

UDC 622.276.8

Pivtorak D.O. master of specialty 185 Oil and gas engineering and technologies
Scientific supervisor: Pashchenko O.A., Ph.D., Associate Professor of the Department of
Oil and Gas Engineering and Drilling
(*Dnipro University of Technology, Dnipro, Ukraine*)

IMPROVEMENT OF DRILLING EQUIPMENT FOR MULTI-STAGE HYDROFRACTURING OF FORMATION

The need to increase the efficiency of field development leads to the development and implementation of new, more effective and economically feasible methods of intensification of inflow and increase of oil yield. One of these methods was hydraulic fracturing (fracking). According to the definition, this is a mechanical method of impact on a productive layer, in which a liquid is injected into the thickness of the layer under high pressure, which leads to the rupture of rocks, the formation of new cracks of high permeability and the expansion of existing ones [1]. The liquid with which the operation is carried out is called fracturing fluid. To prevent the cracks from closing after removing the fluid and depressurizing, a special wedging (fixing) material is pumped into the well - proppant, which, depending on the requirements, has a different fractional composition and manufacturing material [2].

The hydraulic fracturing method has many technological solutions, determined by the specifics of the specific object of processing and achieved by the goal. Hydraulic fracturing technologies differ, first of all, in the volumes of injection of process fluids and proppants and, accordingly, in the sizes of the cracks created [3].

Conducting hydraulic fracturing with the formation of extended cracks leads to an increase not only in the permeability of the near-breakout zone, but also in the coverage of the formation by influence, involvement in the development of additional oil reserves and an increase in oil production in general. At the same time, it is possible to reduce the current water content of the extracted products. The optimal length of a fixed fracture with a reservoir permeability of 10–50 mD is usually 40–60 m, and the volume of injection is from tens to hundreds of cubic meters of fluid and from units to tens of tons of proppant [4].

The development of low-permeability reservoirs (the objects of which are characterized by a low permeability of about 0.5 mD) without the use of hydraulic fracturing is low-efficiency, since extremely low rates of selection from initial reserves are realized and wells are operated with flow rates at the limit of profitability [5].

Currently, there are many technological possibilities for conducting hydraulic fracturing, which are constantly being improved in order to achieve greater reliability and economic feasibility of the technology [6]. Depending on the initial conditions and final goals, the following types of hydraulic fracturing are distinguished [7]. Blind hydraulic fracturing. Conducted in already drilled wells where fracturing was not initially planned. Such wells are characterized by completion using a standard layout with a cemented or non-cemented shank [8]. Standard MDRP. It is carried out in wells that were planned to be affected at the stage of development of project documentation, accordingly, such wells are technically ready for exposure.

The blind fracturing method imposes many restrictions on the possibility of hydraulic fracturing. The main and most significant drawback is the impossibility of controlling the location of the operation in the shaft when using standard fracturing technologies. A way out of this situation in the presence of a cemented shank can be jet hydraulic fracturing with the help of hydrosandjet perforation. Nevertheless, this technology has its limitations and allows producing only small-volume hydraulic fracturing.

With planned hydraulic fracturing, the well can be designed both with an open shaft with a special composition lowered into it, and with a cemented shank. Depending on the decision made, various technologies are chosen for sealing the enclosed space. In the case of a cemented shank, the space is sealed by the cement itself, and in the presence of an open shaft, the shank packers are included in the design of the shank.

Technical means for multi-stage hydraulic fracturing are key elements in the development of oil and gas deposits, especially in the conditions of unconventional reservoirs. The main technical solutions used in hydraulic fracturing are installations with packers, sliding and rupture couplings, as well as hydrosandjet perforation technologies.

Analysis of the use of hydraulic fracturing units showed that devices containing two packers allow isolating certain areas of the well for maximum effect during hydraulic fracturing. Also considered are methods where one packer is used together with cobbles to control the hydraulic fracturing zone, which is an effective but less complex option.

Attention is also paid to sliding couplings used for stepwise creation of fractures in the formation. In particular, several types of clutches are considered. Ball-actuated couplings are a simple and reliable solution used to ensure precise fracturing in a defined zone. Couplings with soluble components are an innovative solution that simplifies the process of activating the couplings without the need for further removal of mechanical elements. Key-operated couplings - allow you to precisely control the activation process thanks to the use of special mechanical keys. Couplings with hydraulic activation - provide automatic rupture control thanks to hydraulic mechanisms. In addition to sliding couplings, couplings with combined activation methods combine the advantages of different approaches to provide flexibility in the hydraulic fracturing process. An important technology is also BPS clutches, which are characterized by increased reliability and efficiency due to the breaking mechanism.

Also, the method of hydro-sandblast perforation allows simultaneous perforation and fracturing of the formation, which significantly reduces the time and costs of operations. This technology is promising for use in complex geological structures.

References:

1. Ішков, В. В., Коровяка, Є. А., & Хоменко, В. (2024). Геолого-технологічні особливості Новомиkolaївського (Мовчанівського) нафтогазоконденсатного родовища (Україна).
2. Ішков, В.В., et al. (2024) Геолого-технологічні особливості Малосорочинського нафтогазового родовища (Україна).
3. Aziukovskyi, O., Koroviaka, Y., & Ihnatov, A. (2023). Drilling and operation of oil and gas wells in difficult conditions.
4. Ihnatov, A., Koroviaka, Y., Rastsvietaiev, V., & Tokar, L. (2021). Development of the rational bottomhole assemblies of the directed well drilling. In E3S Web of Conferences (Vol. 230, p. 01016). EDP Sciences.
5. Ratov, B. T., Fedorov, B. V., Khomenko, V. L., Baiboz, A. R., & Korgasbekov, D. R. (2020). Some features of drilling technology with PDC bits. *Natsional'nyi Hirnychiy Universytet. Naukovyi Visnyk*, (3), 13-18.
6. Ігнатів, А.О., Пашенко, О.А., Коровяка, Є.А., Семехін, В.Ю., Логвиненко О.О., Аскеров І.К. (2021). Деякі пояснення ударного механізму впливу на гірські породи при бурінні свердловин. *Збірник наукових праць НГУ*, 66, 177-192.
7. Войта, М. (2022) Удосконалення технологія розкриття продуктивних горизонтів.
8. Borash, B. R., Biletskiy, M. T., Khomenko, V. L., Koroviaka, Y. A., & Ratov, B. T. (2023). Optimization of technological parameters of airlift operation when drilling water wells. *Scientific Bulletin of National Mining University*, (3).