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THE EFFICIENCY OF DRILLING MULTI-HOLE HORIZONTAL WELLS WHILE DEVELOPING A LOW-PERMEABLE COLLECTOR ON THE EXAMPLE OF TOMSK REGION DEPOSIT

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Due to the universally deteriorating structure of reserves, the growing risks of watering wells in oil and gas fields located at the third or fourth stages of development, the low degree of development of recoverable reserves, it becomes necessary to search for new technologies and rationalization solutions that would enhance the efficiency of developing complex fields, in particular low permeability collectors characterized by low values of oil-saturated thicknesses and filtration-capacitive properties. Under the conditions of developing this type of reservoir, one of the methods to optimize the development system is to drill multi-hole horizontal wells (MHW), which, with the right approach, contribute to solving purely technological problems, as well as economic, environmental and geological ones.

A multilateral well is considered to be a well that, in addition to the main shaft, has one or more branches that are drilled within the same production development site. This technology has been shown to be effective in the exploitation of viscous oil reservoirs, reservoirs with low reservoir pressure, reservoirs with low permeability, reservoirs with underdeveloped natural fracture, reservoirs with a thin-layered or multilayer structure, reservoirs with the risk of the formation of distinct structural or stratigraphic traps (lenses, half-lenses, layers), which are not involved in the development of traditional drilling methods, in deposits with water-oil (gas-oil) contacts and the absence of lithological jumpers, etc [1].

Unlike multilateral wells, which also have several boreholes, but open up different production development sites, multi-hole horizontal wells are located within the same development object, therefore the joint of the boreholes and the bottom holes of the multi-hole horizontal wells are usually located at a small distance from each other. In this regard, according to the TAML classification, multi-hole horizontal wells drilling have the first / second difficulty level [3]. Since the liner is lowered into the main trunk after drilling is completed, sometimes access to the branches is not possible. A distinctive feature of the design of the multi-hole horizontal wells, in comparison with traditional horizontal wells (HW), is the casing of only the main trunk, while the branches remain uncased, or the perforated tube is run if necessary [2].

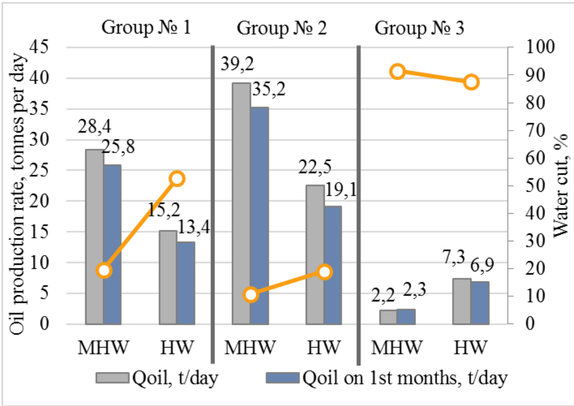
Between 2016 and 2019 twelve multi-hole horizontal wells were drilled at an oil field in the Tomsk Region into a low-permeable formation in order to test the technology and optimize the existing development system. The average depth of the formation is 2.6 thousand m, the effective oil-saturated thickness is 2.3 m, the porosity is 0.15 units, the permeability is 4*10-9 m2, and the core is 0.55 units, sandiness - 0.63 units, dismemberment - 1.2 units, oil viscosity - 1.47 MPa*s. In its genesis, the stratum belongs to the coastal-marine sandstones and has a cover character of areal development, the type of reservoir is stratum, vaulted, the reservoir is characterized as terrigenous, pore.

In the course of the work, an analysis was made of the effectiveness of drilling, well drilling and comparing their technological indicators. Three groups of wells were distinguished per production facility, comparable reservoir properties, reservoir saturation, and depression. In the analysis of the participation of 12 multilateral horizontal wells and 18 horizontal wells.

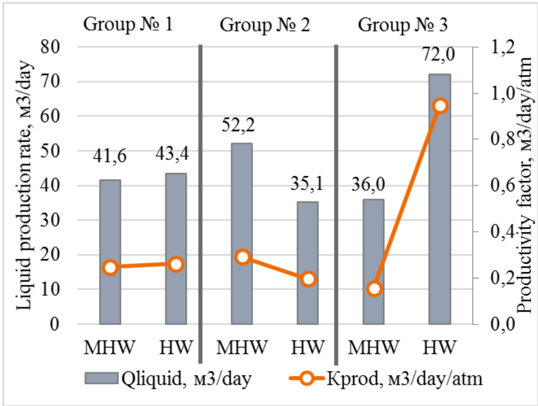
As can be seen from Fig. 1, for two groups of wells out of three, there is a noticeable significant excess of the starting performance of multi-hole horizontal wells over conventional horizontal ones: for group № 1, the average starting oil production rate of the the multi-hole horizontal wells was 28.4 tons / day, and for the horizontal wells - 15.2 tons / day, the average starting fluid flow rate of the MHW - 41.6 m3 / day, HW - 43.4 m3 / day, the water cut of the MHW - 19.6%, HW - 52.7%; for group № 2, the average starting flow rate of oil of MHW was 39.2 tons / day, HW - 22.5 tons / day, the average starting flow of oil of MHW was 52.2 m3 / day, HW - 35.1 m3 / day, water cut of MHW - 10.8%, HW - 19.1%. The rate of decline in oil and liquid production rates of the multi-hole horizontal wells and horizontal wells is characterized by a rapid decrease in production rates in the first three months, after which the wells reach the established operating mode and the decline slows down significantly. In many multi-hole horizontal wells, there is a decrease in water cut after reaching a steady state operating mode and low dynamics of a subsequent increase in the water cut curve - traditional horizontal wells, on the contrary, are characterized by a rapid increase in water cut, which can be associated with hydraulic fracturing of the reservoir at these wells and close location to the oil circuit. All wells are located in similar geological conditions (permeability, saturation and thickness differ slightly) and are exploited with comparable depressions.

For group № 3, the start indicators of horizontal wells are exceeded over the wells of the multi-hole horizontal wells: the start oil production rate of the multi-hole horizontal wells was 2.2 tons / day, at the horizontal well - 7.3 tons / day, the average starting production rate of the liquid MHW is 36.0 m3 / day, HW - 72.0 m3 / day, water cut of the MHW - 91.5%, HW - 87.6%. This is due to non-confirmation of saturation in the areas of well drilling, failure to achieve design productivity and effective penetration of horizontal shafts. In general, the wells of group № 3 are not indicative of analysis and are presented as an example of an unsuccessful choice of the drilling zone for new wells.

In addition to the failure to achieve effective penetration of horizontal wells of the multi-hole horizontal wells, in [5,4], the following reasons are identified for the decrease in the efficiency of the construction of multilateral wells with horizontal endings: mismatch of the length of the horizontal well and geological and technical conditions for well construction, improper location of the well relative to the roof and the bottom of the formation, and anisotropy of properties rocks by thickness and area of the reservoir, differentiation of pressure at the bottom along the length of the horizontal section of the trunk, deterioration of properties, as well as et in nontarget intervals drilling and cement slurries during drilling.



A)



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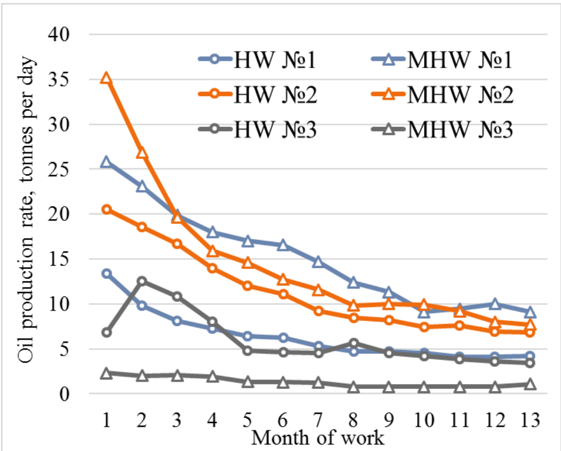
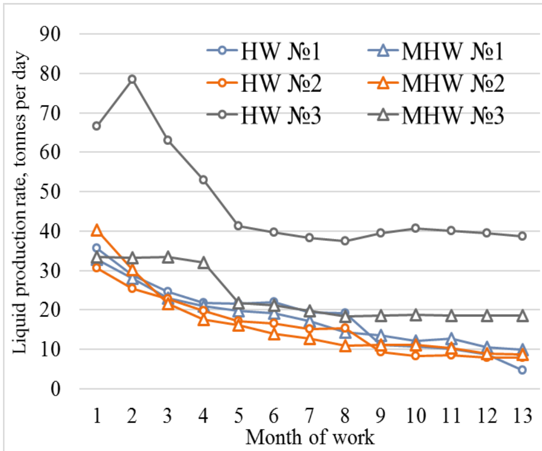


C)



D)

Fig. Comparison of technological indicators for the development of drilled multi-hole horizontal wells and horizontal wells: A - Launch of oil production rates and water cut; B - Launch of flow rate fluids and productivity coefficient; C - The rate of decline in oil production in the first year; D - The rate of decline in fluid production in the first year

In conclusion, it is worth noting that the analysis of the drilling of multi-hole horizontal wells and a comparison of their technological development indicators with actually drilled horizontal wells showed that the multi-hole horizontal wells technology can be quite effectively used along with horizontal wells in the development of low-permeability reservoirs with low reservoir properties and thicknesses.

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