



Increasing the Efficiency of the Production Process and the Operation of Hydrocarbon Production Equipment

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Abstract

The objects of study are the oil fields of Western Siberia: Shinginskoye, Pokamasovskoye, Luginetskoye, Lomovoye, Urmanskoye. The purpose of the work is to study and analyze the effectiveness of the applied geological and technical measures in the oil fields of Western Siberia. Objectives to study the well interventions carried out at the field evaluate their effectiveness, identify the most effective methods. In the process of work, a generalization and processing of information was collected on the entire stock of drilled wells. An analysis of the effectiveness of the application of geological and technical measures was carried out. Also a technological calculation of hydraulic fracturing was made and its economic efficiency was calculated. As a result of the study the most effective and most frequently carried out well interventions were identified, and the approximate economic efficiency of hydraulic fracturing was calculated. To complete the final work, the following were used Microsoft Word text editor tables and graphs were performed in Microsoft Excel.

Keywords: geological and technical measures, hydraulic fracturing, horizontal well, bottom-hole zone, HiWAY



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الخلاصة

أهداف الدراسة هي حقول النفط في غرب سيبيريا: شينجينسكوي ، بوكاماسوفسكوي ، لوجينيتسكوي ، لوموفوي ، أورمانسكوي. الغرض من العمل هو دراسة وتحليل فعالية التدابير الجيولوجية والتقنية التطبيقية في حقول النفط في غرب سيبيريا. أهداف دراسة التدخلات المنفذة في هذا المجال تقييم فعاليتها وتحديد أكثر الطرق فعالية. في هذه العملية، تم جمع وتعميم ومعالجة المعلومات على كامل مخزون الآبار المحفورة. تم إجراء تحليل لفعالية تطبيق التدابير الجيولوجية والتقنية. أيضاً، تم إجراء حساب تكنولوجي للتكسير الهيدروليكي وتم حساب كفاءته الاقتصادية. ونتيجة للدراسة، تم تحديد التدخلات الأكثر فعالية والأكثر تكراراً، وتم حساب الكفاءة الاقتصادية التقريبية للتكسير الهيدروليكي. لإكمال العمل النهائي، تم استخدام ما يلي محرر نصوص مايكروسوفت وورد تم تنفيذ الجداول والرسوم البيانية في مايكروسوفت اكسل.

الكلمات المفتاحية: التدابير الجيولوجية والتقنية، التكسير الهيدروليكي، البئر الأفقي، منطقة الحفرة

السفلية، HiWAY

Introduction:

When developing oil fields, modern companies always strive to extract natural reserves of oil and gas from the bowels of the earth as much as

possible. It is possible to achieve an increase in oil recovery and an increase in the rate of extraction through geological and technical measures (GTM). However, it is not

always possible to achieve this since each deposit has certain properties that characterize the degree of fluid extraction from the Earth's interior. This problem is especially associated with the fields of Western Siberia, the reservoirs of which are mainly low-permeable. In the fields of Western Siberia, this problem becomes more and more significant every year due to a decrease in oil production and productivity, as well as an increase in water cut. It is worth noting that most of these fields are in late stages of development. The choice of a specific stimulation method is complicated due to the different geological conditions in the fields of Western Siberia. The purpose of this work is to analyze the effectiveness of geological and technical measures used in oil fields.

General information about geological and technical activities in order to maintain target levels of oil production and regulate the development of fields at wells, it is

necessary to carry out geological and technical measures (GTM). With the help of geological and technical measures, oil producing companies ensure the fulfillment of design indicators for field development. The main advantage of geological and technical measures, so to speak, a distinctive feature from other activities, is that after their implementation, in most cases, companies experience an increase in oil production. Each oil production company determines independently which activities are classified as geological and technical measures and which are classified as other repairs. In order to maintain and increase the level of oil production, the oil industry sets itself the goal of intensively increasing the scale of development of oil fields. Geological and technical activities are carried out in the following cases: 1) If the permeability of the formation is insufficient to maintain the operating mode of the well, which will allow timely recoupment of investments in

drilling; 2) The permeability of the formation in which the well was completed is sufficient, but the bottomhole zone of the formation is contaminated or damaged during completion drilling or operation; 3) The well productivity coefficient needs to be increased. The relevance of this task is seen in the case when it is necessary to return oil wells to operation, as well as to use areas of the reservoir that were previously untouched to extract oil reserves, the extraction of reserves of which was previously impossible. At all stages of field development, geological and technical measures are carried out, but their most intensive use occurs in the later stages of the process. In fields where oil production decreases with an increase in water cut, usually mature fields, geological and technical measures are especially important. To work oil wells, as well as to use areas of the formation that were previously untouched to extract oil reserves, the extraction of reserves of which was previously impossible. Depending

on the target focus, all geological and technical measures carried out at fields can be divided into two groups: – measures aimed at ensuring the safe operation of equipment (elimination of inter-casing manifestations, inspection of underground equipment, elimination of broken pump and compressor pipes, inspection of the wellhead, dismantling of pipe heads for diagnostics, etc.); – activities that are aimed at increasing well productivity (hydraulic fracturing (fracturing), bottomhole zone treatment (BZT), repair and insulation work (RIW), drilling of horizontal wells, etc.).

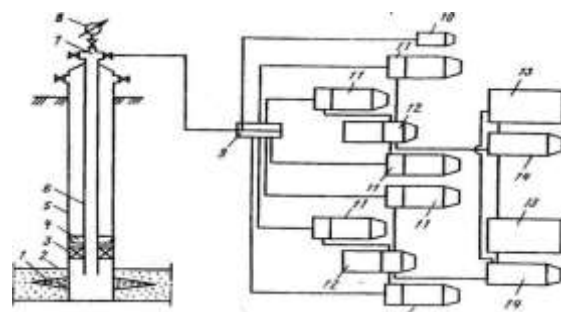


Fig (1): Technological diagram of hydraulic fracturing

Hydraulic fracturing is carried out at pressures of about 70–100 MPa, which often exceed the pressures

permissible for casing strings. To protect the casing strings from high pressure at the lower end of the tubing, a packer with an anchor is lowered into the well and installed above the roof of the formation above which the treatment is being carried out. The elastic element of the packer seals the annulus by compressing under the weight of the tubing. This is done by supporting the packer on the bottom using a perforated liner (packer with bottom support type PM OPM) or by supporting the packer on the casing pipes using packer rams which, when released when the tubing is turned, are moved apart and pressed into the inner surface of the casing (ram packers without bottom support type PS. PG). The anchor serves to prevent the packer from moving under the influence of pressure differences above and below it. The anchor slips are moved apart and pressed into the inner surface of the casing under internal excess pressure. Packers and anchors are designed for pressure drops of 30 -

50 MPa and have a flow area of 36-72 mm, depending on their type and the internal diameter of the casing. It is necessary to template the wellbore before lowering the packer in order to avoid possible jamming of the packer as well as destruction of its elastic element during the lowering process. To carry out hydraulic fracturing, pumping units (units) of the type UN1-630X700A (4AN-700) (Figure 1.2) are used, the maximum operating pressure of which can reach up to 70 MPa and can withstand loads weighing 10 - 12 tons. The pump is powered by a diesel engine whose power is 588 Kw.

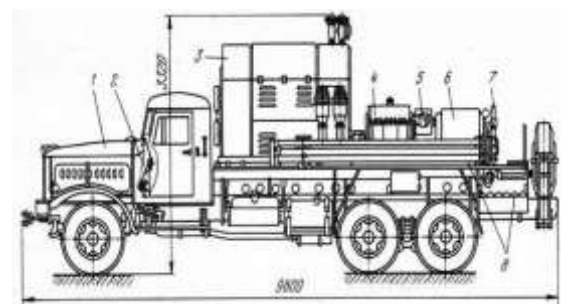


Fig (2): Pumping unit 4AN-700 for TRP

Drilling horizontal wells

The structure of the resource base is as follows: traditional fields with

low-permeability reservoirs for development when drilling vertical wells (VW) may not be economically feasible, sometimes impossible, as a result of which a significant amount of reserves will not be involved in industrial development. Under these conditions, the most rational direction for improving the use of hard-to-recover reserves is the transition to fundamentally new field development systems using hydraulic structures, which, having an increased opening surface and filtration resistance in the near-wellbore zones, are a promising method. If there is high fragmentation, geological heterogeneity, the presence of many zones of replacement of productive strata and pinch-out zones in the fields, then it is most important to use development systems with horizontal wells. The most effective and widespread technology for increasing oil recovery today is drilling horizontal wells (HS). A horizontal well (HS) is a well of

finite length, the axis of which passes between the roof and the bottom of the formation with an inclination angle of 80-100° relative to the vertical. GS are most effective and bring maximum effect when used in the following cases: • when developing reservoirs with fractures of horizontal permeability; • when developing hydrocarbon deposits, when the area for installing drilling equipment is limited; • to increase oil recovery when fields are being reworked at a late stage of exploitation; • when developing productive reservoirs, when rapid formation of water and gas cones occurs; • local deposits of hydrocarbon substances, etc. Thus, the degree of coverage of the formation by drainage increases, and there is a possibility of increasing the impact of the working agent. Passing through the productive formation for hundreds of meters, and sometimes several hundred meters, horizontal wells can open areas of zones with fractures in which increased permeability is

observed in a heterogeneous formation. This will allow companies to obtain flow rates from these wells that are several times higher than they could obtain using vertical shafts. There is a possibility of drilling gas-oil deposits with extensive sub-gas zones and water-oil deposits with a significantly smaller number of wells and developing these objects with minimal drawdowns. Our country and foreign countries today have extensive experience in the use of HS. A lot of difficult work has been done to define and justify the applicability criteria for effective development using GS, which has brought impressive results. According to these criteria, horizontal wells can be used when there is the presence of productive formations with an average oil-saturated thickness in highly permeable formations in zones underlain by bottom water. By reducing their total number at sites, the use of horizontal wells requires significantly smaller (1.5–2 times)

capital investments for drilling wells with a relative increase (up to 70%) in the cost of each well due to the complexity of their designs. However, with mass drilling of horizontal wells, the cost of one meter of drilling, as world experience shows, can be brought up to the cost of drilling a high-voltage drilling. This creates even more favorable preconditions for increasing the efficiency of using GS. When applying oil field development technology using horizontal wells, it is possible to achieve a stable oil recovery rate of 60–80% due to the following factors: – GS can be used to develop reservoirs of different types and conditions at any stage; – when drilling horizontal wells, it is possible to ensure the intersection of natural vertical cracks in the formation, which will maximize the permeability of the formation and the extraction of formation fluids; – to drain an oil reservoir, you need to drill 4–5 times fewer horizontal wells than vertical ones. With the

help of such wells, it is possible to ensure the development of productive formations lying under river beds lakes mountains urban structures etc.

Hydraulic fracturing efficiency analysis

Hydraulic fracturing as one of the effective methods for increasing the productivity of wells at the Shinginskoye field began to be implemented in 2011 on wells exiting drilling. All hydraulic fracturing treatments were carried out at the Yu11 object without incorporating, in most cases, the watered horizon Yu134. The technological efficiency of hydraulic fracturing was assessed by comparing the basic oil production levels for wells calculated before the event with the actual production levels after the event. The average duration of the effect from 2010 to 2016 was nineteen months. During the period under review, a total of 13,013 tons of proppant were injected; the average volume of

injection per well was 91 tons per meter of effective thickness, accounting for 10 tons of proppant. The average values of the starting flow rate of the proppant volume and the productivity coefficient at various oil-saturated thicknesses are shown in.

One of the levers for increasing technological efficiency is high-quality modeling of reservoir conditions, stress profile, stage sizes and prediction of hydraulic fracturing fluid leaks. Undoubtedly, hydraulic fracturing measures are effective since hydraulic fracturing of an object allows not only to intensify the flow of fluid, but also to involve previously undrained areas into development, thereby increasing the final oil recovery. No new technologies were used; analysis of the quality and existing hydraulic fracturing technology shows that it is possible to use aggressive types of designs in the field. Distinctive aspects of the work carried out are a high percentage of

injected proppant with a concentration of more than 1100 kg/m³ (an average of 49% per well), a high final concentration (an average of 1150 kg/m³) and an aggressive injection schedule. The positive aspect of such designs is good packing and uniform distribution of proppant in the formed fracture. Translation for download. The conversion of wells for injection at the Shinginskoye field was used 40 times. Additional oil production amounted to 38 thousand tons, the average increase in production rate was 3 tons/day, the average duration of the effect was 3 months. This type of geological and technical measures will continue to be in demand when expanding the drilling network in order to maintain reservoir pressure in the extraction zones. Well cleaning. Well cleaning is a low-effective type of geological and technical measures for the Shinginskoye field for 2010-2016. 6 well operations were carried out. Oil production increased from 0.1 to 3.6

tons/day. Additional oil production amounted to 0.2 thousand tons, the duration of the effect was from 3 to 153 days. The success rate is 50%. This type of geological and technical measures is not effective for this deposit. Change of operating method. During the period under review, 10 operations were performed to change the method of well operation. Additional oil production 1 thousand tons. The average increase in oil production rate was 0.4 t/day, the maximum duration of the effect was 339 days, the success rate was 80%. This type of geological and technical measures is characterized by low efficiency. Well commissioning. The operation of commissioning wells as a type of geological and technical measures was performed 152 times during the period under review. Additional oil production amounted to 37 thousand tons, the average increase in production rate was 4.7 tons/day, the average duration of the effect was 87 days, the success of this type of geological and technical measures

was 96%. Drilling horizontal wells. In November 2010, the first horizontal well No. 335G was put into development at the field; 18 thousand tons were produced in 2010-2014. oil. The average initial flow rates were 34 t/day, which is several times higher than the initial flow rates of wells that were not subject to hydraulic fracturing.

Method For Developing Oil and Gas Deposit Using Hydraulic Fracturing

The invention relates to the field of oil and gas field development and can be used in the oil industry. The method of developing oil and gas deposits using hydraulic fracturing (hydraulic fracturing) is known to be widely used both in world and domestic oil production practice. The disadvantage of this known method is the low technical and economic efficiency caused by selective hydraulic fracturing in individual wells of the development system. As field practice shows, well production rates after hydraulic

fracturing continuously decrease exponentially and after a period of time from several months to several years return to their original state. Often the costs of hydraulic fracturing are not recouped by the additional oil produced. Hydraulic fracturing in the known method is used mainly to increase the productivity of wells. There is practically no increase in the oil recovery factor. The closest analogue of the invention is a method for developing an oil and gas deposit using hydraulic fracturing by artificial intra-circuit impact on the development object by pumping water and/or gas and/or other displacing agent through injection wells, selecting formation fluids through production wells and performing hydraulic fracturing. The disadvantage of this known method is the low technical and economic efficiency due to the rapid attenuation of well flow rates after hydraulic fracturing. The technical result of the invention is to increase the efficiency of the known

development method by extending the period of effective operation of wells after hydraulic fracturing. The required technical result is achieved by the fact that in the method of developing an oil and gas deposit using hydraulic fracturing by artificial intra-circuit impact on the development object by pumping water and/or gas and/or other displacing agent through injection wells, selecting formation fluids through production wells and performing hydraulic fracturing. According to the invention, hydraulic fracturing is carried out comprehensively on the entire set of injection and production wells; the design and implementation of hydraulic fracturing is carried out on the basis of continuous information on the mechanical properties of rocks in the sections of injection and production wells, which is coordinated with geophysical research, while the direction of hydraulic fracturing is set by selecting zenith and azimuthal angles drilling of injection and

production wells to eliminate the heterogeneity of filtration flows and the period of effective operation of hydraulic fracturing cracks is increased by pumping into them compositions of physical and chemical substances that dissolve clay and other mineral substances filling hydraulic fracturing cracks. In addition, in complexly constructed deposits with a gas cap, the bottom and/or top of hydraulic fracturing cracks are isolated from the bottom water and/or gas of the gas cap. As follows from the work, the displacement efficiency increases with an increase in the pressure gradient on the formation (with an increase in the linear filtration rate). Hydraulic fracturing in individual wells increases their productivity coefficients while slightly changing the filtration field in the entire set of wells. Pressure gradients across the volume of productive sediments change slightly; the residual oil saturation practically does not decrease, that is, there is a low efficiency of oil recovery. If

hydraulic fracturing is carried out in all injection and production wells of the development system, its productivity increases many times over. Pressure gradients increase sharply throughout the entire volume of productive sediments; residual oil saturation decreases significantly, that is, in addition to an increase in reservoir productivity, the oil recovery factor also increases. Increased filtration rates in the formation when implementing the proposed technical solution more intensively remove clay particles with the filtration flow. For this reason, the cracks formed by hydraulic fracturing silt up at a less rapid pace, that is, the effects of hydraulic fracturing will retain. The areas of application of hydraulic fracturing can be significantly expanded if, before performing standard hydraulic fracturing operations to develop and consolidate cracks, plugging compounds, for example, cement-based, are pumped into the well. The latter, by standard operations, are

pushed to the periphery of the crack, creating, after solidification, an insulating screen on the OWC and/or GOC, preventing the penetration of bottom water and/or gas from the gas cap along the fracture to the bottom of the well. To design hydraulic fracturing, as is known, information about the mechanical properties of rocks is needed. The latter is obtained from the results of laboratory tests of core samples. In conditions of scarcity and unrepresentativeness of core material and labor-intensive laboratory work, information on the mechanical properties of rocks is usually used in averaged form. Hydraulic fracturing designed on its basis is not optimal, especially in deposits of complex structure (water-oil, oil-gas, water-oil-gas) in which there is generally a high probability of obtaining negative results. Designing hydraulic fracturing with maximum efficiency is possible if continuous information is used on the mechanical properties of rocks in sections of injection and

production wells. Such information is obtained on the basis of geophysical studies of wells by coordinating the results of laboratory core studies and geophysical information.

Results:

of the analysis of geological and technical measures, the most effective measures were identified. Based on the analysis data, it can be noted that hydraulic fracturing is the most effective activity carried out in the field. The results show that the use of hydraulic fracturing in the field is characterized by significant technological efficiency.

Conclusions:

The work also examined the modern approach to hydraulic fracturing using HiWAY technology. This technology has proven itself well abroad. The use of this technology in the fields of Western Siberia will potentially reduce the volume of materials used by 45%, reduce the cost of electricity and transportation of materials for hydraulic fracturing,

and also reduce the impact on the environment. In the future, it is recommended to continue hydraulic fracturing at the field in new wells in order to further stimulate productive formations. To carry out the economic part, an assessment of the economic efficiency of hydraulic fracturing was carried out. Based on the calculation results, we can conclude that hydraulic fracturing in the field is economically profitable. An analysis of social responsibility at the field was also carried out. The main harmful and dangerous factors that may arise during work at the well pad of the studied field were described and measures were proposed to reduce the harmful effects.

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