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RESEARCH ON MEASURES TO PREVENT WELLBORE DEVIATION BY USING RIGID BOTTOM HOLE ASSEMBLIES

One of the main problems during drilling is spontaneous deviation of the wellbore from the vertical, which leads to increased costs, difficulties with drilling process control and a decrease in the overall drilling efficiency.

The main causes of well curvature are geological factors (difference in rock properties, anisotropy, formation angle), technological factors (drilling modes, axial load, rotation speed) and technical factors (defects in threaded connections, reduced drill string alignment) [1]. Given the causes of well curvature, optimising the design of the bottom hole assembly (BHA) becomes an important element to minimise deviations and ensure a more controlled drilling process.

BHAs for preventing deviations are divided into pendulum and rigid designs. Pendulum BHAs operate on the basis of the overhang effect and are used when a well is detected to be curving during drilling. Pendulum configurations include a bit, downhole motor or weighted drill pipe of a design length to create the pendulum effect. Unlike the pendulum, the principle of operation of rigid BHAs is based on the effect of centring the tool in the wellbore. This arrangement reduces the tendency of the well to curvature, which is why it is most appropriate to use a rigid BHA when drilling in difficult geological conditions. Rigid BHAs consist of a bit, weighted drill pipes or screw downhole motor, several SCE and drill pipes.

The supporting-centering elements (SCE) include calibrators, centres and stabilizers, which are important components of the BHA during drilling [2]. The calibrator is installed directly above the bit and is designed to calibrate the walls of the wellbore to the nominal diameter when the bit wears in abrasive rocks, as well as to centre and improve the bit's operating conditions. Figure 1 shows schemes of typical calibrator designs.

The centres are mounted on the bottom of the drill string or on the downhole motor housing and are designed to centre, stabilise or change the path of the borehole, depending on the installation location. The maximum permissible wear of the centrepiece in diameter is 2-3 mm. Figure 2 shows the diagrams of the centralisers. Stabilisers are installed in the BHA above the calibrator and are designed to stabilise the spatial position of the wellbore.

The main purpose of using a rigid arrangement is to reduce the intensity of borehole curvature while maintaining a given drilling mode without reducing the axial load on the bit. To achieve this, it is necessary to optimally position the centring elements and determine the correct size and number of weighted drill pipes, which are determined based on the need to reduce the diameter gap and increase the rigidity of the assembly. The bending stiffness of the lower section of the weighted drill pipe should be higher than the stiffness of the casing under which the drilling is being carried out.

The main task in calculating the rigid arrangement is to determine the distance between the bit and the calibrator, at which the bit rotation angle will be minimal. This is because deviation of the axis of the arrangement from the vertical leads to rotation of the bit axis and, ultimately, to asymmetric destruction of the wellbore. The diameter of the centring elements should correspond to the nominal bit diameter or be 5-7 mm smaller, and the width of the support elements should provide a specific pressure that does not exceed the yield strength of the rock. The optimal diameter and placement of the centres help to reduce the bit tilt and

reduce the lateral force acting on it. In some cases, additional calibrators may be required to combat the effects of geological factors.

The key criterion in the calculations is to ensure the minimum bit rotation angle. The use of rigid layouts only helps to reduce the intensity of wellbore curvature, but does not completely prevent it, so it is necessary to change the BHA to further minimise the deviation.

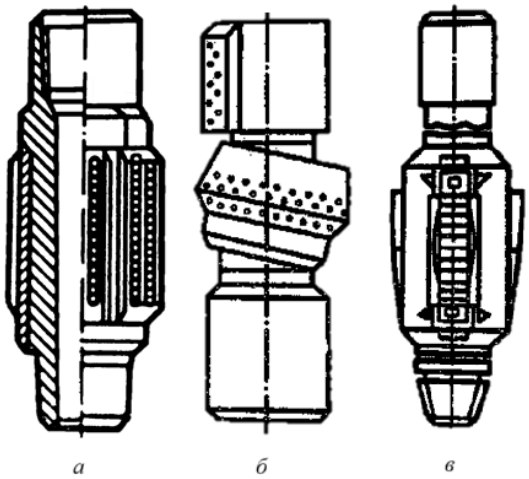

Figure 1 – Schemes of calibrators:
a – blade-type, b – ball-supported, c – roller

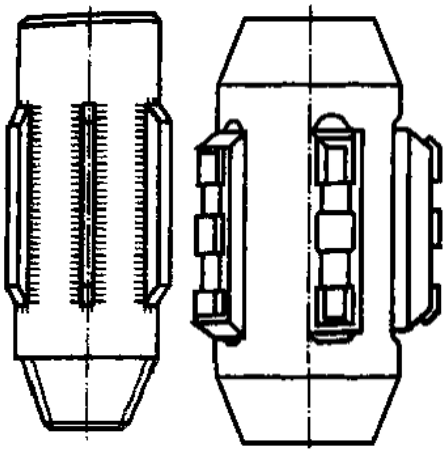

Figure 2 – Schemes of centralisers

References:

1. D. Pobidynskyi , V. Herevych, A. Slauta , V. Khomenko, O. Pashchenko. Reasons of curvature of oil and gas wells. Ukrainian mining forum – 2021: Papers of International Scientific and Technical Conference, November 4 – 5, 2021, Dnipro – 248-255 p.

2. Myslyuk M.A., Rybchych I.I., Yaremiychuk R.S., Well Drilling: Handbook in 5 vols. T3: Vertical and directional drilling - Kyiv: Interpress LTD, 2004.