The use of continuous monitoring systems for simultaneous-separate well operation in order to increase the rate of oil extraction

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The use of continuous monitoring systems for simultaneous-separate well operation in order to increase the rate of oil extraction

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Abstract. The article contains theoretical and methodological materials based on the analysis of literature data and research in the field and in laboratories using actual methods of processing initial information and analyzing them.

Introduction to the technology of simultaneous-separate operation (SSO)

Fuel resources provide energy not only the entire industry of any country in the world, but virtually all spheres of human life. The most important part of the fuel and energy complex in Russia is the oil and gas sector.

According to experts, more than 70% of the oil reserves in Russia are among the hard to recover, among them a significant amount of reserves is concentrated in reservoirs with low filtration and capacitive properties. At the same time, the task of increasing the rate of oil production at existing and new fields remains topical and today, most of the oil and gas fields in the Russian Federation have a multi-layer structure. [1]

At present, the technology of separate exploitation is finding increasing use in the development of a multi-layer deposit. This allows, using a single well grid, to select oil from several layers at the same time. This technology accelerates the production of reserves and allows increasing the volume of extracted products. The problem of accounting and the current state of development of reserves from a multi-layer deposit has not been resolved to date. Particular attention is paid to the tasks of assessing the efficiency of oil extraction. From a multi-layer reservoir with the use of effective technologies for reservoir energy maintenance, their impact on the modes and operation of wells equipped for simultaneous-separate operation (SSO) in conditions of water-gas impact on the reservoir, stationary and non-stationary waterflooding. Also pay attention to the problems that are associated with determining the criteria for selecting wells for the technology of simultaneous-separate operation based on physicochemical and geological characteristics, the reservoir's reservoir properties. Important issues are the creation of a technology for the separation of recoverable products with the simultaneous development of seams.

Analysis of the effectiveness of the SSO

In the industrial development of NGDU Yamashneft there are 9 deposits, which are characterized by small size, difficult to extract reserves, low productivity, zonal and layered heterogeneity of the seams.

The dynamics of oil production and watering for the period of formation and development of NGDU Yamashneft can be divided into three stages. The first and second stages are characterized by active input into the development of new deposits. The third stage is characterized by additional development of existing deposits, optimization of the carbonate deposit development system. Since the discovery of new deposits was not foreseen, an increase in oil production was possible only if the geological section was involved in the development of reserves throughout the vertical. All of the above prompted NGDU Yamashneft to test the WEM technology in 2003 at well # 2046 of the Berezovskoye field. The number of installed units of simultaneous separate oil production today is 238 wells (18% of the total for OAO Tatneft, 19% of total production).

The large-scale application of simultaneous separate operation facilities at OAO Tatneft to date has reached 1,269 wells, but the question of finding ways to improve the profitability of the well has remained topical. As a result of the introduction of simultaneous separate production facilities, 33 wells (or 14% of the total SSO fund) withdrew from the unprofitable category. 25 wells from them have already paid for the incurred costs.

Using SSO technology, they introduced single-shaft plants at 7 sites. The total increase for 7 wells was 37.1 tons per day. on oil.

At the Yersubaykinskoye field, using SSO technology, they successfully installed one-lift units in wells No. 4871 and 4873 and received a total increase of 14.6 tons per day.

Thanks to the combination of simultaneous separate extraction and injection technologies at the Yamashinskoye field, a classical scheme for the development of the site was implemented, which included both the injection zone and the sampling zone. In the wells No. 2524, 2526, 2528, 2531, exploiting the deposits of the Turney stage, the Tula horizon was added. The daily increment in production by the site was 11 tons for oil.

In order to maintain the reservoir pressure and to compensate for the selection during the same period, the injection in the injection well No. 2527n, through which water was pumped into the formation, was injected using the ORZ technology. Accumulated additional production at this site amounted to more than 25 thousand tons of oil.

Using the technology of separate operation at the next section of the Shegurcha field, they incorporated the Tula layer in Bobrikov wells No. 1285, 4772, and introduced single-shaft units, thereby significantly increasing the coverage of the area produced by injection and, therefore, the efficiency of the injection itself. Accumulated additional production in this area along the Tula horizon amounted to 14 thousand tons, the total increase - 10 tons / day. on oil.

Since February 2013. At the Arkhangelskoye field, a zero rate of mineral extraction tax (MET) was applied for high-viscosity oil from the Bashkirian stage. An obligatory condition for such production is the separate accounting of extracted preferential oil. And here the installation of simultaneously separate operation has become an indispensable tool for solving this problem. Preserving reserves for existing facilities, the Bashkirian stage was introduced into the development by introducing two-lift units of separate extraction and pumping (ORDiZ) at 13 wells with a total increase of 40 tons per day.

The technology of ORDiZ can be called an extraordinary solution, and earlier it could not be imagined about the combination of two assignments by one well. New capabilities of the WEM enabled the introduction of the ORDiZ technology in production well No. 10969 in 2010.

Yersubaykinskoye field for the organization of additional waterflooding sites without additional capital costs for development. At the injection well No. 7297, to connect the Bashkirian Stage, thereby increasing the production of reserves for this facility.

All new specialists of the NGDU Yamashneft have always been welcomed. The first installation of a separate small-diameter production at TATNEFT was simultaneously implemented at well No. 16502 of the Berezovskoye field in December 2012, which allowed the development of the western part of the Tula horizon, the central part of which was already exploited by simultaneous separate production facilities. The increase was 4.9 tons per day.

In 2012, the first installation for the simultaneous separate operation of three facilities was tested at well # 4752. The gain was 3,6 tons / day.

The above-mentioned technologies are very relevant for today, since there is a fund of wells for the introduction of these facilities. Potential fund for the implementation of the simultaneously separate extraction of 3 layers is 35 wells. [2]

Analysis of the operation of wells at the Alekseevsky deposit

The development of reserves with simultaneous separate utilization of seams is determined by the adjustment of the pumping equipment based on the potential capacity of the formation determined by the geological service of the oil enterprise.

At the Alekseevskoye field oil reservoir capacity allows the development of a number of facilities with a single well grid. Exploitation of reservoirs by a common filter over the entire history of field development was not carried out by Rostechnadzor bodies and the use of separate exploitation was simultaneously approved to develop reserves of Kizel, Zavolzhsky and Dankovo-Lebedyan productive horizons.

As of October 2016, a significant part of the wells at the same time of separate operation (14 wells) simultaneously conducts separate operation of the Kizel and Zavolzhskiy horizons and 8 wells, which simultaneously operates a separate operation of the Kizelov and Dankovo-Lebedyan horizons. The histogram of the distribution of liquid flow rates is shown in Figure 1. Most wells at the same time separate operation of the Kizel and Zavolzhskiy horizons (Fig. 1, a) operate with a rate of 5.1 t / day (9 wells) along the Kizel horizon, with a daily rate of 5.3 t / d (6 wells). A similar distribution of wells along the selected intervals of fluid flow rates is associated with similar geological and physical characteristics of the seams.

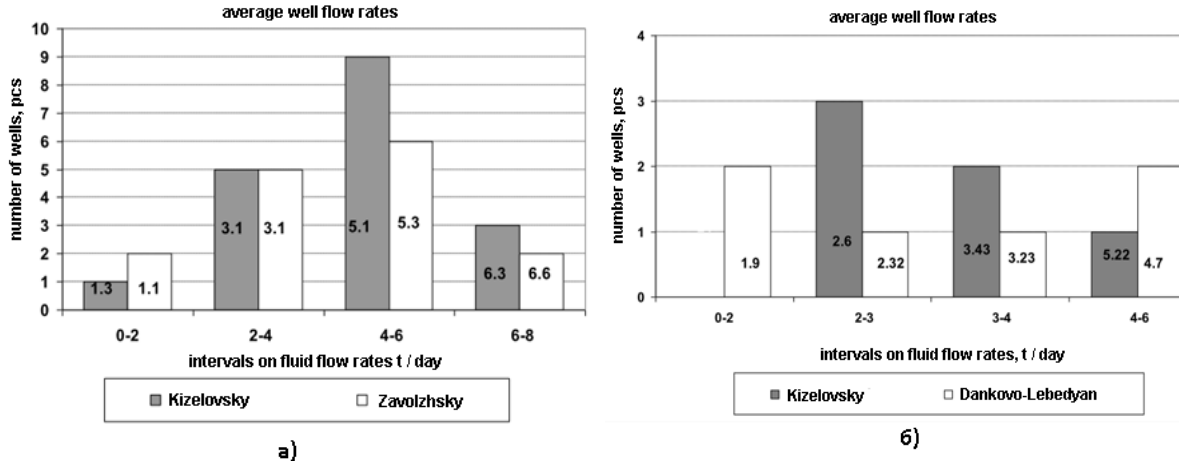

Figure 1 - Histograms of the distribution of liquid flow rates along the wells at the same time as separate exploitation:
a) Kizel and Zavolzhskiy horizons; b) Kizel and Dankovo-Lebedyan horizons

Most of the wells in the Kuzelovsky and Dankovo-Lebedian horizons (Fig. 1, b) operate with an average flow rate of 2.6 t / d (3 wells) along the Kizel horizon. According to the Dankovo-Lebedyan horizon, two wells operate at an average flow rate of 1.9 tons per day and two wells take an average of 4.7 tons of fluid per day. We note a different character of the distribution of wells in terms of the selection of the Kizel and Danko-Lebedian horizons within the allocated groups.

Figure 2 shows a comparative estimate of oil production. Given horizons with reference to the development using the WEM technology and the exploitation of only the Zavolzhskiy horizon and only Kizelov horizons.

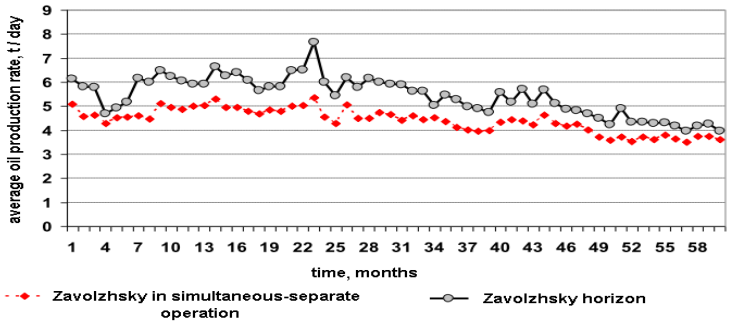

Figure 2 - Dynamics of average oil production through the Volga horizon in the wells at the same time-separate operation and the leading separate operation of the Transvolga horizon

Figure 2 shows that for the wells with simultaneous-separate operation and the wells operating only the Zavolzhsky horizon, there are insignificant differences in operating modes. This indicates the correct selection of the parameters of the installed pumping equipment.

Wells that extract oil only from the Kizel horizon are characterized by lower rates (Figure 3). Perhaps this is due to the fact that wells operating only on the Kizel horizon are in less productive areas (Figure 4).

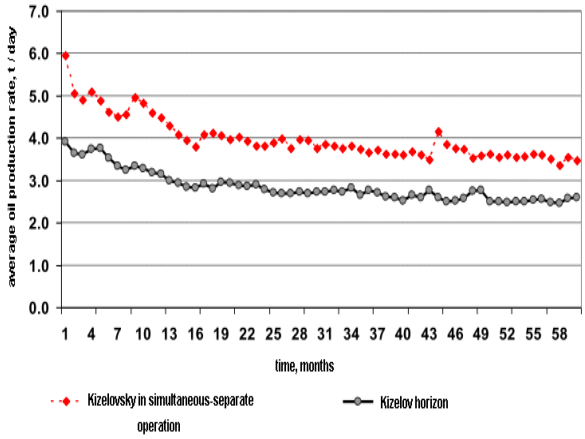

Figure 3 - Dynamics of average oil production through the Kizel horizon in wells of simultaneous-separate operation and leading separate operation of the Kizel horizon

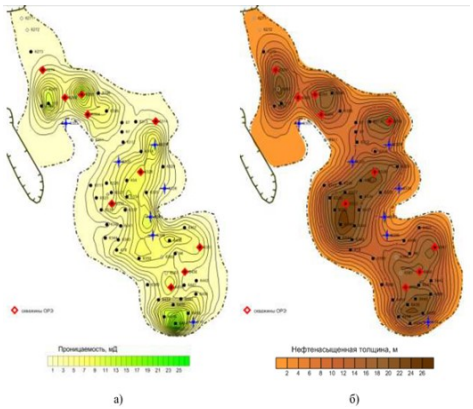

Figure 4 - Permeability maps (a) oil-saturated thicknesses (b) Kizelovskoe horizon

On wells with simultaneous separate operation, working on the dankovo-Lebedyansky horizon, it can be noted that the potential of the reservoir, as can be seen from the dynamics of oil production. (Figure 5), under the given regime, correspond to the productive possibilities for wells working only on the dankovo-Lebedyansky horizon.

Wells of the Bobrikov horizon, with simultaneous use at the same time for almost the entire development period, are characterized by greater productivity compared to the wells that separate the Bobrikov horizon (Figure 6), only in recent years the average flow rate has been reduced due to the increase in water cut.

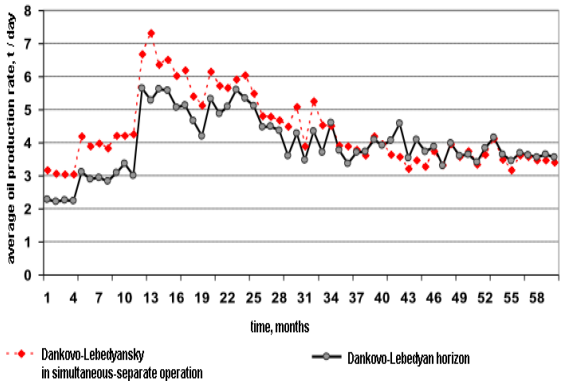

Figure 5 - Dynamics of average oil production through the Dankovo-Lebedyan horizon in wells of separate-separate operation and leading separate operation

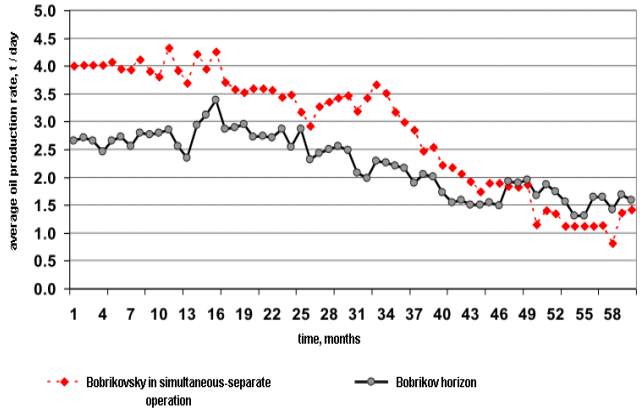

Figure 6 - Dynamics of average oil production. on the Bobrikov horizon in wells with simultaneous-separate operation and leading separate operation of the Bobrikov horizon

Unlike reservoir productivity at various ways oil of the same productive horizon due to the selection of predetermined operating parameters of pump set that optimizes individual wells dual completion formations.

Alekseevskoye field. For this purpose, the geological and physical parameters of the wells are comparable with accumulated oil withdrawals. for the entire period of simultaneous-separate operation.

Basic geological and physical characteristics of productive formations Alekseevskogo field, which is applied simultaneously-lobed operation is: Average depth, reservoir type, reservoir type, the average total thickness of the well, the average net pay thickness, porosity, permeability, gross ratio, dissected coefficient initial reservoir temperature, the initial reservoir pressure, oil viscosity at reservoir conditions, the density of the oil under surface conditions, in absolute mark K, the

volume ratio of oil, sulfur and paraffin oil pressure of oil saturation and gas, GOR and water density at surface conditions. Since oil horizons are considered differences in physicochemical properties, the reference parameter to identify patterns for wells with dual completion is received transmissibility layers.

The ratio of accumulated oil abstraction to formations developed simultaneously and separately is directly proportional to the ratio of the hydroconductivity of the corresponding strata:

$$\frac{Q^1_{\text{нак}}}{Q^2_{\text{нак}}} = f\frac{\xi_1}{\xi_2} \quad (1)$$

Figure 7 shows the distribution of wells at the same time-separate operation, depending on the ratio of accumulated oil sampling and the difference in geological characteristics of the seams. According to the presented distribution of wells with simultaneous-separate operation, four quadrants have been identified, with respect to which three groups of rational application have been singled out simultaneously for separate operation:

Group I (rational simultaneous-separate operation) – the specified operating modes of each of the strata correspond to the potential capabilities of the formation based on the geological and physical characteristics of the reservoirs, the installed pumping equipment operates in the optimal mode. Group II (irrational simultaneous-separate operation for the first layer) – the reservoir properties of the first layer indicate a possible increase in the selection by technological optimization of the pumping equipment, which will allow the well to be transferred from Group II to Group I. Group III (irrational simultaneous-separate operation for the second formation) – the reservoir properties of the second layer indicate a possible increase in the selection by means of technological optimization of pumping equipment, which will allow the transfer of the well well from a group III to group I.

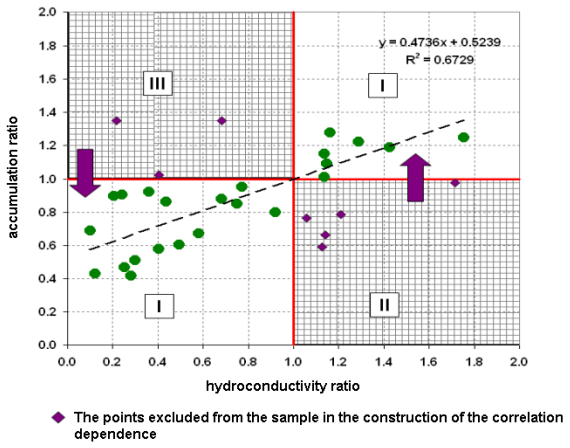

Figure 7 – Distribution of wells at the same time as a separate operation depending on the ratio of accumulated oil abstraction and the difference in the geological characteristics of the seams

Figure 7 shows the main part of the wells (75%), which operates in the optimal mode, that is, simultaneous-separate operation is rational. For 25% of the wells, technological optimization is recommended, aimed at increasing the productivity of pumping equipment. [3]

Thus, it can be concluded that, in general, the implemented technology of simultaneous-separate operation at Alekseevskoye field "Aloyl" is characterized by the coordinated work of carefully selected pumping equipment and productive layers combined for simultaneous separate oil extraction. Such a picture indicates a uniform production of reserves, excluding inter-river flows and other problems of joint development.

Only the expansion of the field of application of the technology, simultaneous and separate production, will allow us to conduct cost-effective operation of wells and deposits, ensuring the maintenance of reservoir pressure, early involvement in the development of reserves while maintaining the existing development system, sealing wells without additional drilling, reducing the project fund, creating water-costs.

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