Problems of development and economic evaluation of production of natural hydrocarbons on the offshore of the Arctic Seas

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Y Bogatkina[1], N Eremin[1,2], O Sardanashvili [1]

[1] Oil and Gas Research Institute of Russian Academy of Sciences, Moscow, Russia
[2] Gubkin Russian State University of Oil and Gas, Moscow, Russia

* Corresponding author: ubgt@mail.ru

Abstract. The purpose of this article is to substantiate taxation models that have contributed to an increase in the efficiency of offshore oil and gas fields that are at the stage of mature development in the harsh Arctic conditions. The development of Arctic fields under the current tax regime is on the verge of profitability. As an experiment, an economic assessment of the main economic indicators of the option for the development of the Prirazlomnoye field was carried out, taking into account various tax mechanisms used to assess the effectiveness of the development of offshore oil and gas fields. The calculation results showed that the application of the tax regime in force in Russia makes the development of the Prirazlomnoye field efficient, but with a relatively low profitability for the license holder. As an alternative, the tax mechanisms laid down in the production sharing agreements in China and Russia were used, which showed a high economic effect with a low level of risk. It can be concluded that the use of taxation models, which are similar in nature to a production sharing agreement, significantly increases the efficiency of the Prirazlomnoye field development, and can bring greater financial benefits to the license holder in comparison with the current tax regime in the Russian Federation.

1. Introduction

The purpose of this article is to substantiate taxation models that have contributed to an increase in the efficiency of offshore oil and gas fields that are at the stage of mature development in the harsh Arctic conditions. More than 20 large oil and gas basins have already been identified on the shelf of the Russian Federation, 32 fields have been discovered, including the super-gigantic gas fields Shtokman, Rusanov, Leningrad in the West Arctic and several large oil fields on the Sakhalin and in the Pechora Sea. The explored and confirmed balance reserves of the Prirazlomnoye field amount to more than 70 million tons of oil, the Shtokman field - about 32 trillion cubic meters. meters of gas and 30 million tons of gas condensate [1-6]. The development of offshore fields in the modern period will depend on the global economic situation in the volatile world hydrocarbon markets. At the same time, the forecast of the initial technical and economic indicators for the development of oil and gas reserves depends on the peculiarities of the geological structure of oil and gas fields, which determine the economic feasibility of its development. All this should be taken into account for the stages of prospecting, exploration and production of arctic oil and gas fields. It is necessary to speed up work on the creation of special technical means for the production of oil and gas and their transportation, as well as the use of reliable high-tech equipment and drilling robots. Offshore oil and gas production is a

technologically more complex production activity compared to onshore field development. The development of arctic fields is aggravated by the difficult geographic, natural and climatic conditions during their development. On September 8, 2021, Gazprom Neft PJSC completed the construction of a new production well at the Prirazlomnoye field in the Pechora Sea. The Directional drilling Complexity Index (DDI*) was 7.05 — this indicator is one of the highest in Russia and allows you to classify a new object as super-complex. The length of the well exceeded 6.6 km, which became a new record for the company's offshore fields.

On October 7, 2021, Gazprom Neft and Gazprom Drilling LLC signed a memorandum of cooperation on the creation of a Russian robotic drilling complex, which will significantly shorten the construction period of wells and increase the safety of drilling operations in the Arctic. Digitalization of drilling processes is the key to complex Arctic assets and increasing the profitability of oil and gas field development. The use of artificial intelligence systems reduces the time and increases the efficiency of the construction of complex high-tech wells. Robotization of descent operations during the construction of oil and gas wells will help to improve the quality of drilling and minimize the influence of the human factor. The prototype of the robotic drilling complex was created within the framework of the Energotechnohab Petersburg project with the participation of Gazprom Neft, Uralmash NGO Holding, Yandex.Cloud and Bitrobotics.

2. Problems of economic assessment of the development of offshore fields on the Arctic shelf

The assessment of the economic efficiency of the development of offshore hydrocarbon resources is based on dynamic modeling of cash flows, which involves forecasting revenue from the sale of natural hydrocarbons, capital and operating costs, including payments and taxes in cost and price. The standards for capital and operating costs are substantiated by the authors of the projects on the basis of design estimates and analysis of factual information, taking into account inflationary price indices developed and approved by the government of the Russian Federation. This approach is widely used in world practice for the economic assessment of the effectiveness of the development of natural hydrocarbon fields [7]. At the same time, the following indicators are the main criteria for assessing the effectiveness of offshore fields: the amount of net present value (NPV); criterion of internal rate of return (IRR), criterion - profitability index (ID) and criterion - payback period (Ppp).

One of the frequently discussed problems of the economic evaluation of projects for the development of oil and gas fields is the accounting of the tax component in the expenses of the organization. Obtaining an acceptable income for the state and oil and gas companies from the development of fields for the extraction of hydrocarbon raw materials sets itself the task of applying an optimal tax regime that takes into account the interests of both parties (state and license holder). The lack of proper systematic taxation of enterprises for the extraction of hydrocarbon raw materials creates difficulties in predicting the economic efficiency of projects for the development of oil and gas fields. The optimal level of taxes should ensure the solution of several problems. First, it is necessary to take into account the interests of the state as the owner of the subsoil. Second, to secure the interest of private companies. Third, to create conditions for the efficient operation of the subsoil use system in order to optimize the net discounted income of the enterprise.

When evaluating options for the design of offshore fields development, the influence of risk is taken into account, which makes it possible to clarify the efficiency and reliability of technical and economic solutions in the development of oil and gas facilities. These include:

- unreliability of the geological parameters of production,
- under-exploration of the field,
- the quality of well construction, high capital intensity,
- insufficient validity of forecasts of the dynamics of production and oil recovery and
- the difficulty of determining future costs and prices in the context of unpredictability of market competition.

It seems that the use of a model based on the theory of fuzzy sets will to some extent solve this problem, forming a complete set of scenarios for evaluating an investment project [8]. Based on a set of fuzzy numbers for analyzing the effectiveness of an investment project, a triangular membership function of a fuzzy number NPV is constructed and the mathematical expectation of this indicator is determined. The V&M risk indicator developed on the basis of fuzzy logic (Nedosekin model) can be used to plan future results on an investment project associated with uncertainty and to assess the risk of investments. The basis for calculating the sustainability of estimates is the variation of the following indicators: production of natural hydrocarbons, sales price, capital investments and operating costs. These indicators affect the value of the main criteria for the economic assessment of options for the development of offshore fields.

The increased volume of research and development work on the exploration and development of offshore fields predetermined the creation of a model of an information database of capital and operating costs, which is the basis for calculating development options with the possibility of an information model functioning using an automated system. The norms of capital and operating costs are substantiated by the authors of the projects on the basis of design estimates and analysis of factual information, taking into account inflationary price indices developed and approved by the Government of the Russian Federation. When attracting foreign partners for investment projects, standards are developed with their participation [1-5].

The structure of the information model is quite simple and meets the requirements of industry methodological developments. Capital investments in the drilling of production oil and gas wells, injection and other auxiliary wells are distributed between the fields in proportion to the actual drilling footage with the determination of the cost of the well [6]. The construction of the offshore platform is separately taken into account. Downhole equipment for offshore operation is allocated on a pro rata basis based on production methods. In this case, special equipment is used to prevent the release of oil or gas. The collection and transportation of oil and gas, oil and gas at sea involves the storage of oil on the platform, as well as a device for pumping oil onto a tanker. The cost of oil treatment facilities involves the use of small-sized plants. The cost of maintaining reservoir pressure is made up of the cost of pumping a working agent. Other assets include electricity and communications costs, automation and telemechanic, production service bases and overhaul management, and industrial water supply costs. Specific operating cost rates are formed in the same way as for onshore fields [9, 10].

3. Economic assessment of the development of the Prirazlomnoye field

As an experiment, an economic assessment of the main economic indicators of the Prirazlomnoye field development option was carried out, taking into account various tax mechanisms Figure 1.

The calculations were carried out from the beginning of 2014 according to actual technological indicators until 2020, and then according to forecast indicators until 2038 using economic models developed at the OGRI RAS. The calculation results are shown in Figure 1. Calculations show that the application of the current tax regime in Russia makes the development of the Prirazlomnoye field efficient, but with a relatively low return for the investor. As an alternative, PSAs of China and Russia were applied, which showed a high economic effect. China's PSA generates compensation and production profitability values using sliding scales based on production levels. The PSA of Russia was applied at the level of compensation production of 90% to cover costs and distribute profitable products between the state and the investor, respectively 40 and 60%. Also, with the help of an automated system, a multidimensional calculation was carried out for the PSA in Russia at various values of remuneration and profitable products. Let us give in more detail the economic assessment of the development of the Prirazlomnoye field under the PSA terms.

To determine the patterns of changes in the income of the state and the investor under the PSA terms, calculations were also carried out for various conditions of the distribution of compensation products used to cover costs and the distribution of profitable oil. At the same time, in accordance with the Law "On Subsoil", the range of changes in the marginal cost coverage from 90 to 50 percent and

the distribution of profitable products from 40 to 60 percent for the investor was studied. All calculations were carried out based on current costs and a stable oil price of $ 50 per barrel with the sale of products to the external market. According to the results of the assessment, it can be seen that the state, as the owner of resources and reserves, with the entire percentage of product sales going to cover the investor's costs and with a fixed distribution of profitable oil, always receives more than 50% of income without financial costs and project risks. It should be noted that the maximum amount of government revenue falls on the minimum compensation conditions for the investor, which indicates the conflicting interests of partners.

It is also known that in case of negative cash flows, design solutions should be excluded from consideration. It was also found that it is when 90 percent of the costs are covered that it is recommended to make decisions that will lead to the agreed and mutually beneficial interests of the state and the investor. The accepted percentage of production, directed to cover costs with the maximum value of the discounted cash flow in the first years, provides a more reliable financial independence of the investor when putting new fields into development. It follows from this that the above reasonable limit of compensatory production should not be a deterrent for the state when making a mutually agreed design decision, which is actually allowed only with the agreement of the state, which agrees to receive a slightly smaller share of the profit. from putting the field into operation, and not to lose it at all in case of refusal from the investment project. This approach can be proposed for negotiations between the state and the investor to make an optimal decision.

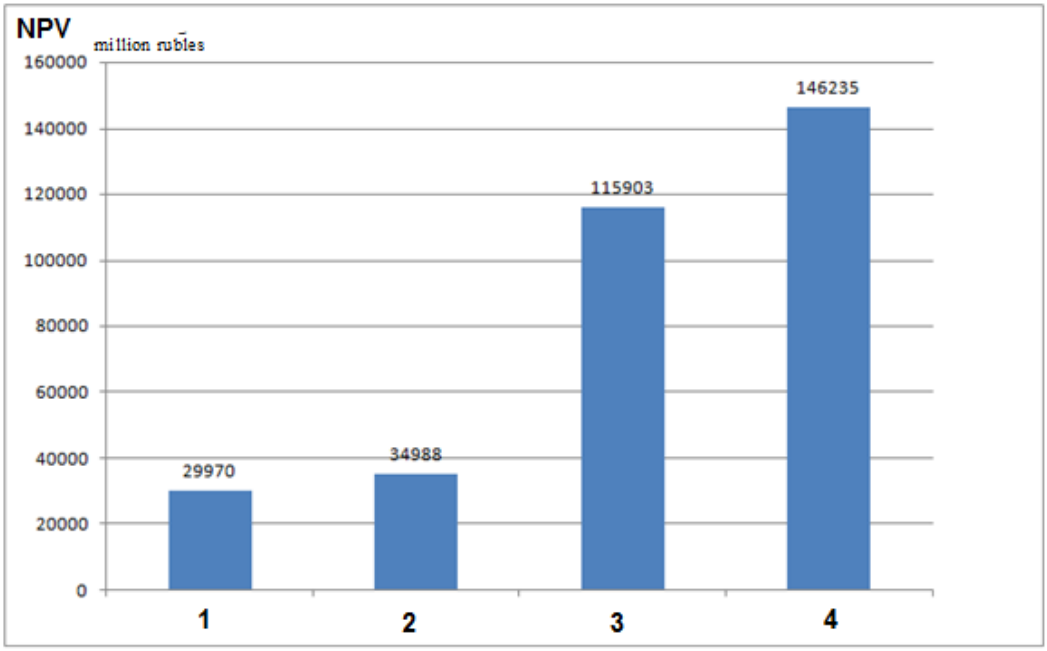

Figure 1. The value of net present value (NPV), taking into account various tax models for the recommended option for the development of the Prirazlomnoye field (1-tax on the extraction of minerals in the Russian Federation,2 -tax on additional income of the Russian Federation, 3- PSA China, 4- PSA in the Russian Federation)

The use of a fuzzy risk assessment model (Nedosekin's model) showed the average stability of the first option. At the same time, the risk indicator was 0.56. Almost the same value is taken by the risk indicator for the second option. According to the calculation options using the PSA tax regime, the risk indicator tends to 1, which corresponds to a low risk. However, we note that the use of PSA models is controversial and controversial, since in Russia this mechanism is not sufficiently developed.

4. Software for the economic assessment of offshore development

The calculations were carried out using a specialized computer system. The system makes it possible to forecast the technical and economic indicators of the study and development of hydrocarbon objects, taking into account various tax mechanisms, as well as to assess the cost of fields and the effectiveness of their development using fuzzy methods for assessing the risks of investment forecasts. It provides prompt and high-quality performance of technical and economic calculations for numerous options and sub-options with the choice of the optimal solution that determines the strategy and forecast for the development of oil production with different sources of funding. This development can be a good addition to the already existing software systems for the technical and economic assessment of the effectiveness of the development of oil and gas fields, which is the most relevant in the period of digitalization of the oil and gas production complex [9,10].

The system provides for the determination of the monetary value of natural hydrocarbon fields based on the calculation of a number of technological and economic indicators. These include the costs of developing fields, as well as the main assessment criteria - net present value, internal rate of return, payback period, profitability index of the field and profit. The developed methodology for a comprehensive economic assessment of the effectiveness of the development of oil and gas fields served as the basis for theoretical and applied research in the field of application of modern information technologies. The methodology assumes the use of the following informational approach: formation of an information technical and economic model of a database on options for the development of oil and gas fields; formation of an information economic model of a knowledge base based on an economic methodology for assessing options for the development of oil and gas fields using semantic networks and the use of various tax models in subsoil use as part of the knowledge base.

Based on the hydrodynamic calculations in the system, predictive models of technical and economic calculations for development options are built. All variants of development systems are subjected to economic assessment using an automated system by years, stages of development, as well as in general for the design period, taking into account the peculiarities of product sales (external and internal markets). In the future, the experts carry out an economic substantiation of methods for stimulating reservoirs with the aim of the most efficient extraction of natural hydrocarbon reserves from the bowels. To calculate capital investments and operating costs for the production of hydrocarbons by options, in addition to geological and technological parameters, it is necessary to differentiate the unit costs by the grid of wells (options) and design stages.

The standards for capital and operating costs are substantiated by the authors of the projects on the basis of design estimates and analysis of factual information, taking into account inflationary price indices developed and approved by the government of the Russian Federation. When attracting projects from foreign partners for investment, standards are developed with their participation. Let's consider the information processing process in more detail. With the help of an interactive interface, the system is asked to form a computational algorithm. This request is processed by the computation planner, as a result of which the initial information is imported from the databases of technical and economic indicators, and then the search for the necessary formulas and software procedures that will make up the calculation module in the BASIC language. The process is also based on the search for known variables included in the database of technical and economic indicators for field development options. Note that the database includes a financial deflator that takes into account the exchange rate of the ruble against the dollar. As a result, the scheduler selects from the knowledge base those procedures that are associated with known parameters. In this case, the graphs pass from the passive state to the active state, which corresponds to the end of the compilation of the computational program. Based on OLE technologies, the program code is transferred to spreadsheets, in which the calculations are performed.

For multivariate calculations, an algorithm has been developed for ranking options in ascending order of net discounted income as an objective function. It is important that the most effective and

optimal option is determined only on the basis of expert opinions, as well as negotiations between the state and the investor (investors).

5. Conclusion

The calculation results showed that the application of the current tax regime in Russia makes the development of the Prirazlomnoye field efficient, but with a relatively low profitability for the license holder. As an alternative, PSAs of China and Russia were used, which showed a high economic effect with a low level of risk. It can be concluded that the use of PSA models to substantiate the effectiveness of the development of the Prirazlomnoye field provides a greater financial benefit in comparison with the current tax regime in the Russian Federation.

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