Geology of minerals of the Tevlinsko-Russinskoe deposit

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Abstract. The territory of the Tevlinsko-Russinskoe field is characterized by instability of the thermodynamic equilibrium of the geological environment, due to the existence of permafrost. The article considers the geological section of the region, its oil and gas content, analyzed the geological and physical information. The main technological solutions of the project document of the Tevlinsko-Russinskoe field are considered. Oil and gas content within the Urengoysky oil and gas region is established in a wide stratigraphic range. Tectonic screens, the presence of which is confirmed by the history of the field, complicate almost all deposits.

1. Introduction

Administratively the Tevlinsko-Russinskoe field is located in the Surgut region of the Khanty-Mansiysk Autonomous Okrug of the Tyumen region, 118 km northeast of Moscow, st. Surgut and 115 km south-west of Noyabrsk.

The field was discovered in 1981, the TPP Kogalymneftegaz LLC LUKOIL-Western Siberia, based in the city of Kogalym, mainly carries out production activities. The closest developed oil fields of the oil production enterprise are Kochevskoe, Severo-Kochevskoe, Kogalymskoe, Yuzhno-Yagunskoe.

The climate of the region is sharply continental. Winter is harsh and snowy with blizzards and frosts. Today the temperature drops to minus 50 °C, in July it is plus 16 °C. Average annual rainfall is 482 mm.

Near the Tevlinsko-Russinskoye field, there are nature protections zones represented in the form of swampy areas and mixed forests.

The entire operating production fund of the field is mechanized: 1,486 wells (98.3 %) ESP units, 18 wells (1.7 %) were sucker rod pumps. Wells equipped with sucker rod pumps account for less than 1.0 % of annual oil production.

2. Materials and methods

Within the Tevlinsko-Russinskoye field, as well as for the whole of Western Siberia, it is customary to distinguish three structural-tectonic levels:

- Proterozoic-Paleozoic basement;
- Permian-Triassic intermediate structural level;
- Meso-Cenozoic sedimentary covers [1].
Metamorphic and igneous rocks of Paleozoic age, effusive-sedimentary rocks of undivided Permian-Triassic age and sedimentary deposits of Mesozoic-Cenozoic age take part in the geological structure of the Tevliansko-Russky deposit [2].

Paleozoic rocks make up the pre-Jurassic basement. Terrigenous sediments of the Mesozoic-Cenozoic age form a sedimentary cover of the West Siberian Plate, the thickness of which, according to seismic data, is more than 3000 m.

The lower structural-tectonic level is composed of Paleozoic and pre-Paleozoic formations, mainly magmatic, metamorphic and strongly altered sedimentary rocks. Their formation took place during the geosynclinals stage of development of the West Siberian Plate. A large number of disjunctive disorders are observed in this complex. The middle structural stage is represented by altered sedimentary and effusive rocks and corresponds to the parageosynclinal stage of development in the history of plate formation.

The Meso-Cenozoic sedimentary cover was formed under conditions of prolonged and relatively stable subsidence and quieter tectonic development of the region. It is characterized by weak dislocation and absence of rock metamorphism.

According to the main oil and geological zoning, the Tevliansko-Russkinskoe field belongs to the Surgut oil and gas region (OGR). In the fields belonging to the northern part of the OGR, oil deposits are located in the stratigraphic range from the Tyumen suite to the Sortymskaya suite.

The main oil-bearing stratum is a complex within the Sortymskaya suite. Oil deposits here are associated with the layers of the BS\textsubscript{10}+BS\textsubscript{12} horizons, as well as the Achimov strata. The largest in size and reserves are the deposits confined to the upper part of the section of the Sortymskaya suite in the BS\textsubscript{10} horizon [3-4].

Within the Tevliansko-Russkinskoye field, industrial oil-bearing capacity is associated with layers YUS\textsubscript{11} and YS\textsubscript{22} \textsuperscript{1} of the Tyumen Formation deposits; YUS\textsubscript{1} \textsuperscript{1} and YUS\textsubscript{1} \textsuperscript{2} of the Vasyugan suite; YUS\textsubscript{0} - Bazhenov formation, YUS\textsubscript{0} and Ach of the anomalous section of the Bazhenov formation; BS\textsubscript{16}, BS\textsubscript{17}, BS\textsubscript{18-19}, BS\textsubscript{21}, BS\textsubscript{22} \textsuperscript{1}, BS\textsubscript{22} \textsuperscript{2} of the Achimov formation; beds of clinoform horizons BS\textsubscript{10} \textsuperscript{2-3}, BS\textsubscript{11}, BS\textsubscript{12} and shelf layers BS\textsubscript{10} \textsuperscript{0}, BS\textsubscript{10} \textsuperscript{1} in the upper part of the Sortymskaya suite [5].

The West Siberian Plate covers a huge area between the fold system of the Urals in the west and the ancient Siberian platform in the east. It has a heterogeneous basement, a widespread uneven-aged slab complex, and a powerful Mesozoic-Cenozoic platform cover. Data on the structure of the basement of the plate with different ages is based on the results of geophysical materials and drilling of about 2500 wells, most of which are concentrated in the Urals and the Middle Ob region. It includes blocks of Karelian, Baikal, Caledonian and Hercynian ages [6-8].

In various regions of the West Siberian plate, the additional plate covers various sections of the Paleozoic and Triassic sections. In general, it is characterized by discrete distribution and block-folded structure. The degree of dislocation of volcanic sedimentary formations in different geoblocks is different. In the northern and eastern regions of the plate, the Paleozoic rocks of the sub plate floor fill a number of rather deep depressions, within which the Paleozoic thickness reaches 4-6 km, and sometimes even more.

According to the results of analyzes of surface samples (taking into account rejection), oil throughout the section: sulphurous (0.17 - 1.87 %), the average is 0.98 %, resinous (0.17 - 20.60 %), the average is 8.97 %, waxy average is 2.85 %. The density of oil varies from 783.9 to 887.0 kg/m\textsuperscript{3} and on average for the reservoirs is 860.6 kg/m\textsuperscript{3}, the viscosity at 20 °C changes from 2.26 mm\textsuperscript{2}/s to 38.14 mm\textsuperscript{2}/s. The composition of the petroleum gas is determined by the released during the stepwise separation of oil obtained by a single degassing. All released gas, during degassing, is fat, the methane content in it is 72.07 % (stepwise separation) and 59.96 % (single degassing), ethane is 24.70 % (stepwise separation) and 36.17 % (single degassing). The content of carbon dioxide in the dissolved gas of the Jurassic strata is higher than that of the overlying ones [9].

In terms of its geological structure, this deposit belongs to the II group of complexity (“difficult” or “very difficult”). As of 01.01.2016, the field is characterized by 20 productive formations, represented by 75 oil deposits [10].
By now, the main part of highly productive reserves has already been put into development; new wells are being drilled in zones of lower productivity. Along with the identified stages of field development, it is necessary to note the stages in the development of the field associated with the activities of the subsoil user, a gradual change in the structure of the technologies used.

Since the beginning of the development of the field 178,730 thousand tons of oil has been produced. The selection from the initial recoverable reserves is 63.3% with the current water cut of 86.6%, the oil recovery factor is 0.248. Liquids since the beginning of development, 489429 thousand tons have been withdrawn; the accumulated water-oil factor is 1.7.

The development of productive formations of the field is currently carried out on the basis of the project document [11].

Basic technological solutions of the project document:

- Selection of 10 development objects: BS$_{10}^{2-3}$, BS$_{11}$, BS$_{12}$, YUS$_{1}$, YUS$_{2}$, BS$_{16-22}$, YUS$_{0}$-Ach, YUS$_{0}$, BS$_{10}^{6}$, BS$_{10}^{1}$;
- Development systems:
  - For the BS$_{11}$ object, an areal inverse seven-point one with a distance between wells of 500 m is selected; development systems:
  - For the BS$_{10}^{2-3}$ facility - three-row block in combination with focal water flooding and an inverted seven-point system, with the placement of wells along a triangular grid with a distance of 500 m between wells, with a compaction of the spatial grid of wells in the zone of development of maximum oil-saturated thicknesses;
  - For the BS$_{12}$ facility, a three-row development system with edge water flooding in the western part of the reservoir with a distance between wells of 500 m;
  - For object BS$_{16-22}$ - areal inverse seven-point with a distance between production wells of 500 m, use of both independent and return well stock;
  - For deposits of the YUS$_{2}$ object - three-row block with a grid of 500 by 500 m (deposits 9 - deposits 3, 4, 5 YUS$_{11}$-YUS$_{12}$), areal five-point system with a distance of 465 m (deposit 12 - deposit 6 YUS$_{11}$-YS$_{12}$, deposit 1 - YUS$_{12}$), areal five-point system with a distance of 450 m, reservoir 14, reversed seven-point system with a 500 by 500 m grid for the remaining deposits;
  - For the YUS$_{2}$ facility - conducting a pilot industrial development (OPD) on the choice of the facility development technology, forming a five-point development system with a distance between wells of 450 m;
  - For the YUS$_{0}$-Ach, YUS$_{0}$ facilities, additional studies to substantiate production capabilities;
  - Commissioning of formation BS$_{10}^{1}$ simultaneously and separately with BS$_{10}^{2-3}$ and BS$_{11}$, introduction of a part of the formation that does not coincide in plan with BS$_{10}^{2-3}$ and BS$_{11}$ with its own well pattern.

The project document for the development of the Tevlinsko-Russkinskoye field describes geological and technical measures (GTM), which are mainly intended to maintain the planned production of oil and gas. To increase the efficiency of the implemented development system, the project document provides for measures to intensify oil production [12-14].

3. Results

Efficiency of geological and technical measures at the Tevlinsko-Russkinskoye field in 2016:

- The number of hydraulic fracturing jobs performed - 85, additional oil production amounted to 1,925,000 tons;
- The number of hydraulic fracturing jobs performed - 85, additional oil production amounted to 1,925,000 tons;
- Number of drilled horizontal wells - 3, additional production 156,000 tons;
- The number of second boreholes drilled - 7, additional oil production - 77,900 tons;
- The number of treatments of the bottom hole formation zone - 15, additional oil production – 11500 tons;
- The number of flow diverting technologies - 2, additional oil production - 22,000 tons.

In total, additional oil was produced after the application of geological and technical measures 2,192,400 tons. In terms of the efficiency of geological and technical measures, drilling horizontal wells and hydraulic fracturing at the Tevliansko-Russkinskoye field are the most effective measures to stimulate oil production.

4. Discussion
The stock of producing wells amounted to 1,463 wells (92.0 % of the main operating stock), idle - 34 units (2.1 %), inactive - 91 wells (5.7 %). The operation of wells using ESP provides almost the entire volume of current oil production (99.7 %) at the field. The average annual production rate of wells for oil is 12.7 tons / day, for liquid is 94.8 tons/day [9].

5. Conclusion
Analyzing the initial geological and physical information on the Tevlinsko-Russkinskoye field, the following conclusions can be drawn:

- The Tevlinsko-Russkinskoe field is located in the Khanty-Mansiysk Autonomous Okrug. The geological structure of the deposit involves metamorphic and igneous rocks of Paleozoic age, effusive-sedimentary rocks of undivided Permian-Triassic age and sedimentary deposits of Mesozoic-Cenozoic ages. The field consists of 75 oil deposits in 20 pay zones. Most of the deposits are stratal, domed, complicated by lithological boundaries, the type of reservoir is terrigenous;
- During the entire operation of the field, 524 geological and technological measures were carried out at the producing well stock of the field. The total additional oil production with a carryover effect was estimated at 772.37 thousand tons. The operations were classified as successful operations, the increase in oil production for which, after the implementation of measures, exceeded 2.5 tons/day;
- The entire operating production fund of the field is mechanized, the main operation falls on wells equipped with ESP units. The main oil-bearing stratum is a complex within the Sortymskaya suite.

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