MINING

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RESEARCH ON OCCURRENCE FEATURES AND WAYS TO IMPROVE THE QUALITY OF PRODUCTIVE HYDROCARBON HORIZONS DEMARCATION

Purpose. On the base of the geological cross-section analysis of the productive stratum and the features of the filtration-capacitance characteristics of the reservoir rocks, to develop effective technological fastening schemes for the delimitation of closely located different-pressure and different-saturated horizons on the example of the Romny group deposits.

Methodology. The proposed work is an analytical and production research on the geological-and-lithological structure features of borehole sections of the Romny structure and the results of their drilling and cementing based on the analysis of electrical, pulsed neutron-neutron, acoustic and other types of loggings. The data on the spectrum of the oil and gas boreholes properties cores was obtained on the basis of macroscopic description, methodical and practical methods of lithological, sedimentological, and facies analysis. The filtration capacity of permeable reservoir rocks was examined with the application of the Darcy's device. Modern methods of experimental research analysis using mathematical and physical modeling techniques, methods for processing research results in SolidWorks, STATGRAPHICS, MATHSAD, EXCEL, control and measuring devices were applied.

Findings. It has been established that currently applied fastening methods do not provide the prerequisites for high-quality delineation of productive horizons, as a result of which interlayer flows occur, that is lead to the loss of the potential flow rate of the boreholes and increasing in the cost of hydrocarbon production. A new design of the borehole is proposed in order to increase the reliability of the fastening. It has been proven that the effectiveness of opening oil-saturated reservoirs increases with the application of specialized drilling flushing fluids capable of minimizing the risk of their clogging. The necessity of cementing the production column and the shank with tamponage materials based on composite cements is substantiated, while effective buffer systems should be applied to separate process fluids.

Originality. On the base of the systematization and correlation of the geophysical material, the specific features of the structure of the productive strata of B-18 and B-19 horizons were evaluated as well as the nature and degree of saturation, the filtration-capacity characteristics of the seams. It has been proven that in order to reliably cover the high-pressure water-bearing horizon B-18 with an operational column, it is recommended to include packer systems of various types of activation in the equipment.

Practical value. On the basis of the detailed multifaceted results of laboratory and industrial testing and analytical model research, technological solutions have been developed for boreholes fastening in the conditions of the occurrence of closely located productive horizons of different pressures and different saturations on the example of the Romny group deposits.

Keywords: *borehole, core, casing, reservoir rock, cementing, productive horizon, packer*

Introduction. The main reasons for the potential decrease in oil production in Ukraine include the natural transition of most main deposits in terms of production and reserves to the late stage of development, characterized by their depletion by 80–85 % after the extraction of oil from the approved initial production reserves. Depletion of deposits is also accompanied by an increase in more than 85 % of production water content. For example, 14 fields of the PJSC "Ukrnafta" oil production company are being developed with an average water content of more than 90 % [1].

It is known that flooding of boreholes is a widely used method for increasing oil recovery. However, the application of this method leads to premature watering of production, an intensive decrease in the flow of oil and, as a result, the stoppage of boreholes and their transfer to the status of unprofitable [2]. This is especially true for fields with highly viscous oils, such as Buhruvativske (horizons B-18–B-14), where the current oil recovery rate is 6.9 %, with realized production reserves of 31.6 % and water content of 47.6 %. However, this nature of production watering is also caused by technological methods for increasing oil yield or by natural processes of water inflow during the water-oil contact changes.

A completely different view of the production flooding causation is focused on the violation of the system of boreholes fastening in the conditions of the occurrence of closely located layers of different pressure and different saturation. As a result of the decrease in reservoir energy of hydrocarbon-bearing reservoirs, which is caused by long-term development, and the presence of closely located water-bearing horizons with reservoir pressure significantly higher than hydrostatic, in the event of a violation of the fastening system, they form the prerequisites for out-of-column flows and an increase in the water content in products, which leads to the cessation of production from boreholes as a whole [3, 4].

In the case when we consider the inherent nature of the phenomena of deterioration of mining and geological conditions or depletion for certain deposits belonging to the category with hard-to-extract reserves, however, they are a significant reserve for increasing their own production of hydrocarbons. In Ukraine, more than 72 % of oil reserves and 10–15 % of natural gas reserves belong to heavy extraction [1]. For example, the share of hard-to-extract mining reserves in the structure of PJSC "Ukrnafta" is about 70 %, among which highly watered deposits are about 27 %, and this trend will steadily grow in the future.

The peculiarity of the borehole construction in the conditions of deposits with hard-to-extract reserves is to ensure their high-quality fastening, which is especially relevant for closely located horizons of different pressures and different saturations. The functional task assigned to the boreholes fastening is to create a reliable communication channel in the "reservoir – cellar" system and ensure high-quality separation of collectors, taking into account the peculiarities of their saturation, while complying with the requirements of environmental protection [5, 6].

Unsolved aspects of the problem. The authors analyzed various technological fastening schemes, which should be considered in more detail with taking into account the extreme relevance and practical value of possible technological algorithms for the qualitative delineation of closely located horizons of different pressure and different saturation [7, 8].

The fastening method, which consists in the application of stepped or sectional cementing of the operational column, can be considered as having received a certain spread. According to the technological scheme of its implementation, cement mixture is pumped into the annular space through the casing shoe in the interval higher than the roof of the oil-bearing formation. Then, without waiting for the solidification of the previously pumped solution, the buffer and insulating liquids are pumped through the step cementing coupling, followed by a portion of the sealing composition. The complexity of the practical implementation of such solutions is caused by the small thickness of the productive interval and the necessity to apply additional devices in the column equipment [9].

Also, the well-known method for cementing closely spaced layers of different pressures involves the installation of sleeve packers between them, which are included in the casing string equipment. Such solutions ensure high-quality demarcation of layers in strong and stable rocks. However, in the cavernous hole section, in soft and unstable rocks, the effectiveness of demarcation of layers by this method decreases or is completely eliminated [10].

A packer filter is proposed for the application in order to increase the efficiency of separation of different pressure layers. It is included in the casing string equipment and installed between different pressure horizons. In the process of filtering the cement mixing water through the packer-filter, a strong, low-permeability cement stone is formed in the annular space, a kind of cement packer that seals the closed space. The proposed method can ensure high-quality demarcation of layers in strong and stable tips. If there are cavernous formations and rocks of low hardness and stability in the hole section, such a technology for demarcating layers is almost unacceptable. It will be useful here to note that the basis of ensuring a high degree of tightness of the enclosed space with this "cement packer" is a strong, impermeable cement stone [11].

Let us take into account the fact that through the application of high-temperature cements with expanding impurities or special expanding cements, as well as thermoplastic materials, positive, but short-term results were obtained in preventing water breakthrough at the initial stages of operation of complicated boreholes [12, 13].

In the conditions of Romny group boreholes, most of the above-mentioned technological solutions were applied, but it was not always possible to achieve results. However, these methods and means for fastening, in particular primary cementing of boreholes, will not provide reliable delimitation of horizons, which has been proven by practice with taking into account the duration of operation and a significant decrease in formation pressures. For such conditions, the features of occurrence and the character of the saturation of layers should be examined in detail, as a result of which new schemes for boreholes fastening would have been developed [14].

Purpose of the article. Development, based on the analysis of the geological section of the productive stratum and the features of the filtration-capacitance characteristics of the reservoir rocks, effective technological fastening schemes for the successful and reliable delineation of closely located different-pressure and different-bearing horizons, using the example of deposits of the Romny group.

Presentation of the main research material. The significant features of the geological structure of the productive part of the overwhelming majority of the Romny group of deposits of the Dnipro-Donetsk Basin (administrative location – Romny district of the Sumy region), including Perekopivskyi, Anastasiivskyi, Korzhivskyi, Artiukhivskyi, as well as Andriyashivskyi, there is an alternation of closely located, differently pressured and differently bearing deposits. First of all, this is the B-18 water-bearing horizon with an abnormality coefficient (the ratio of the initial reservoir pressure to the hydrostatic; according to existing ideas, its value depends on the intensity of folding) of 1.05–1.1 and the B-19 oil-bearing horizon with an abnormality coefficient of about 0.6 [15].

According to the data sources involved in the research [16, 17], as well as the results of the development and extraction of hydrocarbons in the conditions of the Romny group of deposits, the basic technological solutions here do not provide a reliable delimitation of productive horizons. So, for instance, the interlayer migration of fluids in the boreholes of the Romny group is more than 13 % in the Anastasivske deposit and more than 27 % in the Andriyashivske one. According to the industrial data recorded in previous years, the duration of the borehole operation at the Perekopivske deposit before the appearance of extra-column flows was from 2 to 25 years. However, currently, as a result of the decrease in reservoir pressure of oil-bearing reservoirs B-19, the conditions for high-quality fastening and successful boreholes operation have become significantly more difficult. The share of behind-the-casing flows in the Perekopivske deposit is more than 18 %.

We will provide the following demonstrative example to conduct further analysis. The basic design of boreholes accepted for consideration, in the conditions of closely located horizons of different pressures (boreholes of the Romny group), involved the application of techniques and methods of conventional fastening technology. In the indicated boreholes, as a rule, sectional fastening of their trunk with a 244.5 mm casing column in the deposits of the middle carboniferous and its cementing was conducted. Subsequently, the borehole was deepened with bits of 215.9 mm with the opening of the entire productive stratum and sectional fastening with an operational column of 146×168 mm.

An analysis of the geophysical data of the occurrence features of closely located different-pressure and different-bearing horizons was conducted with the application of the example of the 60-Perekopivska borehole (Figs. 1, 2). This horizon is represented by sandstone with a layer (2–3 m) of clayey siltstone (Fig. 2). The sandstone is water-bearing in the intervals 4,360.8–4,379.2 and 4,380.4–4,402 m; its porosity, according to MAD (Maximal Allowable Discharge), is 10.5 %,

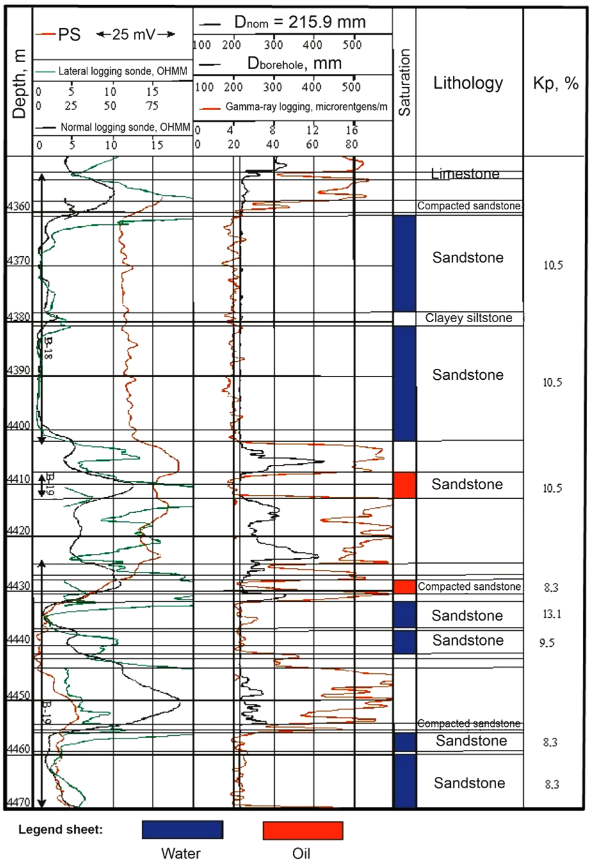

Fig. 1. Lithology of rocks of the B-18 and B-19 horizons and their fluid saturation according to the results of MAD (borehole 60-Perekopivska)

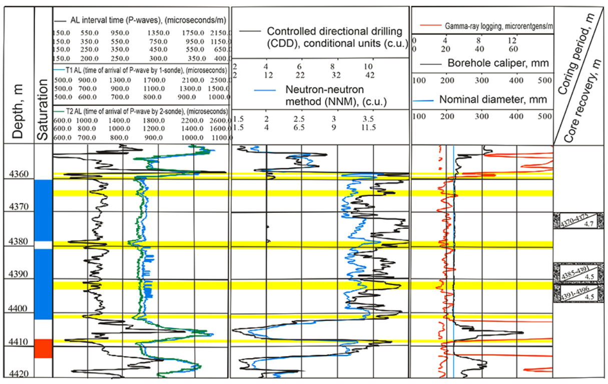

Fig. 2. An example of the selection of compacted layers in the B-18 horizon according to the data of AL and CNL on the 60-Perekopivska borehole

which is in good agreement with the results of the core analysis. It will be useful here to note that the basis for determining the porosity of reservoir rocks by MAD methods is the difference in the physical properties of the solid phase of the rock skeleton and formation fluids filling the pore space. Gamma-gamma logging (GGL), acoustic (AL) and neutron logging (NL and INL) are among the specified methods of MAD, and the most acceptable are radioactive and acoustic methods of MAD [18].

Core samples (Fig. 2) were taken in the interval 4,370–4,396 m (core Nos. 2, 4, 5). Core No. 2 was selected during the penetration of the interval 4,370–4,375 m with a total removal of the core of 4.7 m, which is 94 % of the total penetration. Core No. 4 was selected during the drilling of the interval 4,385–4,391 m with a total removal of 4.5 m, which is 75 % of the entire drilling. Core No. 5 was selected during the drilling of the interval 4,391–4,396 m with a total removal of the core of 4.7 m, which is 78.3 % of the total length of the borehole.

Based on the information about the capacity of the B-18 water-bearing horizon, several compacted clay layers can be identified in it. The availability of information about compacted layers in the B-18 horizon is quite a positive point and makes it possible to determine the possibility of using packer equipment in casing strings, as well as provides an understanding of further possible technological operations for conducting repair and isolation operations on already existing boreholes.

In order to conduct more detailed geological and lithological assessment of the B-18 horizon in several boreholes of the Perekopivske deposit, data from INNL (impulse neutron-neutron logging) were analyzed [19]. Figs. 2 and 3 illustrate the results of the mentioned studies on the example of 33-Perekopivska and 60-Perekopivska boreholes.

According to the analysis of the actual data regarding the geological and lithological characteristics of the boreholes log (Figs. 2, 3) it was established that the upper part of the B-18 horizon is denser due to the presence of clayey layers in it, which alternate throughout the thickness of the layer.

In order to determine the filtration capacity properties (porosity and permeability), 15 samples of core material were selected and analyzed during the drilling of the 60-Perekopivska borehole (Table). Data from the study of natural samples of core material confirm that the B-18 horizon is heterogeneous in its filtration properties. The filtration properties of the upper part are characterized by porosity of 12.4–14.7 % and permeability from $62.9 \cdot 10^{-3}$ to $83.7 \cdot 10^{-3}$ μm^2, and the lower part by 14.6–17.0 % and $269.4 \cdot 10^{-3}$–$434.3 \cdot 10^{-3}$ μm^2.

It can be stated that the B-18 horizon is heterogeneous throughout its capacity, and the rocks presented in it differ in variable filtration properties with taking into account the results of the performed studies. The existing information base for the boreholes of the Romny group, created based on the results of the research, and the geological structure of the B-18 horizon make it possible to consider potential conditions for the isolation of the aquifer due to selective action using water-soluble polymers or mineral binders, which creates prospects for improving boreholes fastening in the specified deposits. In addition, taking into account the negative phenomenon of the increase in the water content of products, complex MAD (in the 60-Perekopivska borehole) and relevant research on the potential source of migration and inflow of in-seam water were conducted [20].

The results of the MAD during the research on behind-the-casing flows are interpreted as follows. A decrease in the dynamics of the temperature gradient was recorded on the background measurement of thermometry (a method for measuring temperature along the hole section) below a depth of 4,382 m. A slight change in the gradient (decrease) was established on the working measurement of thermometry at a depth of 4,350 m. In the interval 4,350–4,412 m (the depth of the

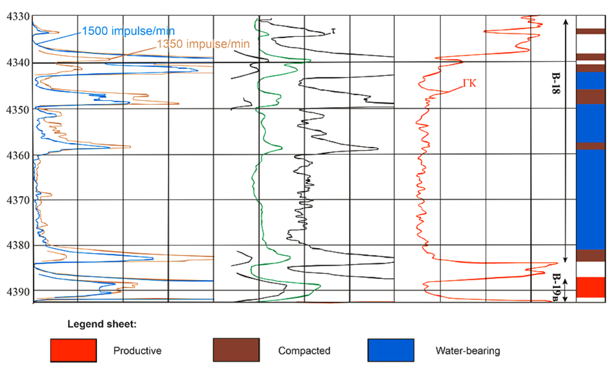

Fig. 3. Logging diagrams of compacted layers in the B-18 horizon according to INNL data for 33-Perekopivska borehole

Table

The results of the description of the core material, the porosity and permeability data of the examined core samples

Sample No	Core selection interval, m	Porosity, %	Permeability, mD (1 mD = 1 · 10^{-3} μm²)	Core recovery, m	Description of core samples
1	4,370–4,371	14.7	183.4	1	Represented by medium- and coarse-grained, light, weakly cemented sandstone. On the ring of the core, traces of the zone of penetration of the leachate of the washing liquid to a depth of 7–12 mm are visible
2	4,371–4,372	–	–	1	Represented by quartz sandstone. The sandstone is medium- and coarse-grained (with the presence of a small proportion of grains of the gravel fraction), light gray, weakly cemented, micaceous with rare stylolites. Traces of the leachate penetration zone to a depth of 3–5 mm are visible along the core ring
3	4,372–4,373	12.4	62.9	1	Represented by quartz sandstone. The sandstone is medium- and coarse-grained (with the presence of a small proportion of grains of the gravelite fraction), light, weakly cemented, micaceous with rare stylolites, as well as layering cracks. Traces of the leachate penetration zone to a depth of 3–6 mm are visible along the core ring
4	4,373–4,374	–	–	1	Represented by quartz sandstone. The sandstone is medium- and coarse-grained, light gray, micaceous, weakly cemented with stylolites and layering cracks. Traces of the leachate penetration zone to a depth of 3–6 mm are visible along the core ring
5	4,374–4,375	13.8	83.7	0.7	Represented by quartz sandstone. The sandstone is medium- and coarse-grained, light, weakly cemented, micaceous, stylolitized with layering cracks. Traces of the drilling mud filtrate penetration zone to a depth of 3–6 mm can be seen along the core ring
6	4,385–4,386	–	–	0.3	Represented by quartz sandstone. Sandstone is medium-grained, light gray to brown, micaceous, weakly cemented with effusions of in-seam water salts
7	4,386– 4,387	–	–	1	Represented by quartz sandstone. The sandstone is medium-grained, light gray to brown
8	4,387–4,388	–	–	1	Represented by quartz sandstone. The sandstone is medium- and coarse-grained, light gray to brown, micaceous, weakly cemented with stylolites and individual cracks along the layering. The diameter of the core is 6–8 mm smaller than that of core No. 2
9	4,389–4,389.9	–	–	1	Represented by quartz sandstone. The sandstone is light gray to brown with many seeps of formation water salts
10	4,389.9–4,390	2.7	$3 \cdot 10^{-4}$	0.9	Represented by dark, clayey, quartzized siltstone with veins of white quartz
11	4,390 – 4,391	3.0	$7 \cdot 10^{-4}$	0.2	Represented by dark, clayey siltstone
12	4,392–4,393	17.0	434.3	1	Represented by quartz sandstone. The sandstone is medium- and coarse-grained, light gray, micaceous, weakly cemented with cracks along the layering. The density of cracks is 1–4 per cm
13	4,393–4,394	15.3	291.8	1	It is represented by quartz sandstone, medium- and coarse-grained, light gray, weakly cemented with cracks along the layering and the density of cracks is 1–5 per cm. The opening of the cracks reaches the size of the grains
14	4,394–4,395	14.6	269.4	1	Represented by quartz sandstone. The sandstone is medium- and coarse-grained, light gray, weakly cemented
15	4,395–4,396	–	–	0.9	Represented by quartz sandstone. The sandstone is medium- and coarse-grained, light gray, weakly cemented. On the ring of the core, traces of the zone of penetration of the leachate of the washing liquid to a depth of 5–10 mm are visible

instrument break-off), the temperature gradient is unchanged in accordance with the overlying interval. According to the data of the performed studies, the likely inflow of liquid into the hole section is observed from the perforated interval 4,408–4,412 m due to the migration movement from the water-bearing interval 4,360–4,402 m (horizon B-18).

It is possible to consider the scheme of blocking it after the initial opening in implementation, by preventing the inflow of water from the B-18 horizon. Such an operation scheme requires the implementation of the MAD complex and a clear correlation of the geological section with the neighboring boreholes, in order to prevent the opening of the oil-bearing horizon B-19. The hole section after opening B-18 should be in a compacted layer. For blocking, a scheme of isolating the B-18 water-bearing horizon with a polymer composition or mineral binders can be considered. Conducting such operations requires the application of special packer equipment for operations in an open hole section. At the same time, all features of the mining and geological conditions of operations should be taken into account as much as possible, in particular, the stability of the hole section walls; technical and technological safety regarding possible fluid manifestations; indifference of special insulating compositions with washing liquids or a system of buffer liquids; impossibility of the negative impact of the specified insulating compositions on hydrocarbon-bearing horizons, if they are present; safety and full compliance with the requirements to exclude negative impact on the environment [21, 22].

The new progressive design of borehole structures for the given fastening conditions has been developed based on the research on the features of the occurrence of closely located productive horizons of different pressures. Fig. 4 shows the location of the water-bearing and oil-and-gas-bearing seams of the B-18 and B-19 horizons in the section of the 120-Anastasivska borehole and the technological scheme of its fastening.

In some cases, after B-18 blocking operations, if they are provided, preparatory operations of the borehole fastening by a casing string are conducted. As an example, it is possible to fasten a 177.8 mm operating column. The equipment of the column should provide a shoe with a non-return valve, an additional non-return valve, centering elements of various types according to the calculation of ensuring the required degree of centricity of the column. At the same time, to increase the reliability of delineation, if the conditions allow for the distance between the horizons, the application of packers will be substantiated. Sleeve-type packers can be applied if there is a stable hole section with a preserved nominal section without cavernousity, as well as water-reactive packers. The adopted packer equipment must withstand a pressure difference between the isolated horizons of at least 350 atm.

For cementing the operating column, it is necessary to apply backfill materials with appropriate physical and mechanical properties and differentiated setting times. At the same time, backfill systems, in addition to the necessary rheological characteristics, should have zero water separation and controlled water flow, and cement stone should be characterized by high strength characteristics, increased elastic-deformation parameters, and resistance to corrosion. Unsatisfactory technological properties of backfill solutions are one of the main reasons for the heterogeneity and low quality of insulating screens formed from cement stone [7]. This circumstance can

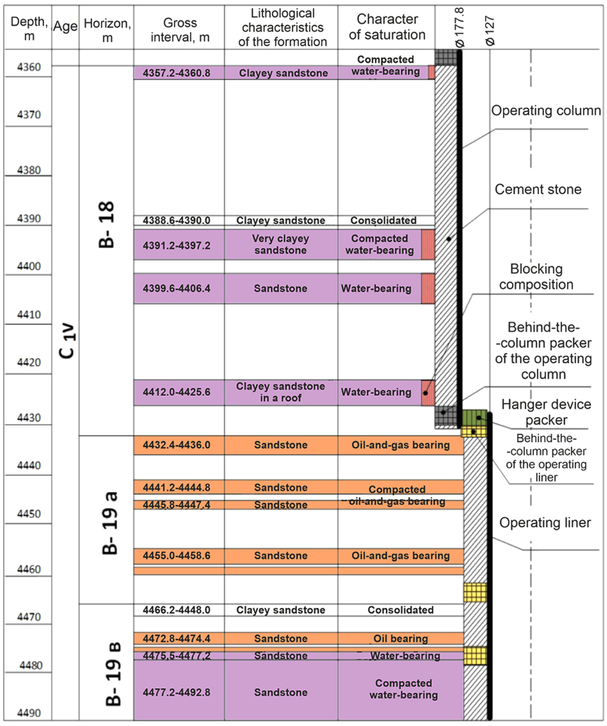

Fig. 4. Geological section of the productive stratum of the 120-Anastasivska borehole and the technological scheme of its fastening

significantly affect the reliability of boreholes operation and become one of the causes of accidents and complications. In some cases, for the purpose of conducting secondary cementing of the production column while eliminating interlayer flows, special backfill materials with increased insulating properties can be applied.

It is necessary to conduct further construction of the borehole with the opening of the oil-bearing horizon B-19 exclusively in the productive layer after the final operations on fastening the production column. Drilling a borehole under the operating liner and subsequent placement of its upper interval in the production column provides opportunities to: effectively conduct the primary opening of the productive layer due to the reduction of the deepening interval and the absence of zones with incompatible drilling conditions; apply special washing fluids to minimize contamination of collectors; decrease the metal density of the borehole; conduct various methods of intensification of the inflow of hydrocarbons; drill a lateral hole or a horizontal section.

Another option for the implementation of measures for the development of hydrocarbon deposits may be the scheme of borehole fastening with a descent of 244.5 mm of the casing string and its subsequent cementing to the roof of the B-18 water-bearing horizon. Opening of the B-18 horizon is possible with the application of washing liquids containing blocking reagents (for instance, these can be polymers of directional action, liquid glass). Blocking B-18, after the initial opening, is sufficiently reliably provided by mineral-based materials with a high tonnage of grinding. The next step will be the descent of 177.8 mm of the tailing column into the compacted layer to the B-19 horizon with special equipment with packer elements and subsequent cementing with composite backfill materials with increased insulating properties. The standard size of the considered casing columns can be changed to a different series to adapt to specific conditions [23].

After the final operations on fastening the 177.8 mm column, deepening under the 127 mm liner is conducted exclusively in the productive layer. In such conditions, factors related to the rationalization of the borehole flushing regime should be taken into account. Such factors are the limitation of the annular channel, the granulometric composition of the mud, the limitation of the joint movement of mud particles, the dynamics of the drill string, the shape of the movement channel, and the rheological properties of the flushing fluid [24]. At the same time, in order to increase the extraction of hydrocarbons, technologies that minimize the negative impact of special process fluids on productive horizons must be implemented.

The application of hydrocarbon-based flushing fluids will be very useful for the considered conditions, which increases the specific productivity of boreholes by 4–20 times, compared to water-based flushing fluids [11]. These fluids, if the mining and geological conditions allow their application, are the key and most effective method of intensification of hydrocarbon production during boreholes drilling in conditions of abnormally low reservoir pressures.

In the practice of drilling operations, the formulation of clay-free and low-clay flushing fluids has been successfully applied for the primary opening of productive layers in conditions of hydrostatic and abnormally low formation pressures, as well as during boreholes drilling with a complex spatial architecture, in particular horizontal ones [25, 26]. A wide range of flushing fluids requires a detailed analysis of the mining and geological conditions of drilling and materials and chemical reagents for effective drilling operations [27]. Industrial experience shows that almost all operations that conducted in boreholes, in particular, their construction, opening of the reservoir by drilling and perforation, underground repair, etc., are potential sources of damage to the initial balanced state of the productive reservoir, and the formation of an interval with impaired filtration properties around the near-breakout zone of the reservoir [28, 29]. Such processes are becoming more and more relevant in deposits with hard-to-extract reserves, which are characterized by a significant depletion of reservoir energy and the secondary influence of technological and physicochemical factors [30]. In such conditions, it is especially important to apply well-founded methods of intensification of oil and gas production and to limit the inflow of in-seam waters.

It is necessary to pay attention to the fact that during the fastening of oil-bearing layers of the boreholes by liners, there may potentially be complications associated with the longitudinal bending of the pipes, in particular, the jointless connection (when unloading the liner columns to the outcrop after the tripping of disconnectors) and difficulties with the disconnection of the acceptance tool; in the end, this threatens the emergence of prerequisites for poor-quality formation of the insulating screen behind the column. That is why, in order to avoid such situations, it is necessary to apply modern devices that ensure reliable installation of the liner column in the previous column on the wedge suspension (anchors), they are equipped by a packer for sealing the annular space, and can ensure quick and reliable disconnection of drill pipes from the casing if additional reserve disconnection systems available.

Therefore, only the presence of reliable information, which includes: digital geological and hydrodynamic models of the deposit, detailed analysis of geophysical and hydrodynamic researches, qualitative assessment and reinterpretation of existing seismic data and additional seismic research, and during borehole drilling and timely analysis and interpretation of received geological geophysical data, is the basis for making informed decisions in real time; as well as the implementation of modern technical and technological solutions during the initial opening and fastening of the boreholes. These approaches create the prerequisites for reliable delineation of closely located different-pressure and different-bearing horizons in boreholes in deposits with hard-to-extract hydrocarbon reserves.

Conclusions.

1. Nowadays, widely applied technological solutions for boreholes fastening in the conditions of occurrence of closely located horizons of different pressures with taking into account the current state of hydrocarbon deposits, do not ensure reliable demarcation of productive layers.

2. The work has convincingly proven that only a detailed analysis of the geological section of the productive stratum and the features of the filtration-capacity characteristics of the reservoir rocks can give an unequivocal answer about the feasibility of specific designs of borehole structures application and effective technological schemes for fastening their sections.

3. The research on water-bearing horizons based on the interpretation and analysis of geophysical data, as well as the research on core material, provides detailed information about the features of the occurrence of the specified horizons, their filtration-capacitive properties and the nature of saturation.

4. Comprehensive data about the water-bearing horizon B-18 and oil-bearing one B-19 makes it possible to evaluate and ensure the selection of backfill materials for primary and secondary cementing of boreholes.

5. The new design of borehole structures for deposits of the Romny group was designed on the basis of the features analysis of the closely located horizons of different pressuresoccurrence, which can also be successfully applied to other deposits with the same conditions.

6. The availability of geological information and the implementation of modern technical and technological solutions create prerequisites for ensuring the reliable delineation of closely located different pressure horizons in boreholes in deposits with hard-to-extract hydrocarbon reserves.

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Вивчення особливостей залягання та шляхи підвищення якості розмежування продуктивних горизонтів вуглеводнів

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Мета. Розроблення, на підставі аналізу геологічного розрізу продуктивної товщі та особливостей фільтраційно-ємнісних характеристик порід-колекторів, ефективних технологічних схем кріплення для розмежування близько розташованих різнонапірних і різнонасичених горизонтів на прикладі родовищ Роменської групи.

Методика. Пропонована робота є аналітично-виробничим дослідженням особливостей геолого-літологічної будови розрізів свердловин Роменської структури й результатів їх буріння та цементування на основі аналізу електричного, імпульсного нейтрон-нейтронного, акустичного та інших видів каротажів. Відомості щодо спектру властивостей кернів нафтогазових свердловин отримані на підставі макроскопічного опису, методичних і практичних прийомів літологічного, седиментологічного та фаціального аналізів. Фільтраційна здатність проникних гірських порід-колекторів вивчалася за допомогою приладу Дарсі. Застосовувалися сучасні методи аналізу експериментальних досліджень із використанням прийомів математичного та фізичного моделювання, методики обробки результатів досліджень у середовищі SolidWorks, STATGRAPHICS, MATHCAD, EXCEL, контрольно-вимірювальні прилади.

Результати. Встановлено, що застосовувані нині методи кріплення не забезпечують передумов якісного розмежуванням продуктивних горизонтів, у результаті чого виникають міжпластові перетоки, що призводять до втрати потенційного дебіту свердловини та зростання вартості видобутку вуглеводнів. Для підвищення надійності кріплення запропонована нова конструкція свердловини. Доведено, що ефективність розкриття нафтонасичених колекторів підвищується при застосуванні спеціалізованих бурових промивальних рідин, здатних мінімізувати ризик їх кольматації. Обґрунтована необхідність цементування експлуатаційної колони та хвостовика тампонажними матеріалами на основі композиційних цементів, при цьому для розмежування технологічних рідин необхідно використовувати ефективні буферні системи.

Наукова новизна. На основі систематизації й кореляції геофізичного матеріалу оцінена специфіка будови продуктивної товщі горизонтів В-18 і В-19, характер і ступінь їх насичення та фільтраційно-ємнісні характеристики пластів. Доведено, що для надійного перекриття високонапірного водоносного горизонту В-18 експлуатаційною колоною, в оснастку рекомендовано включати пакерні системи різного типу активації.

Практична значимість. На основі детальних різнопланових результатів лабораторно-промислових тестувань і аналітичних модельних досліджень розроблені технологічні рішення для кріплення свердловин в умовах залягання близько розташованих різнонапірних і різнонасичених продуктивних горизонтів на прикладі родовищ Роменської групи.

Ключові слова: *свердловина, керн, обсадна колона, порода-колектор, цементування, продуктивний горизонт, пакер*

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