THE SELECTION OF AN EFFECTIVE INFILL DRILLING PROGRAM IN THE CONDITIONS OF AUTO-FRACTURING CRACKS DEVELOPMENT IN INJECTION WELLS

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The state of the lower part of oil and gas fields in Western Siberia in recent years is characterized by a decrease in the quality and structure of industrial oil reserves. New deposits, mining and hydrocarbon production. As a rule, there are highly permeable reservoirs that are at the third / fourth stage of development, when the potential for drilling new wells is almost exhausted. At the same time, despite a decrease in the level of oil production and an increase in reserves, underdeveloped oil reserves remain in many fields under development, which can be involved in a range of geological and technical measures and drilling of tight wells in areas where residual hydrocarbon reserves are located.

The work considers an oil field in the Tomsk region, which develops one operational development object U12+3, which includes two productive formations: low-permeability U12 and heterogeneous U13. Despite significant differences in reservoir properties and, accordingly, production capabilities of the reservoirs, they are combined into one development object and are operated by a single grid of directional wells in order to reduce costs and make the project economically feasible. The development of the U12+3 production facility is characterized by falling levels of oil production and premature flooding of the existing well stock, which, according to the oil-water factor estimate, is not able to produce the approved hydrocarbon reserves, which necessitates the search for reserves in the drilled parts of the field.

In order to localize the residual hydrocarbon reserves and predict oil production levels, a 3D filtration model of the target sector of the field was constructed in the tNavigator hydrodynamic simulator. The average porosity in the model is 0.153 units, the average absolute gas permeability is 5.49 mD, and the initial oil saturation is 0.50 units. Fig. 1 presents a map of the current oil saturation according to the model at the date of analysis.

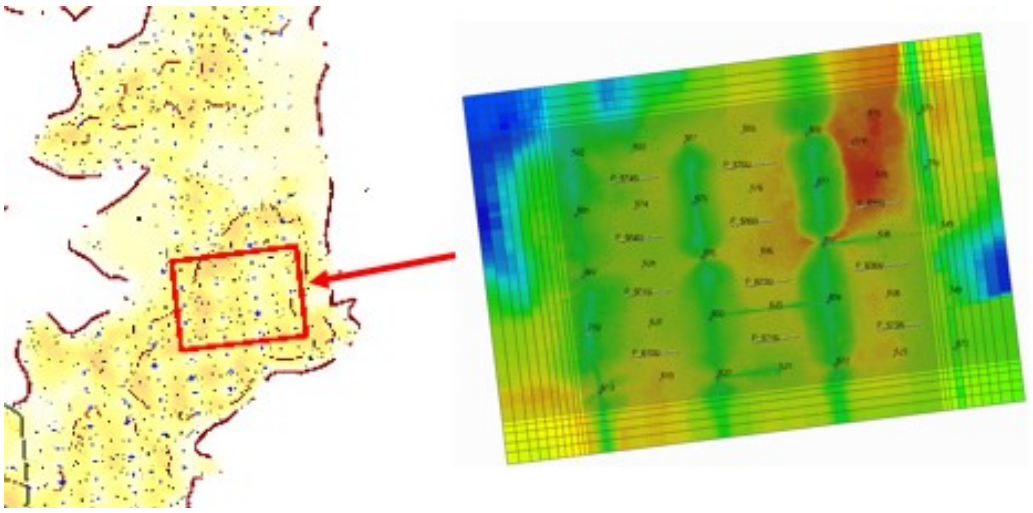


Fig. 1 The map of the current oil saturation of the field sector

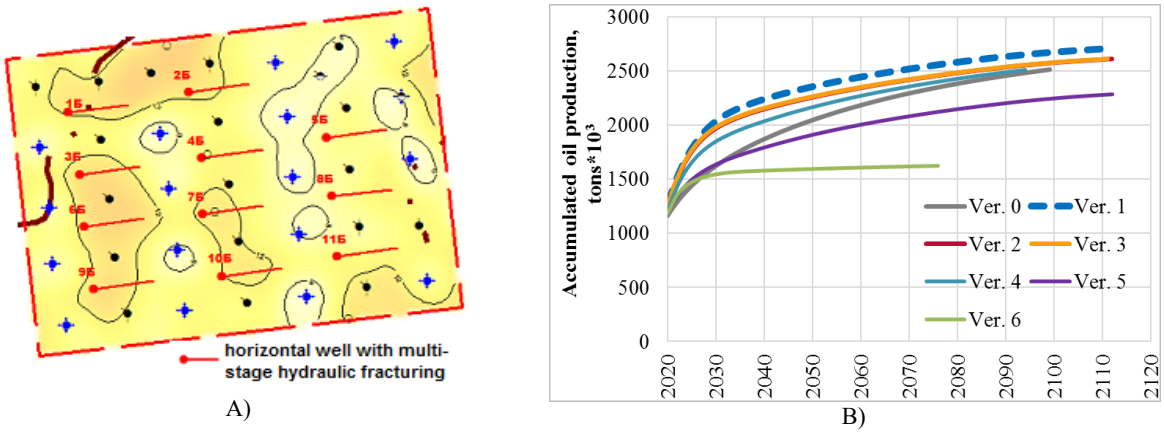
After evaluating the operation of the basic well stock, the formation of weakly drained zones between the wells in the production rows was determined. For the most part, an in-line development system was formed at the field with a row spacing of 500 m. Due to the fact that in all wells during commissioning, fracturing was used as a completion method and the direction of regional stress was not taken into account, a system of cracks was formed in the formation, directed along regional stress. This arrangement of hydraulic fracturing during the formation of rows of injection wells contributed to the unification of fractures into a single "gallery" of filtration. In addition to model calculations, this assumption was proved thanks to a tracer study, the results of which also showed filtration of the injected fluid through joint hydraulic fracturing from one injection well to another - the reaction of the labeled agent in neighboring producing wells is much less noticeable.

When developing low-permeability reservoirs, many producing companies use hydraulic fracturing operations both in producing wells and injection wells, for example, «RN-Yuganskneftegaz» [2]. In the zones of drilling new wells during hydraulic fracturing, cracks propagate in the direction of maximum horizontal stresses if there is no significant change in pressure and temperature fields [5]. In order to maintain reservoir pressure and compensate for fluid withdrawals during the development of low-permeability reservoirs, it is necessary to pump fluid at high pressures, therefore, it is quite difficult to avoid the development of auto-fracturing cracks. As a result of this, the risk of unfavorable waterflood coverage of the reservoir and the formation of weakly drained zones increases significantly, so it is extremely important to consider the possibility of auto-fracturing cracks when choosing a development system.

The complexity of this problem lies in the fact that it is extremely difficult to control the formation of induced cracks in the wells of the injection rows, since there are no sufficiently accurate methods for quantitatively describing the characteristics of auto-fracturing fractures, as well as the dynamics of their development in the reservoir. In [3-4], the following factors for the development of auto-fracturing cracks were identified: the pressure of the liquid at the bottom is higher than the crack propagation pressure; the presence of mechanical impurities in the injected fluid, contributing to the

deterioration of the bottomhole formation zone; low temperature of the injected fluid, which contributes to the cooling of the reservoir.

In order to extract weakly drained reserves between wells in the production rows, several options for developing the sector were formed and calculated on a hydrodynamic simulator: development of a network of horizontal wells with multi-stage hydraulic fracturing with a horizontal length of the trunk of 500 m, 300 m and 300 m at an angle of 45 °, as well as development options a denser grid of directional wells with hydraulic fracturing plus an additional option with the transfer of wells in the production rows to the reservoir pressure support system after running out of stocks. Figure 2 shows the estimated cumulative oil production for six development options and the recommended option scheme. According to the results of calculations on the model, the optimal option for the development of the sector is the option with horizontal wells 500 m long - cumulative oil production will be 2711 thousand tons.



A) B)

Fig. 2 The scheme of the recommended option for the development of the sector (A) and cumulative oil production for all design options (B)

According to a feasibility study, with the current system of field development, in order to increase the coverage factor and, accordingly, the oil recovery coefficient, it is recommended that drilling with a grid of horizontal wells with a horizontal length of the trunk 500 m into weakly drained zones between the wells of the production rows is recommended. In addition, it is necessary to optimize the waterflooding system to maintain reservoir pressure in areas of intensive drilling; this requires the preparation of a program of geological and technical measures aimed at increasing the injectivity of injection wells (repeated hydraulic fracturing, treatment of the bottom-hole zone, hydrodynamic effects). It is also recommended to consider the possibility of applying effective methods for increasing oil recovery and flow diverting technologies in order to isolate highly permeable washed zones of the reservoir and redistribute the flow of filtration to increase the coverage factor and more fully recover oil reserves.

References

1. Bachin S.I. Additional development of residual oil reserves of highly watered deposits with heterogeneous reservoirs: an abstract of the dissertation of the candidate of science: 25.00.17. – Ufa, 2008. – 24 p.
2. Baykov V. A., Burakov I. M., Latypov I. D., Yakovlev A. A., Asmandiyarov R. N. Monitoring the development of technogenic auto-fracturing cracks while maintaining reservoir pressure at the fields of LLC RN-Yuganskneftegah // Oil industry. - 2012. - No. 11. – P. 30-33.
3. Hustedt B., Zwarts D., Bjoerndal H.P. Induced fracturing in reservoir simulations: application of a new coupled simulator to waterflooding field examples // SPE 102467. – 2006.
4. Latypov I.D., Borisov G.A., Khaidar A.M. Reorientation of the azimuth of the re-fracturing fracture in the fields of LLC RN-Yuganskneftegaz // Oil industry. - 2011. – No. 6. – P. 34-38.
5. Longuemare P., Detienne J-L., Lemonnier P. Numerical modeling of fracture propagation induced by water injection / re-injection // SPE 68974. – 2001.