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ANALYSIS OF THE CHOICE OF A ROCK-DESTROYING TOOL FOR DIRECTIONAL DRILLING BASED ON THE EXPERIENCE OF FIELDS IN THE WESTERN PART OF TURKMENISTAN

***Abstract**: the article reviews the analysis and provides recommendations, as well as instructions for the correct choice of rock-breaking tools for directional and horizontal wells in the Western part of the oil and gas fields of Turkmenistan for the purpose of trouble-free wiring and to increase mechanical speed during construction.*

To analyze the choice and mode of operation of rock-breaking tools, materials were used for working out previously drilled wells, with geological characteristics of deposits and physical and mechanical properties of rocks, stratigraphy (lithological section), and data on the durability of bits and mechanical speed obtained from the results of working out bits.

This paper presents a detailed analysis of the created load on the bit and considers the effects of transverse loads on the bit, the difficulties of drilling directional wells, their specific causes. There are also recommendations for choosing the mode of drilling drill bits and operating instructions for different types of rock-breaking tools.

This work can be used to perform the assigned tasks in the construction of oil and gas wells with complex geological characteristics.

***Key words**: bit, vibration, crack, sludge, torque, load, cutting element, downhole motor, layers, shoe, support.*
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Introduction

As the set of curvature, tilt angles and deflection distance increases, the torque and braking of the column often significantly limits the weight transferred to the bit. When such a pattern is observed, the penetration rate is greatly reduced and may even lead to a limitation of the drilling program if the load on the bit becomes insufficient to overcome the strength of the rocks.

The right choice of bits is key to improving drilling speeds in low-load conditions. Bits with fixed incisors usually require less loads to continue drilling than roller bits.

The usual characteristics of roller bits that are successfully drilled at low loads are high displacements of the rollers and a low number of teeth. Bits with fixed cutters with a low-density cutting structure with large protrusions of cutting elements. It can be used to increase the load on a single cutting element, which will cause a greater cutting depth. Sufficiently low loads of 900-4540 kg give quite acceptable penetration speeds. High rotation speeds from the downhole motor, which are usually used in the corner set and lateral sections, help to compensate for the effect of reducing the load on the bits [1, 2].

Some manufacturers of volumetric downhole engines believe that it is necessary to have very low rotational speeds of about 80 rpm, others - as high speeds as possible up to 2100 rpm. However, in the practice of drilling horizontal wells, the speed of downhole motors averages between 150-200 rpm.

Since many horizontal wells are aimed at formations with vertical cracks, dynamic loads should be considered.

Dynamic loads can be caused by cavities, voids, broken rocks, cracks and changes in rock types.

Each of these factors, individually or in combination, make it difficult to maintain the same conditions in the bottom-hole.

The result of such loads is vibrations, jumps, uneven loads on supports and cutting structures, which leads to unpredictable drilling speeds and a reduction in the operating time of the bit.

Plain bearings, compared to rolling bearings, are usually better suited to shock load conditions due to better load distribution.

Cutting structures in the form of steel (milled) teeth are more resistant to breakage and chipping due to alternating dynamic loads and are recommended if the rocks are not too hard or abrasive. In other conditions, preference is given to bits with inserts of tungsten carbide, (TCI), having a small displacement of the rollers, a small overhang and a large number of teeth. Bits with fixed cutters with high density and small overhang of cutting elements more effectively resist breakdowns.

Usually shock absorbers do not work in horizontal wells, because they cannot be effectively placed on the drill string.

With the determination of the placement of the downhole motor, the curves of the translators, measuring and other tools, the shock absorbers have to be placed in relatively inefficient places.

Therefore, shockproof tools practically do not represent a way to reduce dynamic loads during horizontal drilling. [3, 4, 5]

Hydraulic drilling parameters for horizontal wells are selected as well as for vertical ones. The big difference between horizontal wells is due to the accumulation of sludge on the underside of the well.

These conditions worsen the wear of the external surface of the bit and the seals of the supports of the roller bits. The lifetime of the sealed bit supports will also be affected by less efficient cooling of the bit in the horizontal hole.

The accumulation of sludge around the bit can be reduced by increasing the turbulence of the flow and choosing a bit design and flushing scheme that promote cross-flows. The cross flow is obtained with an asymmetric arrangement of the nozzles in the form of double nozzles and their absence on the roller bit.

Turbulence is achieved by more efficient mixing, which can be facilitated by increasing the paws to the outer diameter of the rollers, by using attached cutting structures of the PDC and intensive circulation [6, 7]. The shoes of the bit paws cannot be used if they are not linked to the correct operation of the downhole layout.

With an increase in the angle of inclination of the well from 0 to 45 °, the minimum velocity of the slurry removal solution increases rapidly. This speed may exceed the required speed for a vertical well by 2-3 times. Using reverse expansion to clean the borehole, when sludge accumulates on the underside, it is often possible to increase the problems associated with the wear of the outer surface of the bit [8, 9, 10].

Anti-wear shoes on the paws of the bit and the hardening of its outer surface helps to protect the paws of the roller bits.

In bits with fixed incisors, diamond inserts on the bevels of the calibration part will protect the diameter of the bit during its reverse movement.

Controllability, which is defined as the ease with which a change in the course or direction of a well is carried out, has reached a new level with the advent of methods for drilling horizontal wells with medium, small and ultra-small radius of curvature [11, 12].

In the past, the development of bits for conventional drilling included properties that limited the lateral departure of the bits during drilling.

New developments give properties to bits that not only do not allow, but on the contrary enhance lateral care, controllability.

The calibration shoes of the bits with fixed incisors were dramatically redesigned. The PDC and TSP cutters were placed along their length of the calibrating part of the bit, which was reduced in length, and the downhole surface of the bit was leveled, which led to an increase in the ability of the bits to lateral cutting.

If necessary, the density of diamonds on the calibration part can be increased to obtain additional bit life when necessary.

By reducing the full length of the bit, its controllability can be increased proportionally. The reduction of the neck of a fixed bit is one of the methods of reducing the shoulder of the protrusion. This, in turn, allows the controlled system to drill with a smaller radius (create a large set of angles) at a given bending angle of the downhole layout [13, 14, 15].

Shorter bit necks allow you to increase the ability of downhole layouts to gain an angle by placing the stabilizers closer directly to the downhole surface of the bit.

A neck of ordinary length, therefore, reduces the set of curvature, which, in turn, increases the radius of curvature of the horizontal well [16, 17, 18].

The bending angle of the downhole system can be reduced if it is not desirable to increase the rate of curvature set. Reducing the bending angle of the layout will reduce the displacement of the bit, thereby reducing the force of the dynamic load on the calibration part of the bit.

Being subjected to lateral loading, the bit turns near the point of adhesion to the well wall. This forces the well to follow a path determined by the magnitude and direction of the lateral load, as well as the direction of rotation of the bit.

Thus, a bit rotating clockwise with cutting elements pressed against the bottom wall of the well will tend to drill down and to the right. With hourly rotation and compression of the bit to the upper wall of the well, the trajectory will go up and to the left. This trend is called the departure of the bit.

The neutralization of care depends on the type of bits used. Usually, the behavior of roller bits is more predictable than bits with fixed incisors. The main reason is that fixed bits have more changes in the location of the incisors, the downhole surface, in the length and shape of the calibration part [19, 20].

The development of a plan to achieve the desired trajectory of the well should be based on the available information on the care of the bits and the layout of the bottom in this drilling environment. After the start of the well, corrections can be made to compensate for undesirable deviations.

The torque depends on the interaction of the calibrating and downhole cutting elements with the rock and is primarily a function of the aggressiveness of the cutting structure and the load on the bits.

In comparison with the roller bits, the PDC bits exhibit greater instability of torque with fluctuations in the load on the bit. This is especially evident when drilling in conditions peculiar to the penetration of formations with vertical cracks [21, 22].

The torque changes are especially amplified when using PDC bits with aggressive cutting structures or when working with high-torque low-speed downhole motors.

In practice, changes in torque are a well-established phenomenon, there are also laboratory data, however, there is no complete understanding of torque fluctuations.

However, sufficient experience and laboratory data indicate that bits with fixed incisors work much more roughly than roller bits in similar conditions. This is the result of the alignment of the torque on the bit with the torque of the drill string. Therefore, increased torque changes lead to large changes in the orientation of the downhole surface.

Therefore, depending on the formations, it may be more difficult to maintain the orientation of the downhole surface of the bit when drilling with aggressive bits with fixed incisors. That is why roller bits are preferred in the areas of the angle set.

To reduce torque fluctuations, it is advisable to use PDC bits with smaller protrusions of the cutters and a higher angle of reverse inclination of the cutter.

As in the case of any downhole equipment, the service life of the bit can be predicted only on the basis of experience and knowledge of the design features of the bit in question. The choice of a bit should be made in order to increase the probability of successful drilling of the next part of the well.

Although increases in lateral loads are observed when the angle is set, the sections of the curvature set are usually shorter in length than the service life of the bit. Therefore, unplanned descents and ascents are not always associated with the service life of the bit.

The service life of a bit in a horizontal bore is usually the same as in a vertical well under similar conditions in terms of the bit load and rotation speeds. However, this also assumes the ability of the bit to keep its diameter.

It was found that in the final section of the angle set in the well, rapid wear of the diameter and supports reduced the service life of the roller bits with sliding supports. The short service life of the bits was determined by the high content of fine sludge in the solution, high speeds of the downhole engine and large lateral loads [23, 24].

To increase the service life of the bits in wells where it is difficult to maintain the diameter of the bit, there are various solutions.

Smaller displacements of the rollers or designs of the calibration part with more wear-resistant inserts or with reinforcing materials can be used in the roller bits. The paws of the bits can be protected as described above.

Bits with fixed incisors can use individually or in combination an increased length of the calibration part, increased diamond density, an elongated PDC contact area on the calibration part and TSP materials.

Since the heart of the roller bits is the reference layout, it must be kept in mind, first of all, when analyzing the service life of the bits. Reliability analysis leads to the conclusion that, although the cost of drilling decreases with increasing service life of the bits, the possible savings decrease when the risk of failure of the support exceeds the calculated probability of failure-free operation.

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