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DRILLING TOOL WITH NEGATIVE DRILLING FORCE VALUE

Abstract. Unstableprices for good sintheextr active industry dictate reduction in the cost of used technologies. However, in the modern subsurface management industry, use of innovations in drilling technologies conversely increases the cost of work, complicating operating conditions. The research carried out by scientists is aimed at modernizing the drilling technology and creating new drilling tools of the same type used at the given time. In all used drilling methods, curving of drill pipes is laid in the technological process in advance, as a blunt drilling tool, before cutting into the ground, resists a drill pipe. The authors of the article have developed a new geometry of the drilling tool, which has negative drilling force values, which draws down the drill pipe. Taking into account the negative values of the drilling force P, it becomes possible to exclude the heavy weight drill pipes from the composition of the drill string. Naturally, when tensioning the drill string, there should be no curving process. If such theory is confirmed in industrial trials, there may not be a need for a bent housing. The absence of the borehole curving during drilling allows to exclude stabilization mechanisms in the borehole arrangement. The exclusion of some mechanisms from the drilling complex will obviously reduce the cost of drilling. The creation of such drill chart will undoubtedly reduce the cost of drilling works.

Key words: drilling, curving of drill pipes, drilling tool, drilling force, drill string rotation, borehole, drilling bit, bottom, centralizer, stabilization device, drilling fluid, drill chart, drill pump, criteria of drilling capacity.

Introduction. With the development of techniques and technology, technological processes should be cheaper and easier to use. However, the drilling process with the use of innovations is becoming more expensive and more complicated in operation.

In this regard, the group of scientists is exploring the drilling process in order to develop a drilling tool and drill charts, since the drilling process is used in various economic sectors and various types of drilling tools are used. The oil and gas industry is prevailing and resonant for the economy. Reducing the cost in the oil and gas production will significantly affect the economy of any country in a positive way.

In practice, rotary drilling (about 80%) is widely used for formation of boreholes in oil and gas deposits, where vertical, directional and horizontal drilling methods are used. It is expected to increase the volume of rotary drilling and drilling with screw downhole motors. In Europe and the USA, the main method is rotary drilling, in particularthe rotary drilling expands the volume of drilling by downhole motors [1-5].

It is necessary to pay attention to the fact that in the rotary drilling method, the work is performed due to the rotation of a rock destruction tool (drilling bit, boring head) applied against the bottom, to which the axial stress and rotation torque are transmitted. Not insignificant aspect in the drilling technology is translation of motionto drill pipes and rotation of drilling tool, since the drilling effort directly depends on this process [7, 8].

The principle of operation of the drilling process in all methods is similar, where rotor receives rotation from electric motor or internal combustion engine through driving shaft [9-11]. The shaft rotation by conical rotor gear train is transformed into rotation of the rotary table relative to the borehole axis. Drivinginsertion pieces are installed on the rotary table, to which the rotary table rotation is transmitted. Drivinginsertion pieces (of smaller sizes) are installed inside the drivinginsertion pieces, the inside dimension of which corresponds to the section of upper carrier pipe of the drill string. The section of the drill string's carrier pipe can have square, hexagon, cross and other forms. The inside dimension of the drivinginsertion pieces should have a similar form, rotating the drill string's upper carrier pipe.

The main body of the drill string is drill pipes [12-15]. Heavyweight drill pipes (HWDP) are installed between them and drilling bit, which weight should provide necessary load on the drilling bit during rotary drilling and operation of pipes in the stretched state [9-15].

The main task when borehole drilling is to prevent curving of the borehole and bring the borehole to the vertical in case of its curving.

When borehole drilling, the following basic methods are used to ensure the bore verticality [5-10]:

- use of the "pendulum" effect due to creation of maximum possible deflecting force on the drilling bit, directed to the side opposite to the direction of the borehole curving and increase at that in the borehole wall cutting intensity by the lateral face of the drilling bit;
- preservation of existing minor inclination angle of the borehole due to centering of the lower part, i.e. by the bottom hole assembly (BHA) by arrangement of support-centering element (SCE) at the optimal distance from the drilling bit;
- active reduction of the borehole curving due to the deflecting force or change in the direction of the drilling bit axis.

These methods of laying the vertical borehole are implemented by appropriate technical means: pendulous BHA; rigid BHA; stepped BHA; rotary controlled systems (RCS).

An important technological factor determining the vertical borehole curving is pitch stability of the drill string located above the drilling bit. In the drill string's stability loss, the deflecting force appears on the drilling bit, under the effect of which the drilling bit will destroy the bottom at some angle to the axis of the borehole and cut the borehole wall in the transverse direction, which will lead to the borehole curving.

The above brief analysis on the study of the borehole curving shows that in addition to the drilling tool, there are a number of technological aspects that affect the drilling process. However, the main reason for its curving is the drilling chart itself.

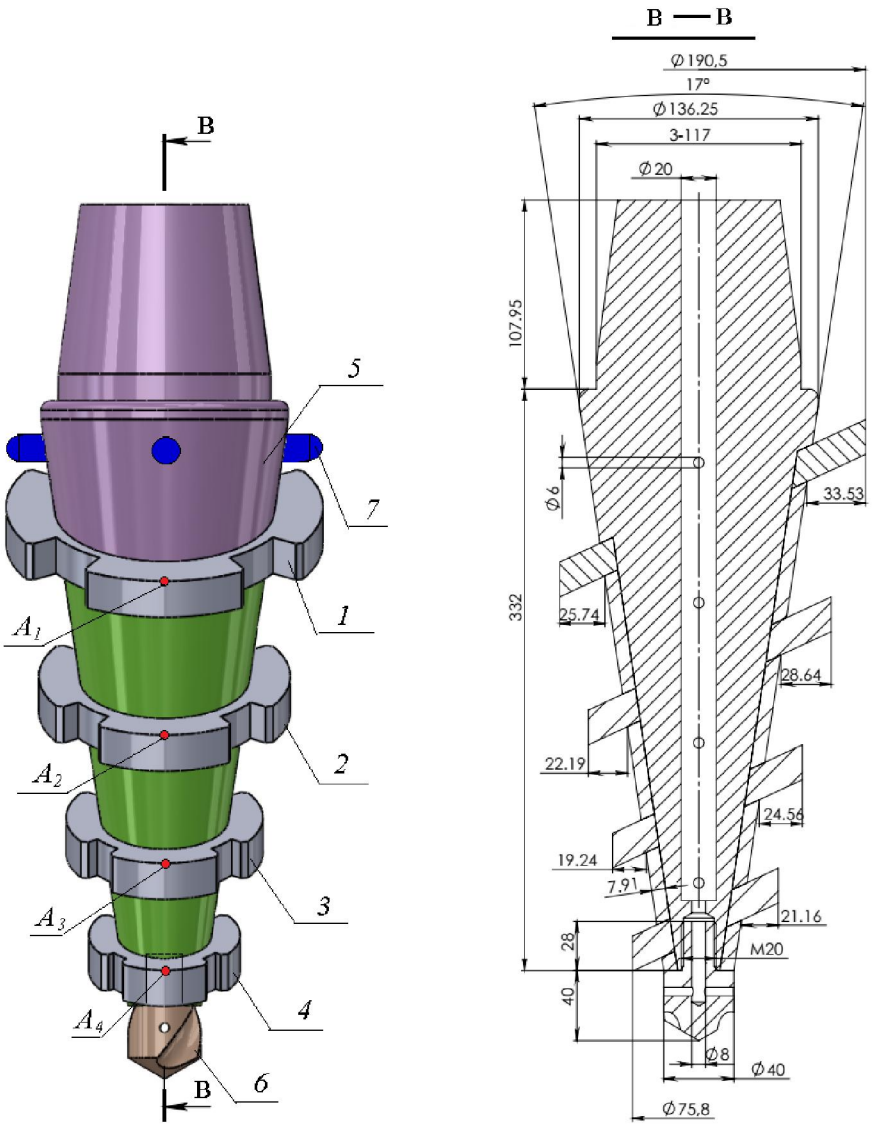
The main part. In the applied drilling charts, where the cutting wedge of the drilling tool crashing into the ground faces a heavystress [10-15]. In these drilling charts, direction of speed and direction of the resulting drilling force have opposite values. As a result, axial stresses are fully transmitted to the borehole of the drilling machine. Considering the length of the borehole and discontinuity of operation of the active drilling tools, the transmitted stresses have a resonant nature, which leads to the destruction of the cementing elements. In order to prevent such situations, such safety elements as a bent housing, centralizer, stabilization device, etc. are provided in advance in the borehole.

The research of the scientists to improve the drilling process and increase productivity is concentrated in:

- creation of a new geometry of drilling tools, which use expensive hard alloys, increasing resistance;
- in order to increase the service life of the drilling complexes, new mechanisms, devices and equipment are created that increase the cost of drilling equipment;
- development of new drilling fluid compositions that improve the drilling process and simultaneously increase the costs of the drilling process;

However, despite the improvement of the process in all used methods, great efforts are being made in the drilling zone [16]. In addition to the cutting pattern, an important reason for the occurrence of large values of the drilling effort is the drilling tool geometry. Since basically the drilling tools are equipped with blunt cutting or raker teeth. The teeth wedge angle sometimes exceeds 90°.

The entire weight of the heavyweight drill pipe is attached from above on the blunt drilling tool. During drilling, the ratio of the applied force and value of the drilling tool rotation are significantly



Drilling tool for rotary drilling: 1, 2, 3, 4 – cutting teeth in the form of a disk; 5 – body; 6 – boring bit for crashing into the ground or rock; 7 – damper

different. In these cases, the teeth are pressed into the ground or rock, and the concentrated force acts in the opposite direction, curving the drill pipes [17-27].

Analysis of the drilling methods shows that in the existing technologies the case of "pipe curving" is laid in advance. To exclude this case, it is necessary to change the drilling tool geometry with the appropriate drilling method.

The proposed drilling method and drilling tool work perfectly according to the different drilling pattern. The geometry of the drilling tool being created allows manage the drilling process, i.e. set amount of emerging drilling forces in advance (figure).

Preliminary tests of the proposed drilling tool design on the layout showed that the cutting teeth at the point *A* touching the wall of the hole on the ground made by the rotary bit 6 begin to crash into the ground, raising the cut ground to the top. In turn, the cut ground layer, opposing, begins to press down the cutting tooth of the drilling tool. In this case the resultant force *P* will have negative values. If combine the arising forces on each tooth of the drilling tool, it can be assumed that during the drilling process the resultant drilling force value will be sufficient to draw the drill pipe down. In this case, it may be possible to make the drilling tool draw the drill strings down, rather than push them off. Having achieved this, it is possible to radically revise the role of constituent elements in the drilling process.

Conclusions. Based on the initial studies carried out, it can be concluded that for the proposed drilling pattern and design of the drilling tool:

1. The acceptable drilling method is rotary.

2. When drilling, it is better to use the drilling fluid for the cut ground with necessary technical means: drill pump; earth storage; rotary hose riser; filter; swivel; swivel sub; sludge separator; travelling block; hook; hose, etc.

3. To set rake of the cutting tooth (figure) in order to force the drilling tool to be drawn down the well within 25÷50° with respect to the criteria of the ground drilling capacity according to the classification of Academician V.V. Rzhevsky.

4. Possibly, to except from the drilling complex composition the mechanisms of the safety elements for the borehole curving:

- curving mechanism;
- stabilization device. However, after a series of experimental demonstrations.

5. Taking into account that the forces are consumed minimally with a pure shear of a rigid body and discontinuity occurs at 45° [28]:

- it is necessary to choose geometrical values of the cutting wedge so as to destruct solid rock at 45°;
- the wedge angle values should not exceed 95°. In this case, taking into account difference in the geometric values of the cutting wedge in statics and kinematics, carry out the sharpening taking into account the kinematic values. It should be noted that the rear angle in kinematics acquires negative values.

6. Install copper or plastic plates between the cutting teeth and bushings (figure) to extinguish impact loads of the drilling process. The thickness of the plates should be chosen in the ratio of the drilling tool tooth geometry:

- prepare the cutting teeth from carbide blades by baking and with subsequent mechanical processing of their plates, applying wear-resistant coatings;
- prepare the cutting teeth from high-speed steel by cutting, hardening and grinding;
- arrange the cutting teeth and bushings on the body and fasten them by isolating connection, i.e. thread. Cut the inside thread on the drilling tool body, and the outer thread on the neck of the bit in the form of a rotary bit (figure). The thread must be left, against the drilling tool rotation.

7. Provide for damper in the drilling tool construction instead of the centralizer on the drill pipe (figure). The damper must be made of structural steels by cutting, hardening and thread connection in the drilling tool body.

The damper will serve as a centralizer, preventing oscillations arising during the drilling process by extinguishing then in the drilling tool location, and at the same time will serve as the drilling tool guiding elements.

8. The drilling mode parameters should be average for solid ground, and high for soft ground.

The research carried out within the framework of the grant theme: "AP0513118 Creation of drilling tools for borehole drilling in the production of solid, liquid and gaseous minerals (Contract No. 164 dated 15.03.2013)" showed that the drill chart being developed should be worked out in such values of the drilling mode to exclude some elements in the borehole. For example, taking into account the negative values of the drilling force P, exclude from the borehole composition the HWDP. Naturally, when tensioning the borehole, there should be no curving process. If such theory is confirmed in industrial trials, there may not be a need for a bent housing. The absence of the borehole curving during drilling allows exclude stabilization mechanisms in the borehole arrangement.

The exclusion of some mechanisms from the drilling complex will obviously reduce the cost of drilling.

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ТЕРІС БҰРҒЫЛАУ КҮШІ БАР БҰРҒЫЛАУ ҚҰРАЛДАРЫ

Аннотация. Кен өндіру өнеркәсібіндегі тауарлардың тұрақсыз бағасы қолданылатын технологиялардың құнын төмендетуге алып келеді. Дегенмен қазіргі заманғы индустрияда бұрғылау технологиясындағы инновацияларды жер қойнауын пайдалану, керісінше, өндіріс құнын арттырып, өндірістік жағдайды қиындатады. Ғалымдардың жүргізген зерттеулері бұрғылау технологиясын жаңғыртуға және сол уақытта қолданылатын жаңа типтегі бұрғылау құралдарын жасауға бағытталған. Бұрғылауда қолданылатын барлық әдістерде бұрғылау құбырларының қисаюы, технологиялық процесте алдын-ала қойылған, себебі доғал бұрғылау құралы, жерді кесіп болмай, бұрғылау құбырын кері итереді. Мақаланың авторларымен бұрғылау құбырын төменге тартатын, кері бұрғылау күшіне ие бұрғылау қондырғысы әзірленді. Бұрғылау күші Р теріс мәндерін ескере отырып, бұрғылау топтамасынан ауыр бұрғылау құбырларын алып тастауға болады. Әрине, бұрғылау бағандарын тартқанда, қисықтық процессі болмауы керек. Егер мұндай теория өнеркәсіптік сынақтарда расталса, онда қисықтық механизмінің қажеттілігі болмауы мүмкін. Бұрғылау барысында бағандар қисықтығының болмауы, бағандарды құрастыру кезінде тұрақтандыру механизмдерін алып тастауға мүмкіндік береді. Бұрғылау кешенінен кейбір механизмдерді алып тастау, бұрғылаудың өзіндік құнын айтарлықтай төмендетеді. Бұрғылаудың мұндай сұлбасын жасау, бұрғылау жұмыстарының өзіндік құнын төмендетеді.

Түйін сөздер: бұрғылау; бұрғылау құбырларының қисаюы; бұрғылау құралы; бұрғылау күші; бұрғылау тобының айналуы; ұңғыма; қашау; кенжар; орталықтандырғыш; тұрақтандырушы қондырғы; бұрғылау ерітіндісі; бұрғылау сұлбасы; бұрғылау сорғысы; бұрғылану критерийлері.

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БУРОВОЙ ИНСТРУМЕНТ С ОТРИЦАТЕЛЬНЫМ ЗНАЧЕНИЕМ СИЛЫ БУРЕНИЯ

Аннотация. Нестабильные цены товаров в добывающей промышленности диктуют снижение себестоимости в используемых технологиях. Однако в современной отрасли недропользования применение новшеств в технологиях бурения, наоборот, повышает себестоимость работы, усложняя условия эксплуатации. Проводимые учеными исследования направлены для модернизации технологии бурения и создания новых буровых инструментов, аналогичных используемым в данное время. Во всех применяемых способах бурения искривление бурильных труб заранее заложено в технологическом процессе, так как тупой буровой инструмент, не успевая врезаться в грунт, отталкивает бурильную трубу. Авторами статьи разработана новая геометрия бурового инструмента, имеющая отрицательные значения силы бурения, которая втягивает вниз бурильную трубу. С учетом отрицательных значений силы бурения Р появляется возможность исключения из состава бурильный колонны утяжеленных бурильных труб. Естественно, при натяжении бурильного ствола не должно быть процесса искривления. Если такую теорию подтвердить в промышленных испытаниях, возможно, отпадет надобность применения механизма искривления. Отсутствие искривления ствола при бурении дает возможность исключить при компоновке ствола и механизмов стабилизации. Исключение

некоторых механизмов из бурильного комплекса, очевидно, снизит себестоимость бурения. Создание такой схемы бурения, несомненно, снизит себестоимость бурильных работ.

Ключевые слова: бурение; искривление бурильных труб; буровой инструмент; сила бурения; вращение бурильной колонны; скважина; долото; забой; центратор; стабилизирующее устройство; буровой раствор; схема бурения; буровой насос; критерий буримости.

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