Analysis of Distortion Mechanisms Used in Rotary Steerable Systems

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INTRODUCTION

Horizontal drilling is one of the promising methods of intensification of oil and gas production, which increases the filtering area of the reservoir fluid due to the length. The development of directional drilling so far is related to complex horizontal wells and wells with a significant deviation from the vertical. Rotary steerable systems (RSS) are most often used in directional drilling (Mostovoy et al., 2019; Novoseltsev, 2014; Kein, 2014; Mostovoy and Savenok, 2019; Galikeev et al., 2018; Shevschenko, 2014; The Weatherford website; The Schlumberger website; The Halliburton website; The BakerHughes website).
The DART (Downhole Adjustable Rotary Tool) is a 100% mechanical tool for drilling wells on smooth curves with constant intensity angle changes. The curvature on the principle of three-point stabilization is provided by applying constant lateral force from non-axial stationary stabilizer to the bit (Fig. 1).

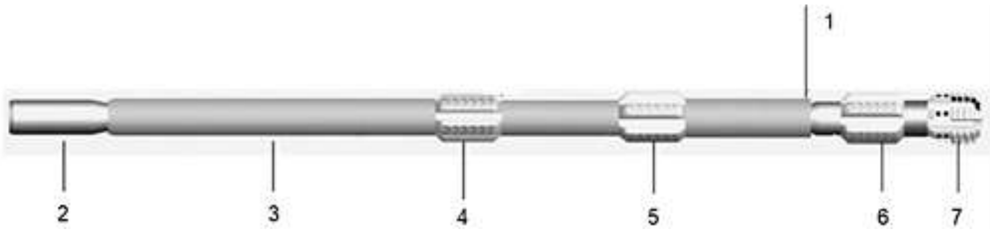

Fig. 1 Rotary steerable system DART:
1 - End face orientation mechanism; 2 - Core; 3 - Non-rotating mass eccentric; 4 - Coaxial stabilizer; 5 - Off-axis stabilizer; 6 - Scratcher; 7 - Bit

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During drilling, the direction of the drill is supported by a non-rotating mass eccentric, which is permanently suspended due to gravity. The bit is skewed when it is detached from the face while pumps are switching off ant that takes no more than 3 minutes.

The DART system includes the following elements and devices:

1. core passing through the tool to transfer torque and rotate the bit; it is used as part of the mechanism to change the orientation of the bit;
2. a squeegee which is part of the core and rotates with it. The diameter of the squeegee is smaller than the diameter of the bit, and usually the squeegee does not touch the walls of the wellbore. It is designed to remove all the bends formed during the drilling and which can hinder the promotion of non-rotating stabilizers (coaxial and non-axial);
3. non-axial (control) stabilizer non-rotating, full-size, slightly shifted about the axis of the core. This displacement creates a lateral force on the bit, allowing to control the trajectory of the wellbore in three dimensions;
4. coaxial stabilizer – concentric, also non-rotating, creates a third support point for three-point stabilization, which is necessary for accurate and predictable control of the layout with the DART system. Also, this stabilizer takes on the weight of the mass eccentric.

Figure 2 shows an example of the operating principle of the system: the non-axial stabilizer transmits a lateral force to the bit, which directs the end of the tool by 45° to the right of the zenith point. Thus, drilling is carried out along this vector.

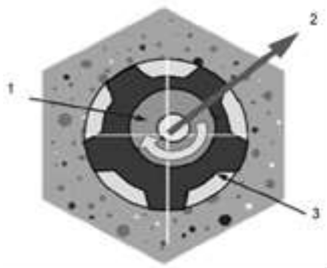

Fig. 2 The principle of the system:
1 - Core; 2 - Drilling vector; 3- Off-axis control stabilizer

Methodology of research

For the bit slope to be adjusted, the following actions should be performed: detach the bit from the face and stop the rotation of the drill-stem; stop the pumps; rotate the drill column by the number of clicks of the rotor needed to set the new orientation of the end (each click of the rotor shifts the drilling vector to the right by 2.25°); stop rotation when the specified orientation of the tool-face is reached; start the pumps and start circulation with the normal flow; continue drilling.

If the drill-stem is not rotated by the rotor when the pumps are stopped, the bit skew will remain unchanged.

To orient the tool-face of the bit at the zenith point, perform the following: detach from the face and stop the rotation of the column; stop the pumps; rotate the column more than 180°. Each click of the rotor shifts the system tool-face orientation by 2.25° clockwise. The column is rotated by a rotor until the drill-stem is directed to the zenith point. The rotation of the column by more than 180° is guaranteed to bring the orientation of the tool-face to the zenith point, regardless of the initial orientation. After that, the drive of the tool-face orientation mechanism is switched off and the tool-face remains oriented at the zenith point. Further rotation of the drill-stem cannot affect the orientation of the tool-face.

Procedure for installing a new drilling vector after the orientation of the tool-face at the zenith point: stop the rotation of the rotor; perform the duty cycle of the pumps (i.e. start the pumps, bring the solution to normal drilling level, maintain circulation for 20 seconds, then again stop the pumps). This procedure re-activates the system orientation mechanism and further orientation of the tool-face is performed in usual mode by rotating the drill-stem to the required speed (Baranov et al., 2017).

Drilling of sloping sections using DART system is performed by the alternating orientation of the tool-face in opposite directions. Because DART is easy and quick to change the direction of the tool-face, this procedure does not increase drilling time and enables the straight hole to be obtained.

Table 1 shows a comparison of the results of the drilling of two 155.6 mm test boreholes with a downhole engine and a DART drill-stem in the Middle East.

Table 1 Comparison of drilling results

	Length along the well hall from - to, m	Sinking, m	Drillingtime, h	Sinkingrate, m/h
Well 1, Section 1	1747-4303	2556	152.25	16.7
Well 1, Section 2	1752-4255	2503	113.75	20.5
DART Section	1727-4220	2493	61.25	40.7

A comparison of the drilling of two 155.6 mm diameter control wellbore with a bottom hole motor and a barrel drilled with a DART system shows that the speed of the sinking has been doubled compared to the control wells. All areas are drilled on identical rocks at the same depth. Conical ball bits were used in all layouts, including the DART system.

ROTARY STEERABLE SYSTEM GEO-PILOT AND EZ-PILOT FROM SPERRY-SUN

The Geo-Pilot rotary steerable system (Fig. 3) uses a controlled deviation consisting of a solid shaft located between the bit and the top of the tool.

Made of stainless high strength steel, the shaft has an internal channel for the passage of the mud. The compact and durable deviation unit placed inside the non-rotating top of the body transmits the controlled deviation to the shaft through two rotating eccentric rings. Communication with eccentric rings on top and bottom is carried out by two drive systems.

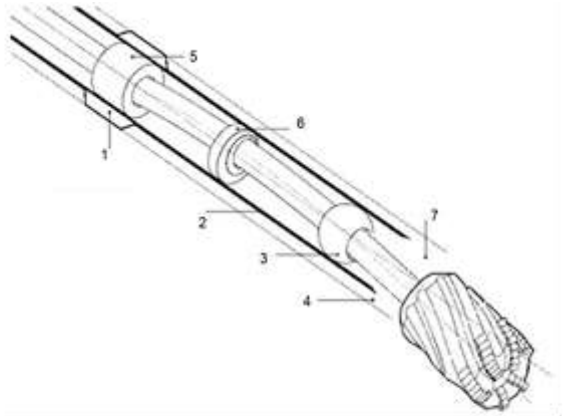

Fig. 3 Geo-Pilot rotary steerable drilling system:
1 - Supporting stabilizer; 2 - External housing; 3 - Floating bearing; 4 - Wellbore; 5 - The upper bearing of the fixed end; 6 - Eccentric rings; 7 - deviation range

As a result of the operation of one or both drive systems, the rings are rotated together or separately and moved the shaft to the side about the center line of the housing, causing the shaft to curve and orient the bit to the specified angle of the deflector. Specially designed rotating seals inside the housing disable the mud to get inside the system and the lubricant fluid to flow out.

The shaft section passing through the housing is supported by a fixed main shaft upper bearing, radial support bearing and a lower floating bearing. When eccentric rings bend the shaft, the shaft bends between the main shaft upper bearing, which prevents the shaft from bending above itself and the lower floating bearing, which facilitates the bet deflecting in any given direction and rotates freely. Since the main load on the bit is transmitted through the body, the shaft can be thinner and more controllable.

To ensure maximum service life and reliability of the Geo-Pilot system, seal bearings and other internal moving parts are immersed in lubricating oil. Equipment working in isolation from the flushing fluid, there is practically no compatibility problem with the drilling fluid.

Located at the top of the layout, a compact, robust and computerized unit controls shaft deviation. This enables the direction of the bit movement to be continuously under control. Thus, in the well it becomes possible to regulate the direction of the drilling and the desired rate of the set of curvature.

Advanced sensors powered by a long-lasting internal battery monitor the bit position, column speed, and internal parameters of the equipment.

A typical layout for drilling with the Geo-Pilot system is shown in Figure 4a.

The system is designed for use with a diamond bit with an extended calibration part.

Another development work of Sperry-Sun is the EZ-Pilot system. The layout with the EZ-Pilot system is shown in Figure 4b.

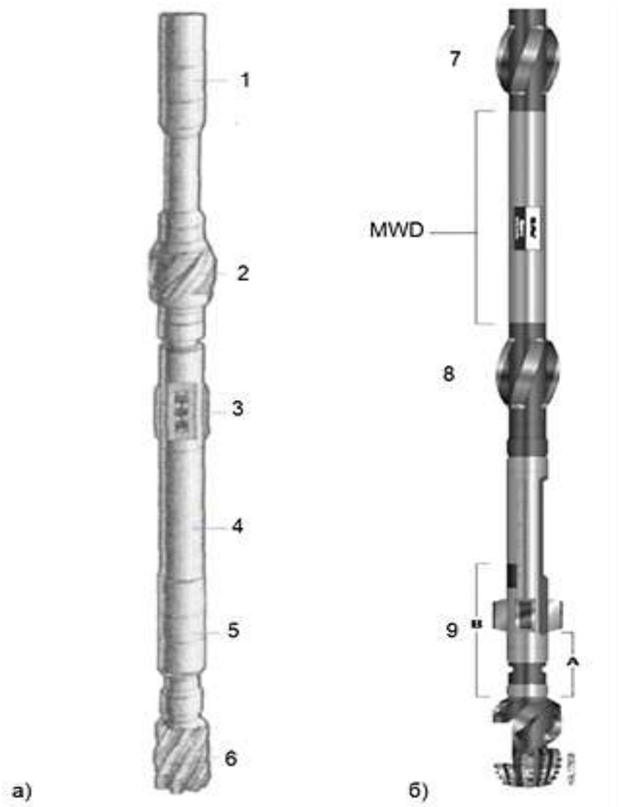

Fig. 4 Sperry-Sun rotary steerable system: a - Geo-Pilot rotary steerable system configuration; b - Sperry-Sun RSS configuration.
1 - The interface of the data acquisition system during drilling (MWD); 2 - spiral stabilizer; 3 - Correction stabilizer; 4 - Non-rotating casing; 5 - Device for changing the angle of inclination; 6 - Case bit with extended calibration part; 7 - 1/8 inch full-sized distributor of the stabilizer; 8 - 1/16 inch incomplete stabilizer control valve; 9 - full-sized stabilizer control valve

The EZ-Pilot system is a fully equipped, super-bit stabilizer consisting of three main elements, including an eccentric inner sleeve and a heavy non-rotating outer body.

The tool works by controlling the eccentric direction of the inner sleeve, which shifts the shaft and consequently the bit in a given direction. Rotation of the inner sleeve in order to change the orientation of the tool face of the drill is performed by a DC motor with ultra-high torque powered by a lithium battery (Mostovoy and Savenok, 2019).

The location of the outer housing is constantly monitored by the computer, and the tool automatically adjusts the eccentric position of the inner sleeve if it is necessary to maintain the appropriate orientation of the tool place of the drill. The specified drill work face location is set by simple speed commands transferred from the surface to the electronic module installed in the tool.

The EZ-Pilot system can avoid the additional costs for a separate data transmission system. The tool can drill in any given direction or drill in a straight line. The advantage of the EZ-Pilot system is easy to use.

SCHLUMBERGER POWER DRIVE XTRA SYSTEMS WITH BAKER HUGHES AUTO TRAK SYSTEM

Schlumberger's Power Drive Xtra system with Baker Hughes Auto Trak is shown in Figure 5.

The systems use automatic orientation mechanisms and control the path of the well by milling the well wall. In expandable systems the non-rotating stabilizer provides a static lateral force applied to the well wall, causing a counteracting force effected the stabilizer and the bit. The intensity of the borehole curvature is determined by the ratio of lateral cutting and forward drilling scope. In both systems, at the bit level, the axis of rotation of the bit is always at an angle relative to the axis well. The value of this angle is determined by the tool geometry and the radius of hole curvature (Mostovoy and Savenok, 2019; Mingaleva et al., 2019).

The main blocks of the considered RSS are highlighted in Figure 5.

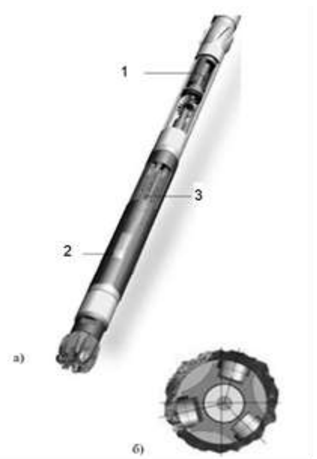

Fig. 5 AutoTrak Rotary System:
a) the main components of the system; b) non-rotating expanding stabilizer
1 - Integrated MWD system; 2 - The above-bit sector of deviation;
3 - Downhole computer

The integrated MWD system measures the zenith angle and azimuth, vibration value, provides connection to the system located on the surface. The borehole computer compares the data obtained by the MWD control system with the design characteristics of the trajectory, and then sends the command to the above-bit deviation unit to adjust the course. It transmits data to the surface and receives back instruction to adjust the course. The above-bit deviation sensor monitors the deviation of the bit. Transmits data to the MWD downhole control system.

Using PowerDriveXtra controlled rotor systems to drill wells with high vertical deviation allows better drilling performance and bore quality compared to boreholes drilled with regular technology using a screw bottom hole motor.

POWER DRIVE X5 BY SCHLUMBERGER

Schlumberger PowerDrive X5 rotary steerable system implements a push-the-bit curvature set. RSSPowerDrive X5 provides drilling with a fully rotating rotary system for directional drilling and drilling of straight wells. The RSS layout is capable of receiving real-time data when used with PowerPulse and PowerScope telemetry systems (Fig. 6, 7).

Fig. 6 Rotary steerable system before launching into the well

PowerDrive X5 rotary steerable system enables to get the following results:

- ✓ measurement of zenith and azimuth angles in the immediate vicinity of the bit;
- ✓ measurement of vibration level and impact load of the bottom hole assembly;
- ✓ measurement of the rate of rotation of the bit;
- ✓ measurement of gamma radiation for geo-steering;
- ✓ automatic maintenance mode of the zenith angle.

The design of the valve in all diverter systems with a bit being deviated is similar and the principle of its operation is shown in Figure 7.

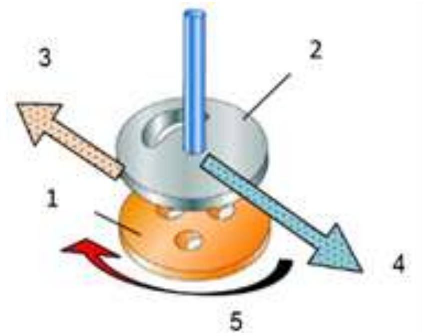

Fig. 7 Valve operation diagram: 1 - plate with holes; 2 - valve disc; 3 - the direction of pressure on the blade; 4 - the direction of curvature; 5 - the direction of rotation of the bit

POWER DRIVE XCEED 675 BY SCHLUMBERGER

PowerDriveXceed 675 rotary steerable system is designed for directional drilling and can be used for drilling new directions of well bore, drilling of extended diameter wells. The RSS PowerDriveXceed 675 is capable of receiving real-time data with PowerPulse and PowerScope telemetry systems used. The system enables automatic maintenance of zenith and azimuth angle of the well, measurement of zenith and azimuth angles in close proximity to the bit, measurement of rotation speed chisel. The diameter of the bit is 212.7-250.8 mm. The maximum intensity of curvature is 8 degrees/30 m. Flow rate of washing solution 1098-3098 l/min. Maximum rate of rotation 350 min-1. The length of the layout is 7.62 m. Distance to the second stabilizer 3.38 m, to the first 0.34 m. PowerDriveXceed 900. The diameter of the bit 311.2-444.5 mm. (Mostovoy and Savenok, 2019)

Analysis of the distortion mechanism based on the asymmetric destruction of the face, due to the distortion of the rock destruction tool

Rotary steerable system of Point the bit type which are based on the asymmetric destruction of the face mechanism of curvature through the distortion of the rock destruction tool. Here the analysis of the mechanism of curvature.

The intensity of curvature of the asymmetric disruption of the face (Fig. 8) is determined by the dependence:

$$i_a = \frac{57.3(D_c - d_k)}{l^2} \tag{1}$$

where:

D_c, d_k – diameters of the well and the RSS hull at the point of contact with the well wall in case of a distort, m;

l – distance from the face to the point of contact of the continuously operated deflector with the well wall in case of a distorting of the lower part deflector, m;

P_p – spacing force, H;

γ – slope angle of rock destructive tool, deg.

From the formula (1) and the diagram in Fig. 8 it follows that the intensity of the borehole curvature is determined by the design dimensions of the RSS and the diameter of the well, and the deviation force of the propulsive tool is absent.

As a result of the design of the RSS, which implements the asymmetric destruction of the face, are less loaded and deformed, and therefore are quite simple in design and in operation are quite reliable, as well as differences in the ability to predict the intensity of the curvature and obtain it at the curvature with high accuracy. The process of the borehole curvature due to the asymmetrical destruction of the face at the absence of deviation force on the bit has the following advantages:

1. Improvement of operating conditions of bits equipment, increase their durability and decrease of wear rate of calibrating tackles of the bit as a result of the absence of transverse deviation force.
2. The most effective use of energy parameters of downhole engines due to the maximum transfer of their developed power and the spinning moment for the destruction of rocks on the face.
3. 3.Ability to drill at increased axial loads on the bit, which increases the drilling rate.
4. As a result of the combined impacts of factors 2 and 3 it is possible to distort the well with high drilling speed, the intensity of the curvature in this case not depending on the milling rate and mechanical drilling speed, and therefore the parameters of the drilling mode.

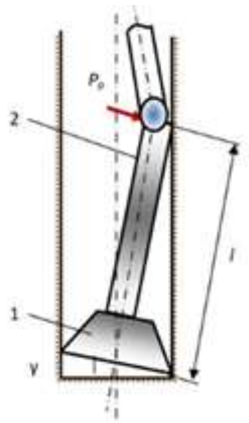

Fig. 8 Diagram of the curvature increasing of the RSS of asymmetric fracture of the face (Point the bit) 1 – rock cutting tool; 2 – housing RSS

However, the curvature process only under the uneven fracture of the face has such a disadvantage as the limited intensity of the bore-hall curvature, which increases the drilling interval and the amount of work with the diverting bottom-hole assembly.

The radius of bore curvature due to uneven fracture of the face R milling the well wall in the absence of deviating force on the bit is determined by the formula

$$R_a = \frac{L_m^2}{mD - d_m - 8f} \quad (2)$$

where:

L_m is the length of the bottom hole engine with the bit, m;

m – the coefficient of the trunk widening ($m = D_c/D$, D_c – diameter of the well, m); D,

d_m – diameters respectively of the bit and the bottom hole engine, m;
f – deviation of the bottom hole engine, m
It follows from formulas (1) and (2) that borehole distortion as a result of uneven fracture of the face may occur at a permanent intensity along the arc of a circle radius Ra, with the parameters included in these formulas keeping constant.

Analysis of the curvature mechanism based on milling well wall

Rotary steerable system of Push the bit type is based on the mechanism of curvature realized by milling of the well wall. We will analyze this mechanism. The curvature intensity realized by the cutter type diverter system can be determined by the following analytical dependence:

$$i_f = \frac{57.3 v_f}{v_b L_r} \tag{3}$$

where:
v_f, v_b – the milling rates of the well wall under the action of the deviation force and the deepening of the face, m/h;
L_r – the length of the rigid base of the diverter system, m
Fig. 9 shows diagrams explaining the process of curvature set by milling the well wall under the Pd deviation force. In this case, the ideal realization of this type of curvature will be equality to zero of the angles of misalignment of the axis of the rock destruction tool in relation to the axis of the well.

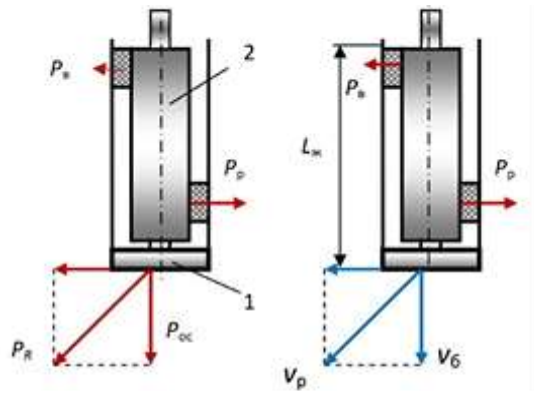

Fig. 9 Diagrams explaining the process of curvature gain by milling the borehole wall under a deflecting force P_{dfl} 1 - rock cutting tool; 2 - housing of the continuous deflector

The advantage of the borehole curvature due to the milling of the wellbore wall is a significant increase in the intensity of the borehole curvature, which reduces the drilling interval and the volume of work with the diverting bottom-hole assembly. At the same time, as it follows from dependence (3) the process of setting curvature by milling is significantly limited by the value of the drilling rate. For example, a high drilling rate will limit or moreover eliminate the borehole curvature. The optimal drilling speed, at which effective curvature is fully realized by milling the well wall, is the speed of 0.8-1.0 m/h.

The ratio of v_f and v_b speeds in the process of curvature set by milling with the intensity of 0.5; 1.0; 1.5 and 2º per 10 m penetration can be 0.0044; 0.0087; 0.0131 and 0.0174 respectively.

The ratios of milling speeds and bottom depth regardless of the values of the deviation force and an axle load on the bit and other factors are extreme. These ratios, having the value of the drilling speed in borehole curvature, are the basis for the limit value of the milling speed of the well wall to be calculated.

It is necessary to emphasize that some operations in drilling of wells like a new one, correction of an already curved barrel and in other cases cannot be chosen but milling the bore hall.

Analysis of the curvature mechanism with both of distortion of the bit and milling of the wall

The hybrid curvature mechanism is the basis for a hybrid rotary steerable system. There is an analysis of this mechanism in here.

For deflectors which do milling and asymmetric fracture of the face in dissimilar processes simultaneously, the curvature intensity can be determined by the following expression:

$$i_{f-a} = 57.3\left(\frac{v_f}{v_b L_r} - \frac{D_c - d_k}{l^2}\right) \quad (4)$$

According to the scheme in Figure 10, the deviation force stems from the deviation of the deflector rotor shaft and triggers the distortion of the bit on the face opposite to the direction of milling the wall well.

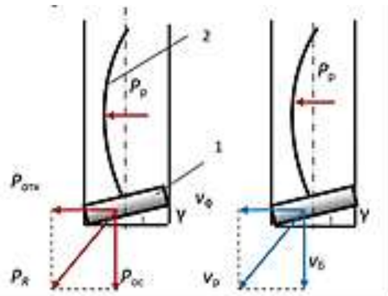

Fig. 10 Diagrams explaining the process of well curvature on mismatching in the direction of milling of the well wall under the deflecting force and skew of the rock cutting tool. 1 - rock cutting tool; 2 - a shaft of the continuous deflector

Figure 10 shows a diagram explaining the curvature under the pressure of the deviation force denoted as P_{def} and the distortion of the rock destruction tool 1.

The following conditions are indispensable to the most efficient use the deviation capability of the bore:

- ✓ sufficient deviation force to allow the milling of the barrel wall to be effective;
- ✓ the bit shall have sufficient lateral milling capability and shall not limit the process of artificial curvature of the bore.

For any layout that make as joint milling as asymmetric fracture of the face, the bore curvature under the milling is 4.84 times more active than the uneven destruction of the well face. In other words, for any layout to divert, 83% of the

possible increment of the well curvature can be achieved by milling the well wall and only 17% due to uneven asymmetric destruction of the face.
During drilling the diverter system being elastically deformed, the proportion of the borehole distortion as a result of uneven fracture of the face will decrease and at a certain value will aim to zero, and the proportion of curvature due to milling the barrel wall, on the contrary, will increase and reach 100%. In further bending of the deflector, the bit is skewed in the opposite direction of action of the deviation, which will reduce the intensity of curvature increasing.
The deviation force of the P_{def} owing to the deformation of the drill pipes located above the curved mandrel sub curve can be determined by the formula:

$$P_{def} = \frac{2EJ_t}{3al} sin^2(\Delta_p - \gamma_t) \qquad (5)$$

where:
J_t is the rigidity of the drill pipes placed above the turbo-drill, Nm^2;
a is the displacement of the drill pipes during their deformation in the well trunk, m;
Δ_p and γ_t are the distortion angles respectively of the axes of threaded connections curve adaptor and turbo-drill in well, deg;
l - length of turbo-drill with a bit, m.

$$a = D_d - \frac{d_t + d_b}{2} \qquad (6)$$

where:
D_d, d_t, d_b are diameters respectively of the bit, turbo-drill and drill pipes, m;
The angle γ_t is determined by the dimensions of the turbo-drill:

$$\gamma_t = \frac{D_d - d_t}{l_t} \qquad (7)$$

As follows from the formula (7) it indispensable to use curves translators with large angles of distorting axles of threaded connections to increase the deviation force it is necessary to increase the rigidity of the drill pipes installed above the curve adapter and the downhole hydraulic motor. The length and diameter of the downhole engine have a certain impact on the deviation force.
To increase the deviation force or its regulation, in the drilling operations, heavy drill pipes are usually installed over the turbo-drill with a curved subverter. Under the Pdef the well wall is milling, and the bit, being skewed, provides a curvature increasing by the asymmetric destruction of the face.

CONCLUSIONS

Recommendations for choosing rotor-controlled systems depending on tasks based on the type of curvature mechanism

The rotary steerable system recommended for sidetracking. Sidetracking is an effective technology to increase oil production in old fields and the recovery rate of oil from the strata, to put oil wells into operation, which could not be returned to the fund by other means. For drilling additional boreholes for artificial faces, it is advisable to use a rotary steerable system with the mechanism of milling the wall, due to the high intensity of the crookedness increase. A striking example of such a system is PowerDriveXtra by Schlumberger.

Rotary steerable systems recommended for crookedness increase

When moving from a vertical section of the well to a horizontal section, or when moving from an inclined shaft to a horizontal one, there is a need to carry out a significant crookedness increase within a certain, local section of the well.

To meet this issue, the optimal choice is a rotary steerable system with the mechanism of the crookedness increase by milling the wall, as such a system enables one to get the curvature increase with high intensity. A striking example of such a system is PowerDriveXtra by Schlumberger. If there is a task of a smooth and controlled crookedness increase, the best choice is a system implementing the mechanism of asymmetric rock destruction due to the distortion of the bit.

A model of such a system is the Geo-Pilot system by Sperry-Sun. This choice can be explained by the fact that the systems which provides the distortion of the bit are more controlled, as there is no dependence on the milling speed and mechanical drilling speed.

Rotary steering systems recommended for drilling horizontal wells

On building a horizontal section of the well, precision and controllability of the drilling are required. Also, due to the fact that drilling of the horizontal section is usually performed on the collector, it is necessary to drill quickly. It is known that the collector is a quite brittle material and the drilling speed can reach 20-40 m/h. It drives to the conclusion that the rotary steerable system with the wall milling mechanism is not effective for drilling horizontal sections, as for this mechanism there is a direct correlation between the drilling speed and the intensity of the crookedness increase. It could be stated that the higher the speed, the lower the intensity. Thus, when drilling a horizontal section with a high-speed RSS, with the wall milling mechanism is ineffective (Bozek and Pivarciova, 2013). The rotary steerable systems with asymmetric rock destruction mechanism by distortion of the chisel, on the contrary, are the optimal choice in this situation. In the fact that there is no dependence on the mechanical drilling rate, it is possible to drill quickly, which increases the efficiency of the drilling process.

A striking example of such a system is the EZ-Pilot by Sperry-Sun and, unmentioned earlier, Weatherford's innovative Revolution system.

Rotary steerable systems recommended for drilling horizontal well holes

Directional drilling technologies are used not only to the curvature increase or to drill a branch hole. There is also a need for them for drilling vertical barrels. Thus, rotary steerable systems are actively used to maintain the verticality of the boreholes in the drilling. In such a situation, it is necessary to use the power variant, which provides the RSS of milling the wall. An example of such a rotary steerable system is the PowerDriveXceed system from Schlumberger and, unmentioned earlier, the Power V system from Schlumberger. The results of this analysis are shown in Table 2.

Table 2 Recommendations for choosing rotary steerable systems for different tasks based on the type of curvature mechanism implemented

Benthousing	Capabilities and Operations				
	Sidetracking	**Smooth drift deviation**	**Sharp drift deviation**	**Lateral drilling**	**Verticality keeping**
Well bore milling	+ PowerDriveXtra by Schlumberger		+ AutoTrack by Baker Hughes		+ Power Drive Xceed by Schlumberger, Power V by Schlumberger
Asymmetric destruction of the face because of bit setoff		+ Geo-Pilot by Sperry-Sun		+ EZ-Pilot by Sperry-Sun, Revolution by Weatherford	
The mechanism of joint milling of the wall and the warp of the bit (hybrid)	+ (Power Drive Archer by Shlumberger)				

RESULTS and DISCUSSION

As a result of analytical studies presented in this paper, it is available to conclude that the technology of drilling wells with rotary steerable systems are superior to other directional drilling technologies, which was proved by the cases of drilling specific wells compared to drilling with other state-of-the-art diverters.

Drilling with a rotary steerable system, the mechanical drilling rate increases by two times compared to drilling with a screw downhole motor, which provides significant savings drilling-time. The effective length of the horizontal section increases, which enables to increase the production rate more than twice. It is found that in comparison with the bottom hole motor, the rotary steerable system provides drilling smoother well, which reduces the risk of accidents to come out. The correlation between the type of curvature mechanism implemented and the most rational area of its application was established. On the basis of the analytical study of the mechanisms of curvature realized by rotary steerable systems, recommendations on the choice of rotary controlled systems were made, for various tasks, encountered in the directional drilling.

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Abstract: Drilling with a rotary steerable system, the mechanical drilling speed increases by two times compared to drilling with a screw bottom-hole motor, which provides significant savings drilling-time. The effective length of the horizontal elbow increases, which enables to increase the production rate more than twice. It is found that in comparison with the bottom hole motor, rotary steerable system provides drilling smoother barrel, which reduces the risk of accidents to come out. The dependence between the type of the bent housing and the most rational fields of its application is revealed, recommendations on the choice of the rotary steerable system for various issues of directional drilling are developed.

Keywords: rotary steerable system, distortion mechanisms, horizontal wells, crookedness increase, horizontal well holes