.

Other engineering technologies are used on the territory of Western Siberia. This is a technology that reduces construction time by an average of 35%, costs by about 20%, and is called the construction of horizontal wells of a three–column structure compared to horizontal wells of a standard four-column structure.

There are a large number of nature protection zones in the Urals, so the company focuses on the use of environmentally friendly engineering technologies. At the stage of geological and seismic exploration, the work is carried out with the help of small-sized equipment, which reduces the amount of deforestation and contributes to the preservation of soil cover and groundwater.

The use of the above-mentioned technologies makes it possible to increase the production of hydrocarbons. The results of the production growth are presented in Table 1.

Table 1. LUKOIL performance indicators [9].

Indicators	2018	2019	2020	2021	2022
Processing of crude oil, million tons	67.316	68.746	58.608	62.959	70.056
Production of petroleum products, million tons	63.774	65.081	54.964	60.015	65.766
Light output, %	71	73	72	73	72
Processing depth, %	88	89	93	92	90
The Nelson Index	8.6	8.6	8.6	8.7	9.2

PJSC LUKOIL does not stop at the introduction of oil and gas engineering only at the stage of exploration and extraction of hydrocarbons, it also actively implements new technologies for the production of oil refineries (refineries). PJSC LUKOIL includes four refineries in Russia (in Perm, Volgograd, Nizhny Novgorod and Ukhta), two refineries in Europe (Romania and Bulgaria), and the company also owns a 45% stake in refineries in the Netherlands. The total capacity of the refinery is 66.2 million tons.

Since 2016 modernization has already begun at individual plants, during which 12 modern plants for recycling and refining of raw materials were put into operation (11 in Russia and one in Bulgaria). About $ 12 billion has been spent on this. Since 2017, the processes of spot modernization of the company's refineries have been underway so that this process does not affect the suspension of oil refining. The result of such systematic work has led to the completion of modernization by 2022, considering modern technologies of the raw material processing at the Nizhny Novgorod Refinery and the Volgograd Refinery. The modernization mainly concerned the technologies of delayed coking, hydrotreating of diesel fuel and gasoline, gas fractionation, production of hydrogen and sulfur.

4 Conclusion

The results of the study allowed us to formulate the following conclusions:

1. The relevance and availability of a high-tech sector in the oil and gas complex, which is based on engineering activities, is substantiated.
2. The features of the oil and gas complex are determined, which determine the specifics of engineering in terms of understanding its essence and highlighting the list of necessary components.
3. The built-up industrial support system will solve the problem of providing oil and gas enterprises with critical components, as well as realize the scientific and technical potential available to Russian organizations.
4. Currently, the possibilities of applying reverse engineering in Russia are limited. Representatives of the large oil business proposed to the government to revise the rules back in 2022, but the implementation of the measure was postponed in order

to better assess its consequences for industrial safety and avoid the risks of increased accidents.

5. Oil and gas companies do not wait for options for using reverse engineering, but resort to technological and research developments to increase the productivity of the enterprise on existing equipment.

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