

# Investments in oil field development by the example of Tomsk oblast

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**Abstract.** The article describes the geologic structure of the formation located not far from Strezhevoy Tomsk Oblast. The formation has been poorly studied by seismic methods. The reserves categories  $C_1$  and  $C_2$  as well as hydrocarbon potential are presented. 4 exploratory and 39 production wells are designed to be drilled depending on geologic knowledge and formation conditions. The article deals with the investment plan including development, oil export expenditures and implementing cost calculation.

## 1. Introduction

The field license area of 1192 km<sup>2</sup> is located 460 km from Tomsk to the North-West, 300 km from Strezhevoy to the South-East. The nearest settlement is Kedrovoy, which is located 90 km South-East from the field and is the major oil-and-gas producing industry in the southern territory. There are no highways or railways in this area. The territory of license area is considered of little value for agriculture and forestry. The seismic grid interval of CDPM is: in total – 0.77 km/km<sup>2</sup>, in 1986-99 – 0.01 km/km<sup>2</sup>. The field is poorly studied by seismic CDP methods [5].

The geologic structure of the formation is complex; the oil deposit is confined by terrigenous Upper-Jurassic sandstone formations  $J_1^2$  and  $J_1^3$ . The major oil-and-gas formation consists of horizons  $J_1$  and  $J_2$ . In terms of reserves, it is referred to small and is of up to 5 mln. tons. It has been developed since 2009, in 2012 the production wells were first drilled. The project drilling depth is at 2961 m. In total, 4 exploratory and 39 production wells are designed to be drilled [3].

## 2. Hydrocarbon potential and reserves

Oil formation is confined to sandstone formations  $J_1^2$  and  $J_1^3$  horizon  $J_1$  of Vasyugan suite. Formation  $J_1^2$  is a hanging type controlled by OWC from West to South at minus 2345 m, from East – lithologically capillary sealed at minus 2300 m to minus 2320 m. Formation  $J_1^3$  is developed throughout the elevation area, but is significantly shaled out in the East forming a lithological seal, where oil accumulation is controlled by the OWC from the West to the South at minus 2355 m. From the East the boundary of the oil field is a lithological seal revealed within the hypsometric limits from minus 2320 m to minus 2300 m. Oil deposit is a blanket-like accumulation with an overlying seal.



According to the State Reserves Register the parameters of the prospected deposits: gross pay/net pay thickness of producing reservoir  $J_1^2$  – 3.0/2.6 m, effective porosity – 15%, hydrocarbon saturation – 0.59, oil recovery efficiency – 0.3.

Oil reserves (prospective/recoverable) of category  $C_1$  is 2168/542 000 tons and  $C_2$  – 635/159 000 tons [2].

Gross pay/net pay thickness of producing reservoir  $J_1^3$  – 5.6/4.4 m, effective porosity – 16%, hydrocarbon saturation – 0.67, oil recovery efficiency – 0.25.

Oil reserves (prospective/recoverable) of category  $C_1$  is 1113/223 000 tons and  $C_2$  – 2124/425 000 tons.

### 3. Forecasting development parameters

To forecast the development parameters the ultimate reserve categories  $C_1$  and  $C_2$  were used. It was assumed that the confirmation factor of category  $C_2$  – 50 %.

The following geologic information was used for forecasting: layout of net formation thickness distribution (indirectly reflecting changeability of reservoir properties) and layout of oil-saturated formation thickness distribution [4].

The layout of net formation thickness distribution of  $J_1^2$  and  $J_1^3$  formations shows the improvement of filtration characteristics in the crest.

Production well pattern is based on the layout of oil-saturated formation thickness distribution of  $J_1^2$  and  $J_1^3$  formations.

In terms of exploration and reserve statement the field development is planned in the stages:

I stage – production test of well №1 after its recommissioning, according to well test operation plan (1 year), recommission of exploration well and its test implementation (2 years). Within this period the appraisal drilling of 4 wells is performed to delineate the field and identify other formations. Construction of development and pipeline facilities begins at this stage;

II stage – drilling six production wells and field development, simultaneously, grid-type seismic-geophysical operations are performed to specify the structural field plan and field junction zones. Construction of development and pipeline facilities is completed. Artificial lift is implemented (electric centrifugal pump (ECP) and beam-balanced pump (BBP) with the capacity from 10 m<sup>3</sup>/day to 60 m<sup>3</sup>/day). The relationship of the well number equipped with ECP and BBP – 40/60. The period lasts 2 years. Then – design of field development plan;

III stage – implementation of the field development plan.

In a period of 15 years to explore the geological structure of the field, it is planned to make the seismic grid denser. The initial cost of geologic exploration for additional field exploration is about 7 mln. roubles (100 lineal km. common depth point seismic 2D) (figure 1) [2].

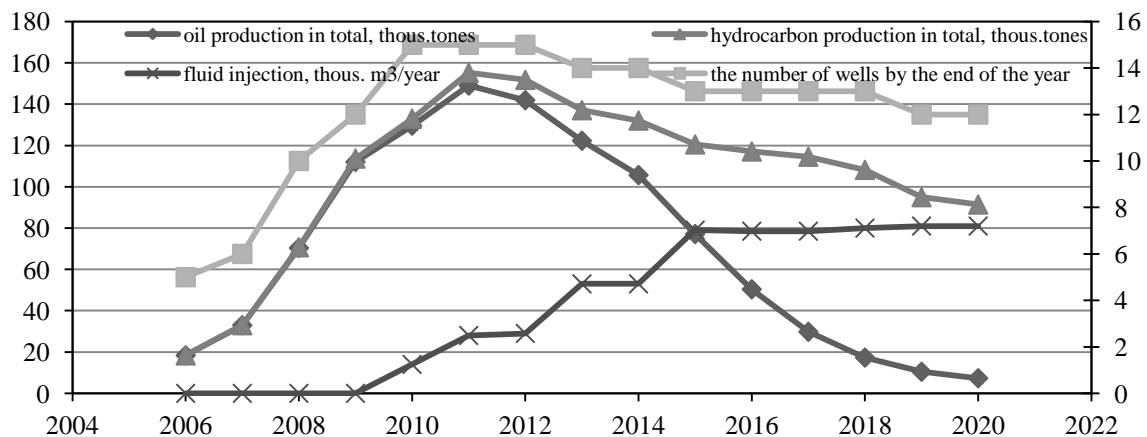


Figure 1. The chart of studied field development.

The formation is planned to be drilled in production well pattern of 700\*700 m, boundary net-pay thickness of well placement – 2 m, in total, 10 production wells are designed to be drilled, 3 of them – injection ones. In the course of field development special attention should be paid to the dynamics of gas-oil factor change, as there can be a gas cap.

At the first stage of field development the recovery rate from the reservoir of recoverable resources will not exceed 3 % (of total), the forecasting annual oil production – 18400-33000 tons, cumulative oil – 51400 tons.

At the second stage of field development six production wells are implemented, in two of them hydraulic fracturing treatment is performed. The recovery rate from the reservoir amounts about 10 % of all recoverable resources, annual recovery from 40 to 112 000 tons, water cutting increases to 1.5 %, oil production at the second stage – 182400 tons.

According to the field development plan, at the third stage of field development, 4 more wells are drilled, in 3 of them hydraulic fracturing treatment is performed. The annual production achieves 149.0 000 tons, water cuttings – 92 % by the end of the given period, recovery rate from the recoverable resources decreases from 14.5 % to 1 %. At the given stage 840800 tons of oil are planned to be recovered. The spot contour waterflooding system will be implemented in the field. In total, 3 wells will be converted into injection after oil production.

All in all, over 15 years 1075000 tons of oil will be produced (97.0 % of approved reserves of categories  $C_1+C_2$ ).

#### 4. Economic analysis and calculations

Commercial efficiency of investments in field development is estimated on the basis of accepted drill footage, production level, well stock conditions.

Calculation of key economic indicators is performed for 15 years of field development. The calculation includes taxes and duties, which are reported and paid by an enterprise for the budgets of different levels in the course of its economic activity (table 1):

- 1\* unified production tax – 340 roubles/t with the coefficient describing the dynamic of the oil world market prices,
- 2\* property tax – 2 %,
- 3\* income tax – 24 %.
- 4\* road fund tax – 1 %,
- 5\* unified social tax –35.6 %.

Commercial evaluation of field development was made under the conditions:

- 30 % export sale,
- 70 % domestic sale.

The sale price in the domestic market is 8200 roubles/t (with VAT), in the international market – 50 USD/barrels.

Export cost for oil transport to the borders is calculated in accordance with the rate equal to 22 USD/t, duty – in accordance with the RF Law “On Custom Tariff” taking into account the average cost rate of Urals crude oil in the world market is included in the calculations [1].

The most critical indicator for calculation of investment projects is oil price. Changes in oil sale price in domestic market and for export, its cuts will result in increase of payback period. Oil price increase (domestic up to 8200 roubles/t and export up to 50 USD/barrels) will allow paying back the investments in field development within 5.1 years.

The present paper considers the reserves confirmation of category  $C_2$  by 50%. The maximum risk in the field development is reserve non-confirmation of category  $C_2$  by more than 50 %. In this case there are changes in dynamics of fluid and oil withdrawal and, in terms of expert appraisal; the payback period for these operations may exceed 8 years, which makes it economically unattractive under the existing norms [3].

**Table 1.** Investments in field development of 2010 (thous. USD).

Name, months	2010											
	1	2	3	4	5	6	7	8	9	10	11	12
<i>Operations</i>												
License acquisition												
Operation allotting	3188											
Exploration program												
Exploration well drilling project and project evaluation												
Reinterpretation of seismic data												
Well re-suspension and implementation												
181, 183 по временной схеме	998											
Preparatory operations for well implementation 187-p (L),190-p (L)	0											
Well re-entry 187-p (L)	101	0										
Well re-entry 190-p(П)		101	0									
Pre-drilling studies and new pad implementation	288											
Straight-hole drilling 185-p		1143										
Well drilling 187-p			1429									
Well drilling 188-p				1429								
Hydraulic fracturing (5 wells)		214	214	107								
Pre-drilling studies of exploration well 186-p	107			511								
Straight-hole drilling 186-p - exploration						1 096						
Seismic survey 600 1.km2D or 150km2 3D	134	134	134	134	134	134	134					
Drill lease	32	32	32	32	32	32	32	32	32	32	32	32
<b>TOTAL COST PER MONTH</b>	686	631	1855	2243	199	1278	181	47	47	47	47	47
<b>TOTAL COST WITH</b>												
<b>CUMULATIVE TOTAL (DEMAND FOR INVESTMENTS)</b>	4360	5991	7847	10090	10289	11566	11747	11794	11842	11889	11936	11983
<b>TOTAL PRODUCTION PER DAY (m<sup>3</sup>)</b>	40	120	255	390	450	450	450	450	450	450	450	450
<b>TOTAL PRODUCTION PER MONTH (m<sup>3</sup>)</b>	1200	2400	6900	11100	12900	13500	13500	13500	13500	13500	13500	13500
<b>TOTAL PRODUCTION PER MONTH (barrels)</b>	7536	15072	43332	69708	81012	84780	84780	84780	84780	84780	84780	84780
<b>Oil production of total cumulative per month (barrels)</b>	22608	37680	81 012	150720	231732	316512	401292	486072	570852	655632	740412	825192

The field development is planned to be performed in stages taking into account the geological terms and reserves conditions:

Calculation of commercial efficiency of field development is performed using the system of indicators specified by the current “Methodical recommendations of investment project evaluation and selection for support”.

According to the decisions taken in the present paper the development of promising N fields is connected with high investment risk as evidenced by small cash flow (or net present value (NPV)) at the discount factor 40%. Changes in oil prices and possible decrease in tax burden (MET, profit tax relief) may increase the performance indicators of the given operation and make it attractive for investors.

Calculating the indicators sensitivity towards oil prices change with price decline by 28.5% (export up to 35USD/barrels and domestic prices up to 4500 roubles/t) the payback period of capital investments exceeds 10 years. With increase in prices for export oil – up to 55USD/barrels and domestic prices – up to 8000 roubles/t the payback period decreases up to 5.1 years.

## 5. Conclusion

Thus, the greatest effect can be achieved by cost reduction for construction of new wells by 10 %; the capital exposure decreases by nearly 8 % and, consequently, decreases the payback period of oil field development.

Evaluation of performance factors for oil field development is carried out on the basis of proven oil reserves and suggested operational process design. To forecast the production indicators the ultimate reserves of the categories  $C_1$  and  $C_2$  are used. It is suggested that reserve confirmation of the category  $C_2$  – 50 %, at less confirmation the oil development is non-commercial in the current economic conditions.

The given oil field has a well-developed infrastructure. There are special facilities for oil and gas extraction, different vehicles, cranes, construction equipment, and relocatable buildings for personnel. Oil produced at the given field will be transported in pipelines and then further processed.

## References

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