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Financial analysis of oil fields development efficiency

Análisis financiero de la eficiencia del desarrollo de yacimientos petrolíferos

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Contents

ABSTRACT:
The article provides an overview of the financial indicators used to analyze the efficiency of oil field development. The technique of calculation, the scale normative values and their interpretation in the framework of the objectives of the analysis.
Keywords: analysis of economic efficiency, capital investments, operating costs, cash flow, energy costs

RESUMEN:
El artículo proporciona una visión general de los indicadores financieros utilizados para analizar la eficiencia del desarrollo del campo petrolífero. La técnica de cálculo, los valores normativos de escala y su interpretación en el marco de los objetivos del análisis.
Palabras clave: análisis de eficiencia económica, inversiones de capital, costos de operación, flujo de caja, costos de energía

1. Introduction

Oil and gas are one of the groundworks of the Russian economy. Russia takes one of the leading places in the world in the field of production and export of crude oil and natural gas. About 6.1% of the world's explored oil reserves are concentrated in the depths of Russia. Approximately 60% account for Urals and Siberia share, which creates potential export opportunities in both the western and the eastern directions. Russia's fuel and energy complex (including coal) provides 27% of the land's GDP. At the same time, 43% of oil and gas revenues to the budget account for the fuel and energy complex, the share of the fuel and energy complex is 63%, in the export sector, in addition, the share of citizens employed in the fuel and energy sector is 3.6% of the total number of employees. Russia is also the world's largest

exporter of natural gas and energy resources in general.

According to FSSS, oil production in Russia, including gas condensate, increased in the first quarter of 2015 by 1.2% to 132 million tonnes. Gas production fell by 8.2% to 150 billion m3. Coal production increased by 6.8% to 91.1 million tonnes. (FSSS: Official statistics. 2015)

Oil companies around the world spend large amounts of money on computer modeling of oil fields annually. From the economic point of view, it is necessary to determine the oil levels to obtain the maximum economic efficiency of the oil field development investment project.

This problem becomes urgent and especially important in terms when oil and gas prices are low or unstable, and the profitability of the project is at risk.

The task of analyzing the economic efficiency of the oil field development project is to calculate the main economic indicators of the project evaluation, choose the most profitable of them that will ensure the maximum economic effect, determine the payback of planned investments, and obtain the planned gross profit from the project.

When making a decision, it is also important to clarify the dependence of the influence of various factors on economic efficiency. In this situation, a rapid and quality analysis of a large number of options based on economic criteria is essential. Economic assessments should take into account the geological-physical, geological-industrial, technological and ecological features of the production facilities and development fields.

2. Methodology

Let us consider the main financial and economic factors affecting the oil production process and form a set of indicators enabling to assess its effectiveness.

When determining the influence of economic factors on oil production efficiency, it is necessary to reflect the conditions of product distribution in the market (external, domestic market), changing of the current tax system (applying preferential taxation or reducing tax rates), and various discount rates.

Evaluation of the effectiveness of taken decisions is assessed by a set of calculated indicators serving as economic criteria.

Economic assessments should include the following factors:

- bringing the forthcoming various expenses and incomes to the conditions of their proportionality in economic value during the initial period;
- inflation assessment affecting the value of the used funds;
- assessment of risks relating to design work;
- justification of the feasibility of participation of interested enterprises, banks, Russian and foreign investors, federal and regional government bodies in the implementation of project solutions (Economic messages, 2015).

Economic evaluation of development options is carried out using a metrics peculiar to the market economy, widely used in foreign and now in domestic practice. The calculation procedure should be in accordance with the procedure of technological documents drawing up for the development of oil and gas-oil fields (RD 153-39-007-96, 2009).

The main criteria for assessing the effectiveness of the project are:

- capital investments for the development of the field;
- operating costs for oil production;
- cash flow (undiscounted); discounted cash flow or net profit value (NPV);
- the payback period of capital investments;
- internal rate of return (IRR);
- investment return index (P1);

- state income.

Capital investments. Capital investments include fixed assets, including costs for capital construction, expansion, reconstruction and technical re-equipment of existing enterprises, purchase of machinery, equipment, tools, inventory, design and survey work, and other costs.

Capital investments are calculated by the years of introduction of field in the development until the end of the drilling and arrangement and further beyond that time, if necessary.

For oil formations equipped and already brought into development, the purpose of capital investments is determined in accordance with their reproductive structure: new construction, expansion, reconstruction or technical re-equipment.

When drawing up the project documentation for the fields under development, especially if they are geographically adjacent to other fields, capital investments should be calculated with due account for the possibility to use the available capacities of the field facilities for the needs of the projected facility.

Capital investments can be calculated also by specific areas including the costs for drilling wells and construction. Capital investments in drilling wells are determined on the basis of the estimated cost of 1 m of sinking by boring, determined depending on the well depth, the number of producing, injection, and other wells bringing from drilling (Economic messages, 2015)

Capital investments in the construction of facilities for oil gathering and transportation, integrated automation of technological processes, water supply of industrial facilities, power supply, communications and the production service base are determined by multiplying the specific capital costs in the appropriate direction by the number of oil wells brought from drilling, and in flooding oil reservoirs – by the number of injection wells.

For the preparation of oil, treatment facilities, capital investments are calculated by multiplying the specific capital costs in the appropriate direction by the oil production and cleaning capacity introduced in the given year.

The infrastructure is calculated as a percentage of the cost for oil field construction. The costs for environmental protection measures are calculated as a percentage of the total amount of investments cost including the cost of drilling operations (Altunin A.E. and Semukhin M.V., 2007).

Operational costs. When evaluating development options, operating costs can be calculated by expenditure costs - calculation articles or cost elements. In this case, these costs are calculated using a method based on the calculation articles.

The operating costs are calculated in accordance with the specific operating costs and volumetric technological indicators in the context of the following articles (Altunin A.E. and Semukhin M.V., 2007):

- maintenance of production and injection wells;
- energy costs for mechanized extraction of liquids;
- reservoir pressure maintenance;
- gathering and transportation of oil and gas;
- processing of oil;
- overhaul of wells;
- depreciation of equipment.

The costs of servicing the production wells are determined depending on the number of active wells and include the wages (basic and additional) of workers, shop costs, general production costs, as well as the costs for equipment maintaining and operating.

Energy costs are calculated depending on the volume of mechanized extraction of liquid. The calculation of these costs is based on the average cost of electricity and its specific consumption.

The costs for gathering, transportation of oil and gas, processing of oil are calculated depending on the volume of produced liquid without regard to depreciation charges.

The costs of reservoir pressure maintaining are the sum of the costs of servicing the injection wells and the costs of water loading. The costs for water loading are determined on the basis of the amount of water pumped into the reservoir, its cost and energy consumption. The standard for determining the energy consumption when pumping water into the reservoir is established on the basis of specific electricity consumption and the cost of 1 kWh of electricity (Terekhov L.P. and Antonyan L.A., 2006).

Depreciation of fixed assets is calculated on the basis of their balance value and current standards for their full recovery. Depreciation charges are one of the sources of reproduction of fixed assets. Various ways of accrual of depreciation can be used at their estimation: linear (proportional) and accelerated(Altunin A.E. and Semukhin M.V., 2007).

At present, depreciation is mainly calculated by linear or proportional method. This method involves calculation of depreciation charges for renovation based on the average life of fixed assets. During this period, the balance value of these funds is completely transferred to production costs. As a rule, this standard in the oil industry makes 10-20%. If the field is already developed and there are previously established funds, then not only the newly but already created funds must be taken into account in calculating the depreciation charges.

Accelerated depreciation provides a complete transfer of the balance value of fixed assets to production costs within a shorter period than it is provided for by norms of the current depreciation charges. Thus, it becomes possible to create a reserve fund used for new capital investments and expansion of production capacities (Altunin A.E. and Semukhin M.V., 2007).

Environmental costs, credit payments, and taxes related to production cost are included in the operating costs of oil and gas production in addition to the traditional articles of calculation (Ermolov B.A. and Tsykin I.V. and Leonov L.V., 2008).

Cash flow (NCF). The cash flow is the sum of the profit from sales and depreciation charges, reduced by the amount of investment and calculated by the formula (Terekhov L.P. and Antonyan L.A., 2006):

$$NCF = \sum_{t=1}^{T} (NP_t + D_t) - C_t , \text{(1)}$$

where NCF - cash flow in the t- year;

NP_t - net profit in the t- year;

D_t - depreciation charges in the t- year;

C_t - capital investments in the development of the field in the t- year;

T - duration of the calculation period, years;

t - the current year.

Net present value (NPV). Net present value is otherwise called current value. It is defined as the sum of the profit from sales and depreciation, reduced by the amount of investment spent for oil field development; it is defined as the sum of the current annual flows reduced to the initial year [25]:

$$NPV = \sum_{t=1}^{T} \frac{(NP_t + D_t) - C_t}{(1+r)^t} , \text{(2)}$$

where NPV is the net present value;

r - discounting rate,%.

The payback period of capital investments (DPP). The payback period is the span during which the initial negative values of the accumulated cash are completely compensated by its positive values. The payback period can be determined from the following equation:

$$NPV = \sum_{t=1}^{DPP} \frac{(NP_t + D_t) - C_t}{(1+r)^t} \cong 0, \text{(3)}$$

where DPP - the payback period, years.

This is the period beyond which the NPV is created and in the future remains non-negative. Hence, this is an indicator established by the time of recovery of initial costs typical for newly commissioned fields which require a complete arrangement. The smaller the value of this indicator, the more effective is the option under consideration.

Internal rate of return (IRR). The internal rate of return is a certain value of the discount rate at which the sum of net income from investments is equal to the sum of investments, i.e. capital investment is paid off. In other words, this is the value of the discounting standard, in which the amount of the total cash flow for the settlement period is zero:

$$NPV = \sum_{t=1}^{T} \frac{(NP_t + D_t) - C_t}{(1+IRR)^t} = 0, \text{(4)}$$

where IRR - internal rate of return, %.

The indicator of the internal rate of return determines the rate of return on the invested capital required by the investor, compared with the current interest rate on the loan. If the estimated IRR index is equal to or greater than the interest rate, the investment in this project is justified. Here it is necessary to note the fact that the IRR index plays an important role in the evaluation of projects for newly commissioned fields requiring significant capital expenditures.

In the projects of further development, which, in general, do not require significant capital investments, as well as in projects involving the use of enhanced oil recovery methods at the late stages, associated mainly with increased running costs, the IRR index plays a supporting role and, as a rule, is not applied when choosing the best option.

Index of profitability (PI). The profitability index characterizes the economic return of the invested funds and represents the ratio of the total resulted net proceeds (profit from the sale of oil and depreciation charges) to the total discounted volume of capital investments:

$$PI = \frac{\sum_{t=1}^{T} \frac{NP_t + D_t}{(1+r)^t}}{\sum_{t=1}^{T} \frac{C_t}{(1+r)^t}} , \text{(5)}$$

where PI - profitability index.

The index of the profitability is used to design new fields with large capital outlays. In this case, its value is interpreted as follows: if PI>1, the option is effective, if PI<1 - the development option is unprofitable.

When developing fields that are already equipped or in the late stages, this index is determined with taking into account existing fixed assets.

The income of the state is taxes and payments to the budgetary and extra-budgetary funds of the Russian Federation.

All listed technical and economic indicators are presented by field development periods - 5, 10, 20 years. The main integral indicators are calculated at a discount rate of 10 and 15% (Somov G.R., 1991).

The ultimate goal of the economic evaluation of the development options is to choose the best option to ensure the feasibility of industrial development of the facility under the project and the greatest efficiency of oil production. It is recommended to compare the various options and choose the best one using the above mentioned system of indicators. This system of indicators, used to determine development project effectiveness, takes into account the interests of direct participants of the project implementation, as well as the interests of the federal and local budgets.

The main indicator determining the choice of the recommended option from all considered is the discounted cash flow (NPV). The best option is the one with the maximum NPV value for the design term of development. A characteristic feature of this indicator is that, as a criterion for choosing an option, it is applicable both for newly introduced fields and for fields already under development. The calculation of NPV gives the answer on the effectiveness of the option in general (Analysis of oil production efficiency indicators, 2015).

3. Research

Financial efficiency of the development of one of the fields located in Western Siberia in the north of the Tyumen region, Russia was assessed on the basis of the presented methodology. Estimation of fields can be carried out at any stage of development. It should be stressed that the development of the field is considered to be cost-effective, with an internal rate of income exceeding the discount rate used in the calculations.

When conducting a financial evaluation of this project's effectiveness, the price base was used as of 01.01.2015, the project period was 12 years (from 2012 to 2023), the discounting rate was 12%. The price for the sale of oil was taken in accordance with Order No. 413-E / 11 of the Federal Tariff Service of the Russian Federation dated December 24, 2008 "On wholesale prices for oil and gas produced and sold to consumers of the Russian Federation". The fixed prices were adjusted according to the forecast of prices changes in 2016-2020. (State Corporation "Bank for Development and Foreign Economic Affairs (Vnesheconombank)", 2008).

Capital investments in the development of the field are calculated on the basis of the estimate documentation for the construction of wells and the facility construction (Table 1). The average estimated cost of the well construction is $ 1.56 million, the total capital costs for the construction of 7 wells will be $ 11.15 million. The cost on the facilities is determined with taking into account the need for oil treatment, underground and surface disposal of significant volumes of reservoir water, creation of operational base for servicing the facility construction.

The operational costs in the development of the field are determined by calculation with taking into account the data on the analogs in the prices as on 01.01.12 (Table 1)

Table 1
Capital investments, mln. dollars

Year	Well consrtuction	Field facility construction	Total capital investments
2012	11,15	3,44	14,59

2013	0	1,56	1,56
2014	0	0	0
2015	0	0	0
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	0	0	0

Table 2
Basic data for calculating the economic efficiency of the project

Indicators	Meas. unit	Σ
1. Well infrastructure development	piece	7
2. Decommissioning (liquidation)	piece	0
3. Number of active wells	piece	-
4. Annual average oil production	mln. m3	30,04
5. Cumulative oil production	mln. m3	360,48
6. Operating costs (without MPT), including:	mln. dollars	18,47
for oil production	mln. dollars	3,65
for oil processing	mln. dollars	0,43
for water disposal	mln. dollars	0,37
depreciation charges	mln. dollars	14,02

7. Capital investments in construction of wells	mln. dollars	11,15
8. Capital investments in construction	mln. dollars	5
9. Associated extraction of water	thousands m3	1750,49
10. Cost of oil production	dollars/1000 m3	55,84
11. The price of sales of oil without VAT	dollars/1000 m3	-

Revenues from sales are determined depending on the prevailing market price on the valuation date. Calculation of taxes for a legal entity is made in accordance with the Tax Code of the Russian Federation. The economic efficiency of the field development project is calculated on the basis of the data on the volume of capital investments and operating costs for the extraction of minerals.

Table 3
Operational activities for the project

Indicators	Meas. unit	Σ
1.Revenues	mln. dollars	47,53
2. Current cost	mln. dollars	18,47
including wells liquidation	mln. dollars	0
3. MPT	mln. dollars	1,66
4. Gross profit	mln. dollars	27,40
5. Property tax	mln. dollars	2,09
6. Income tax	mln. dollars	5,26
7. Total taxes	mln. dollars	7,36
8. Net income	mln. dollars	20,05

Table 4
Financial indicators of the project

Indicators	Meas. units	Σ
Cashflow	mln.dollars	17,91
Cumulative cash flow	mln.dollars	17,91

New discounted income (NDI) (i = 12%)	mln.dollars	2,24
New discounted income (NDI)	mln.dollars	2,24
Internal rate of return (IRR)	%	15,02
Payback period (simple)	years	5,9
Payback period (discounted)	years	9,3
Index of return of capital investments	fr. units	1,14

Table 5
Formation of profit from the sale of oil, mln. dollars

Years	Oil production, mln.m3	Revenues from sale without VAT	VAT on sold products	Property tax	Income tax	Net income
2012	0,52	0,05	0,01	0,15	0,00	-0,55
2013	14,11	1,44	0,26	0,30	0,00	-0,46
2014	43,79	5,15	0,93	0,29	0,60	2,41
2015	43,77	5,92	1,07	0,26	0,76	3,04
2016	43,90	5,94	1,07	0,23	0,77	3,08
2017	41,38	5,60	1,01	0,21	0,71	2,84
2018	35,34	4,78	0,86	0,18	0,56	2,23
2019	31,82	4,31	0,78	0,15	0,47	1,89
2020	29,22	3,96	0,71	0,12	0,41	1,64
2021	27,11	3,67	0,66	0,09	0,36	1,45
2022	25,48	3,45	0,62	0,07	0,33	1,30
2023	24,04	3,25	0,59	0,04	0,29	1,17
Total:	360,48	47,53	8,56	2,09	5,26	20,05

4. Results

Thus, the payback period of the capital investments in the project is achieved after 5,9 years of oil production (or 9,3 years with cash flow discounting). The project brings losses during the first 5-7 years due to the large volume of capital investments in the construction of wells and development of the field. It is possible to reduce the payback period with a reduction of production costs level or in case of outpacing growth in oil prices. The consolidated budget revenues are 32% of the sales. Evaluation of the field development effectiveness based on the proposed indicators proves economic efficiency of field development.

5. Conclusion

Within the scope of the research of the indicator set for financial evaluation of the field development efficiency, the author made a number of interrelated conclusions:

1. The correct selection of a set of indicators in the evaluation is the basis for the development of strategic managerial decisions by the investor. This helps to increase the adaptability of an industrial enterprise to the market.

2. Indicators of the project's economic efficiency can be significantly changed due to changes in various internal and external factors.

3. The proposed set of indicators for calculating project efficiency is universal for the oil industry and can be used to determine the company's long-term strategy and its adjustment.

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