

# ROLE OF HORIZONTAL WELLS AND HYDRAULIC FRACTURING IN INCREASING THE EFFICIENCY OF OILFIELD DEVELOPMENT USING THE EXAMPLE OF OIL AND GAS PRODUCTION DEPARTMENT «AZNAKAYEVSKNEFT» TATNEFT PJSC

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**Abstract.** At a late stage of development, with deterioration in the structure of reserves, the use of advanced technologies and development principles helps to maintain the level of oil production and fully develop reserves. Technologies such as drilling horizontal wells and hydraulic fracturing are undoubtedly technologies with a wide range of applicability at various sites and in different mining conditions. It is especially important to use development systems with horizontal wells in fields with high geological heterogeneity, stratification, presence of numerous replacement zones of reservoirs, zones of wedging, sections of thin reservoirs. Such complex objects include terrigenous sediments of the Bobrikovian horizon of deposits No. 2,3,33 and carbonate sediments of the Kizelian horizon of deposits No 281, 292 of the Romashkino field.

Horizontal technologies for the purpose of involving reservoirs of the Bobrikovian horizon have been actively used since 2015. More than 40 wells with an average increase of more than 15 tons per day have been drilled, this is one of the main factors of production growth in the upper horizons. In 2016, a horizontal well No. 3745G with an input rate of 10.9 tons per day was built on the Kizelian horizon, which is 7 times higher than the production rate of vertical wells.

Main results and achievements of Oil and Gas Production Department «Aznakayevskneft» Tatneft PJSC in the field of horizontal drilling and hydraulic fracturing are considered. According to the strategy of Oil and Gas Production Department, it is projected to drill 55-60 horizontal wells and carry out 20-30 fracturing processes in horizontal wells every year until 2025.

**Keywords:** horizontal wells, hydraulic fracturing, oil recovery, low-permeability reservoir

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The most rational direction of increasing the oil recovery factor of hard-to-recover reserves is the transition to fundamentally new systems of field development. Horizontal wells, having a large penetration area, reduce the filtration resistance and are an effective method of not only increasing the productivity of wells, but also the oil recovery of reservoirs.

It is especially important to use development systems with horizontal wells in fields with high geological heterogeneity, stratification, presence of numerous replacement zones of reservoirs, zones of wedging, sections of thin reservoirs.

Such complex objects include terrigenous sediments of the Bobrikovian horizon of deposits No. 2,3,33 and carbonate sediments of the Kizelian horizon of deposits No 281, 292 of the Romashkino field. The annual production of the Bobrikovian horizon is increased due to the drilling of horizontal wells. With one of the highest annual rates in the company (11.9% per annum),

the efficiency of the geological and technical measures allows to restrain the water cut of the extracted products. Designed oil recovery factor is 0.359, actual – 0.260 (Fig. 1, 2).

Horizontal technologies for the purpose of involving reservoirs of the Bobrikovian horizon have been actively used since 2015. More than 40 wells with an average increase of more than 15 tons per day have been drilled, this is one of the main factors of production growth in the upper horizons (Fig. 3, Table 1).

Increase in drilling volumes for carbonate reservoirs in 2015-2016 allowed to increase production. Production growth in 2016 was 30% (Fig. 4).

Deposits of carbonate reservoirs of Oil and Gas Production Department Aznakaevskneft have small dimensions and small oil-saturated thickness (4-6 meters). The development of such reservoirs by conventional methods is ineffective, in the current economic conditions it is unprofitable.

In 2016, a horizontal well No. 3745G with an input rate of 10.9 tons per day was built on the Kizelian horizon, which is 7 times higher than the production

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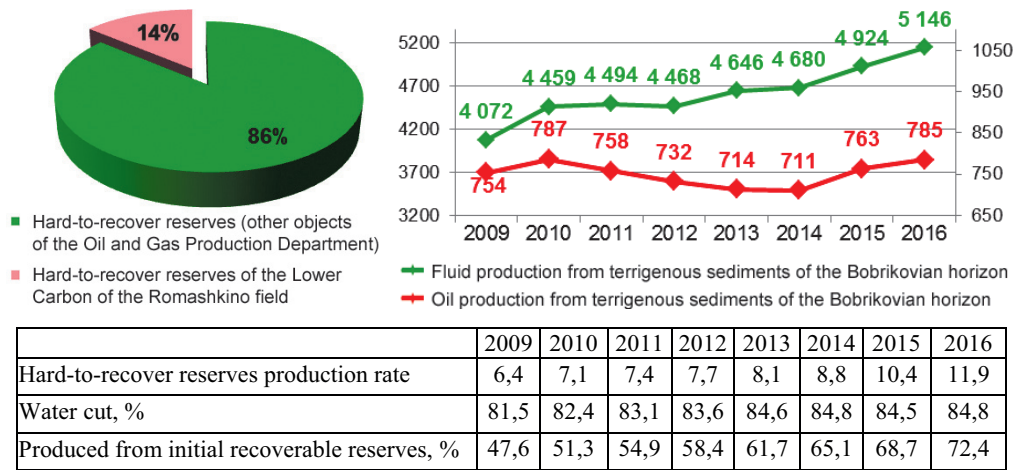


Fig. 1. Dynamics of development indicators for the Bobrikovian horizon of the Romashkino field of the Oil and Gas Production Department Aznakaevskneft

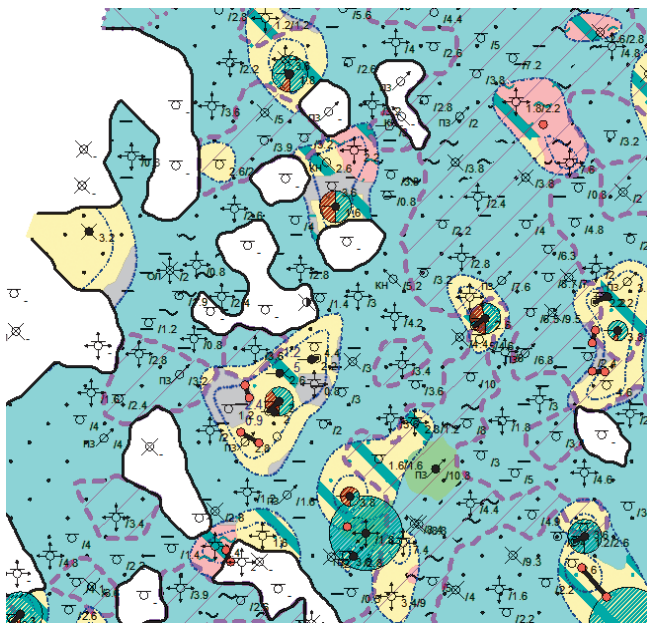


Fig. 2. Compilation of the development map of deposit No. 3 of the Romashkino field

rate of vertical wells. The construction of wells on the Kizelian horizon of deposits No. 281, 292 is actively developing. In 2017, it is projected to drill 15 horizontal wells on carbonate sediments (Fig. 5). 10 wells were put into operation with a current production rate of 6.5 tons per day. However, even penetration of the carbonate reservoir with a horizontal trunk does not always ensure economically justified production rate.

Because of the natural inefficiency of carbonate sediments, an essential condition for intensification is the conduct of bottomhole treatment to create cavernous zones along the trunk, caverns of storage. In recent years, the implementation of hydrochloric acid treatment in the bottomhole zone using a jetting nozzle has been widely used. The technology consists of a hydromonitor treatment with the help of coiled tubing along the entire length of the trunk with the intermittent injection of acid. The treatment of horizontal trunks due to the “excision” in the rock of additional oil supply channels

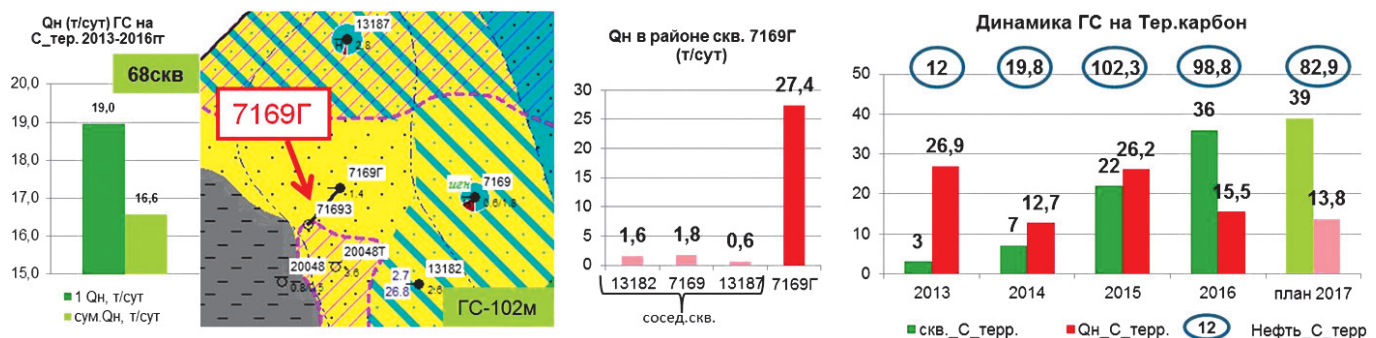


Fig. 3. Application of horizontal drilling on the objects of the Bobrikovian horizon

	2015		2016		2017	
	Number	Production, tons	Number	Production, tons	Number	Production, tons
Drilling of horizontal wells on Bobrikovian horizon	6	18720	18	55414	17	22854
Cutting off the sidetrack, horizontal sidetrack along the Bobrikovian horizon	3	1898	28	38668	6	5926
Drilling of horizontal wells on carbonate sediments	0	0	2	1815	14	20042

Table 1. Dynamics of drilling, cutting of lateral and horizontal holes on Bobrikovian, Kizelian, Dankovo-Lebedyanian horizons

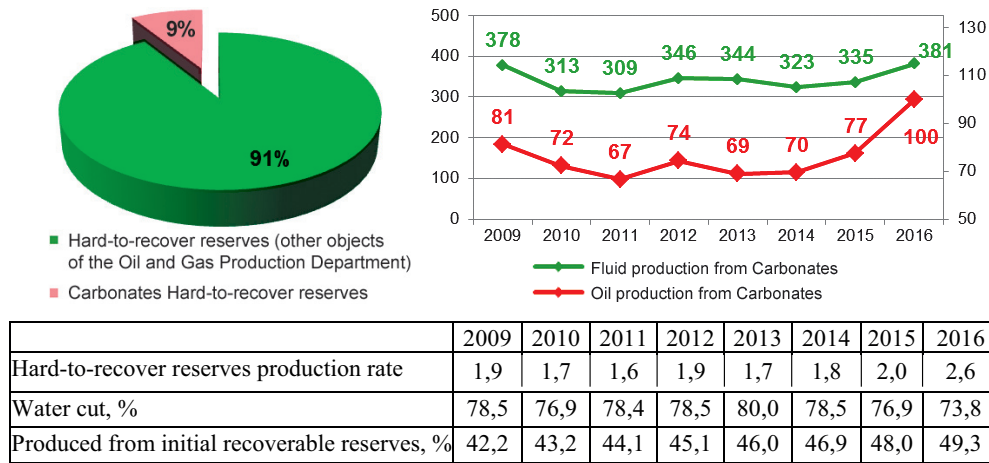


Fig. 4. Dynamics of development indicators for carbonate deposits of the Romashkino field of the Oil and Gas Production Department Aznakaevskneft

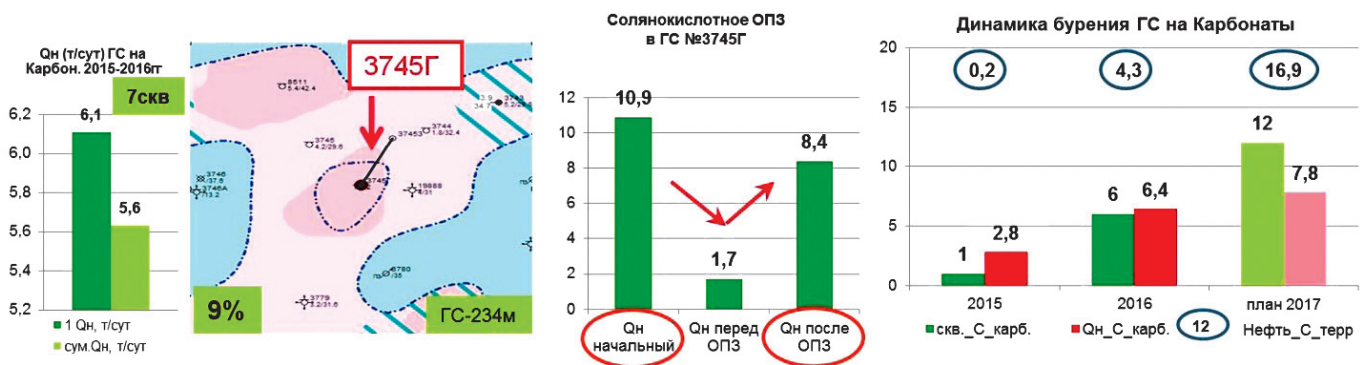


Fig. 5. Application of horizontal drilling on the objects of the Kizelian horizon

(cracks) makes it possible to increase the efficiency of acid treatment. In addition, periodic acid treatments with a constant feed through the “tubes” without lifting the downhole pumping equipment should allow maintaining the production rate during operation.

With the current depletion of reserves, much attention is paid to the search for oil in the transit horizons. Such deposits include the Aleksinskian horizon. Attention to these deposits was inadequate due to the extremely complex geological structure: lace, head-shaped forms of the deposit, often represented by lenses and a rare oil occurrence during drilling. Lithological heterogeneity and substitution are characteristic. At core sampling, oil saturation signs were detected only in one of 18 wells.

After delineating the deposit, the location of five horizontal wells with small diameter was chosen, two of which were drilled this year. According to the results of development, the well has no flow. After the hydraulic fracturing, an inflow was obtained. The current flow rate of the liquid is 10 m<sup>3</sup>/day, Q<sub>oil</sub> = 6.1 t/day, water cut = 31%. As a result, the further drilling of the well section No. 18318G with the hydraulic fracturing was continued (Fig. 6).

The process of building horizontal wells is constantly evolving. One of the directions is the development of Russian-made near-bit modules,

which will allow to abandon the final logging. In the horizontal well No. 6110G of the East Leninogorsk area, a LWD logging tool was used while drilling by the VNIIGIS-ZTK company. The bottomhole assembly included a near-bit module with gamma-ray sensor, and a downhole telesystem with inductive electromagnetic, gamma-ray, neutron-neutron sensors. The current production rate of 40 t/day is provided by the involved interval (Fig. 7).

It is not possible to achieve significant indicators, without the constant search for the technology that involves reserves of various horizons and taking into account the depletion and reservoir characteristics. The Pashian deposits of the Romashkino field are no exception. Beginning in 2012, 12 horizontal wells drilled with an initial average oil production rate of 12 tons/day for the development purpose of the washed oil zones of the terrigenous Devonian. In 2016 horizontal well No. 4619G was drilled in Aznakayevsk area, oil production rate of which is 2-5 times higher than the adjacent vertical wells. In order to extract hard-recoverable oil reserves 48 horizontal wells have been drilled with average oil production rate of 10 t/d (Fig. 8).

The increased interest in hydraulic fracturing is explained by the fact that it can be considered as an element of a system for developing reserves of low-permeability reservoirs (the share of which has grown

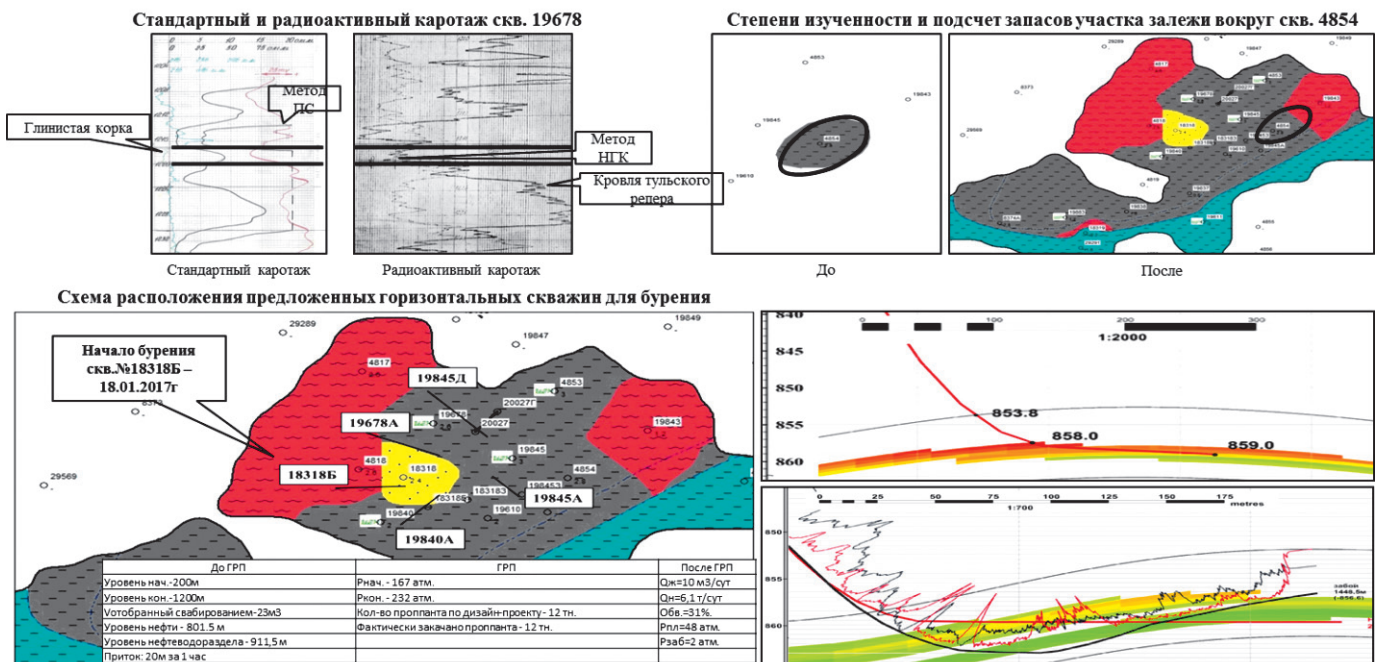


Fig. 6. Involvement in the development of reserves of the Aleksinskian horizon

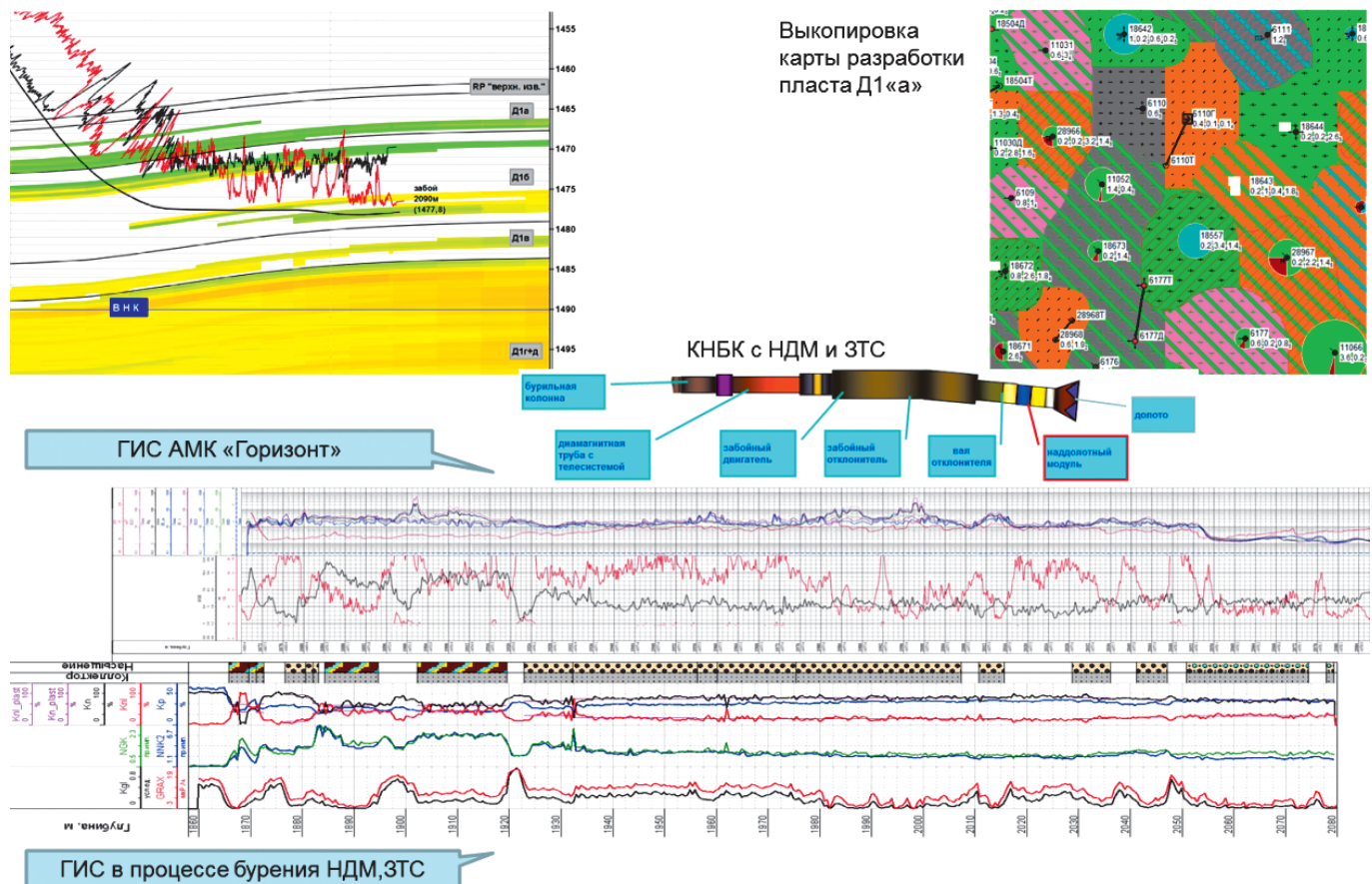


Fig. 7. Logging while drilling well No. 6110G of the East Leniogorsk area

significantly). Hydraulic fracturing affects not only the bottomhole zone, but also the remote sections of the reservoir, and thereby contributes to enhanced oil recovery. In addition, the hydraulic fracturing method is the most powerful method for treating the bottomhole zone, which is capable of creating artificial channels in the reservoir with sufficiently large length.

Hydraulic fracturing in Russia in recent years is being revived on a new technological and technical basis. The reason is mainly due to the fact that for many development facilities with low-permeability reservoirs, there are simply no alternative methods. Only hydraulic fracturing allows intensifying low-productive wells, including weakly draining zones of the reservoir. Of

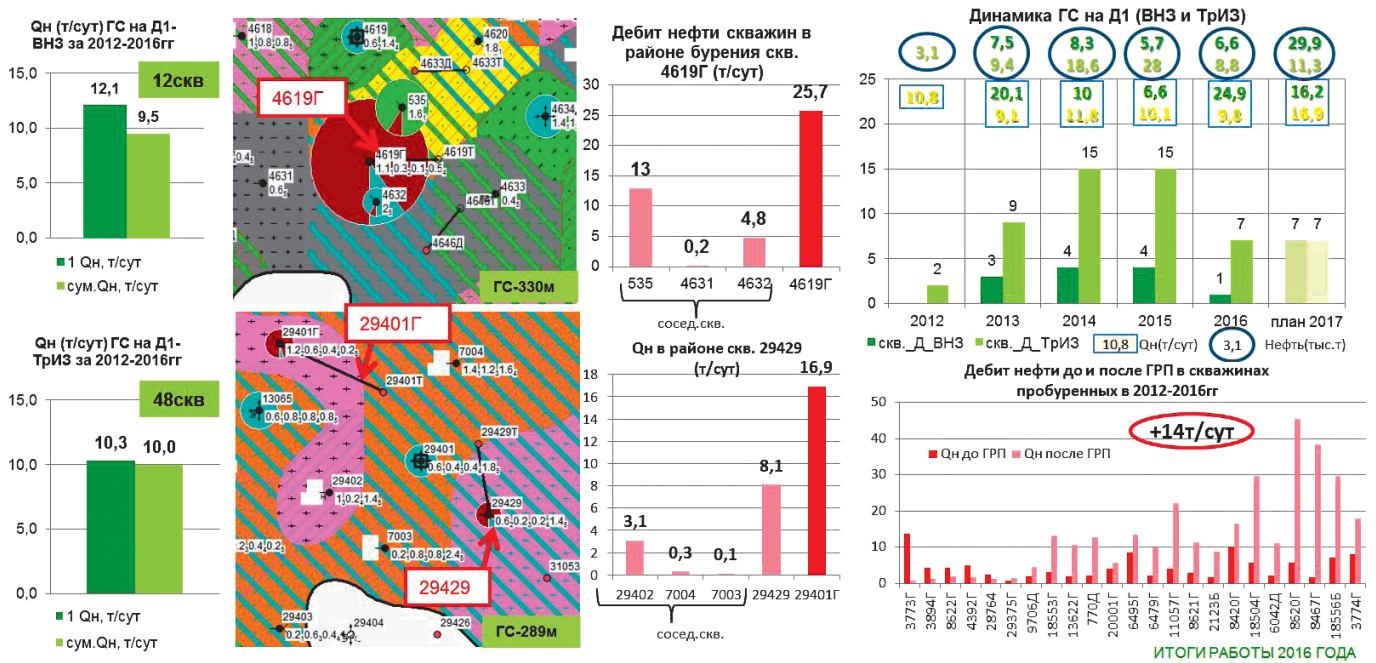


Fig. 8 Drilling of horizontal wells as a method (technology) for the development of reserves from washed zones and hard-to-recover reserves of the terrigenous Devonian

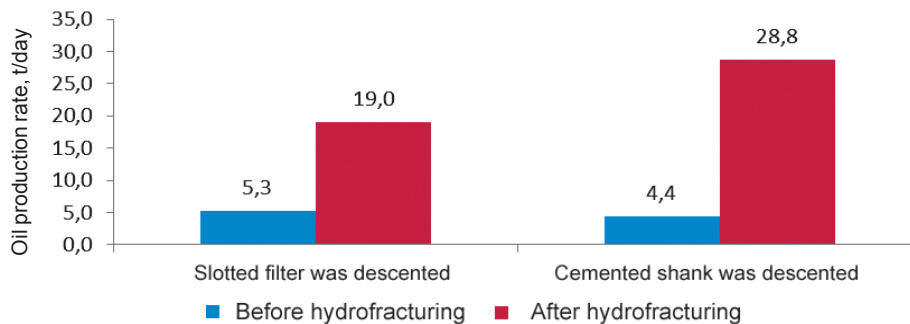


Fig. 9. Efficiency of hydraulic fracturing on horizontal wells of the terrigenous Devonian

course, this applies to horizontal wells, in which not the entire horizontal trunk is involved in the operation due to the considerable heterogeneity of the lateral strata. Since 2012, more than 70 wells have been drilled into the Devonian terrigenous sediments. In order to fully involve the reserves of the entire length of the trunk, fracturing processes are carried out.

The hydraulic fracturing is carried out in two options, depending on the method of completion of the well during construction: 1) by a common filter during descent, 2) intervally during descent of the cemented shank. The results of the hydraulic fracturing in horizontal wells of the terrigenous Devonian are presented in Figure 9.

The upper layer of the terrigenous Devonian strata is a complex reservoir, represented by the interlayering of clays and sandstones both along the lateral and along the strike. The construction of horizontal wells with subsequent hydraulic fracturing allows efficient development of these reservoirs. An example of the impossibility of extracting reserves from highly clayed reservoirs without integrating horizontal wells and

fracturing technologies is well No. 8264G of Pavlovsk area. A 30 m long sock was perforated on the well. According to the logging data, the reservoir in this interval consists of clay with no flow. The oil production rate after the hydraulic fracturing was 11.8 tons/day with a gradual decrease in production rate; in December 2016 it was decided to conduct hydraulic fracturing on a second interval. The increase was 28 tons/day (Fig. 10).

At a late stage of development, with deterioration in the structure of reserves, the use of advanced technologies and development principles will help maintain the level of oil production and fully develop reserves. Technologies such as drilling horizontal wells and hydraulic fracturing are undoubtedly technologies with a wide range of applicability at various sites and in different mining conditions. Only application of these technologies will allow increasing oil recovery factor in old fields and supporting the development of objects at a cost-effective level. According to the strategy of Oil and Gas Production Department, it is projected to drill 55-60 horizontal wells and carry out 20-30 fracturing processes in horizontal wells every year until 2025.

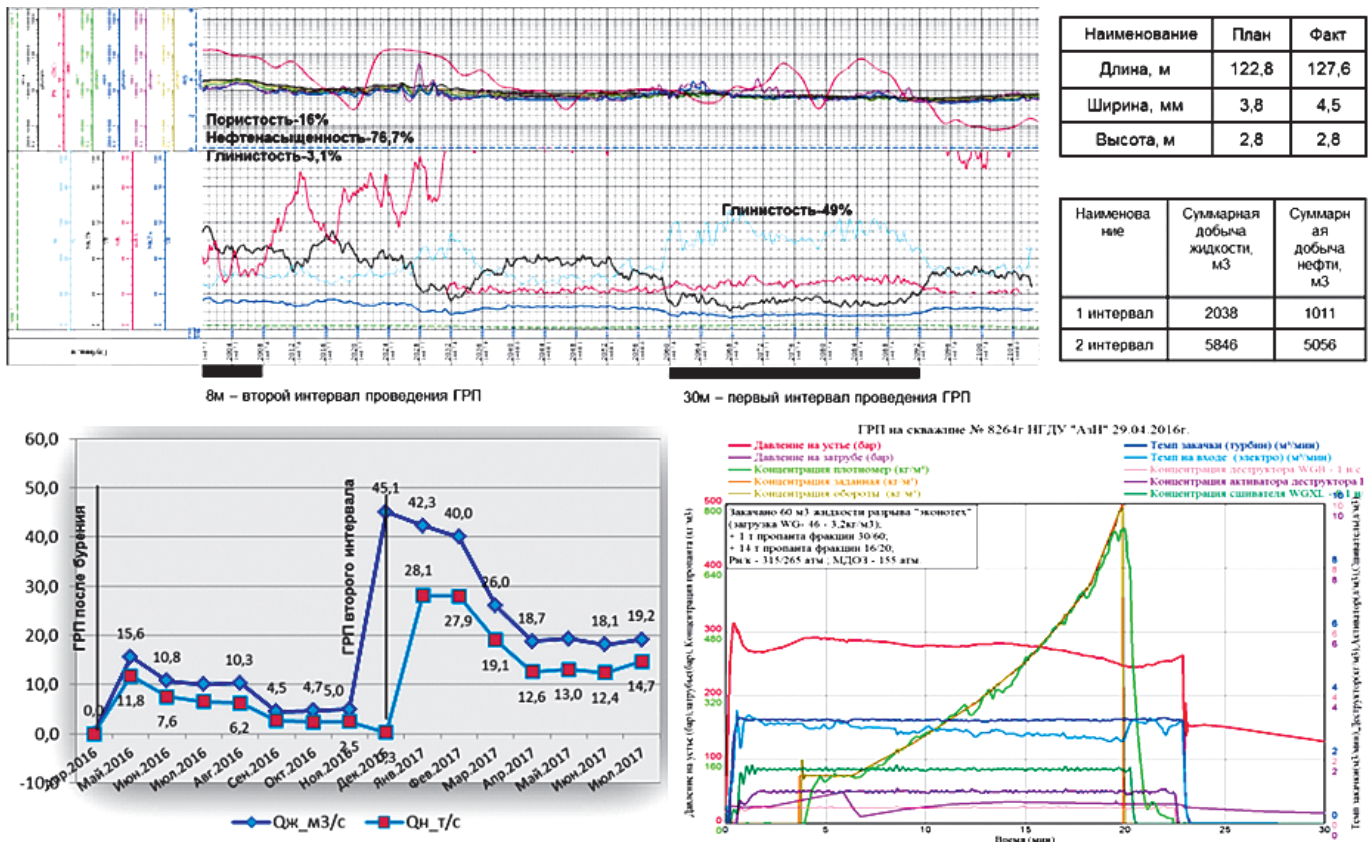


Fig. 10. Example of hydraulic fracturing in a clay reservoir in a horizontal trunk

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