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IMPROVED RESILIENCE THREE ROLLING CUTTER DRILL USING CAD / CAE-SYSTEMS

Розглядаються типові конструкції кріплення твердосплавних зубців до корпусу шарошки у тришарошкових долотах. Запропоновано нову конструкцію посадки породоруйнувального елемента у шарошку, яка покращує якість закріплення зубця за менших напружень у з'єднанні. Проаналізовано напружено-деформівний стан запресованого зубця та шарошки у типовій конструкції та модернізованій за допомогою cad/cae системи.

Standard design fastening hard alloy teeth to the body of cutter of three rolling cutter drill are discussed in this article. new design landing rock cutting element in the rolling cutter, which improves the quality of the consolidation of the tooth at smaller stresses in the connection has been offered. exertion and strain condition of pressed tooth and rolling cutter in a typical and upgraded construction is analyzed for help cad/cae system.

Statement of the problem. Development of mineral resources is an important problem that faces the workers in the sector of the national economy. Industry requires oil and gas more. Engineers need to look for ways of improving production of hydrocarbons from wells. In this regard, reducing the cost of construction of wells is extremely actual problem. Now in Ukraine main volumes deep drilling performed by rotary method using three rolling cutter bits. That is why improving production technology and changes in instrument design parameters of the bit is important reserve increase technical and economic parameters of well construction [1, 3].

This is only possible when using the new upgraded high-performance drilling tools advanced construction technology of oil and gas wells. In a relatively short period of time rock cutting drilling tools used in oil and gas wells has changed. The design of the drilling tool is quite complicated and being

modified on the basis of scientific achievements and experience leading national and foreign companies that manufacture drill bits. During drilling set all new, stricter requirements for three rolling cutter bits. Cutter bits are the most universal rock cutting drilling tools, since the scope of applications, covering almost all the rocks from soft to very hard.

Currently drilling is widely used high-performance drill bits and drill heads from the best companies in the world such as “Hughes tool company”, “Smith tool company”, “Reed tool company”, in Russian factories JSC “Волгобурмашу” SPE “Бурінтех” JSC “Уралбурмаш” [3]. Essential restructuring of technics and technology of bits is performed on the basis of international experience in Drogobytskiy Drilling Plant Ltd “Universal drilling equipment”. As a consequence, all new types of rolling cutter bits come in oil and gas wells.

There is about 70 % failure bits because breaking down of the rock cutting teeth and destroyed hull of cutters when drilling abrasive rocks of medium to very strong.

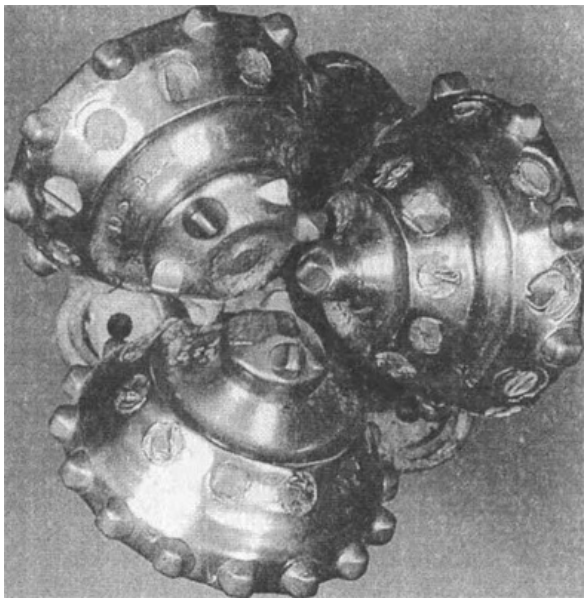

Fig. 1 Three rolling cutter drill bit with teeth of hard alloys after use

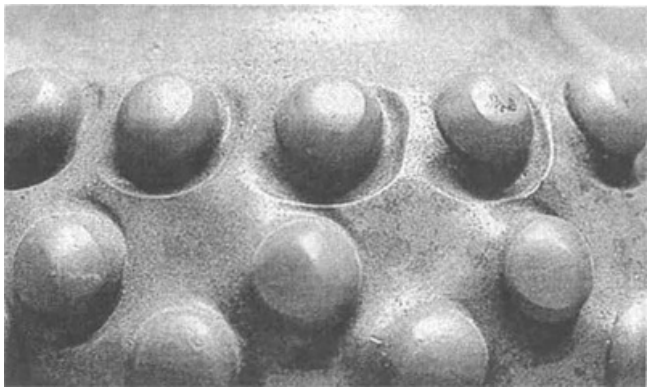

Fig. 2. Sample plot erosion cutter with teeth. of hard alloy

This is due to the proliferation of high internal stresses that arise in cutter during drilling. Planting teeth of hard alloy is performed in the apertures on their rolling cutters while cold pressing of tension. In this case when working bit if value of tensions set less minimum it contributes departure teeth of apertures, and increase the value of tension contributes sudden increase in tension, and as a consequence - the development of cracks around the teeth and the destruction of hull cutters [1].

Moreover, there is a abrasive deterioration of body cutters around the teeth if used forced mode of drilling. This leads to higher appearances teeth over the body rolling cutter.

The result of this erosion is to increase the intensity of the load. Thus deterioration a body rolling cutter reduces the length of the shank pressed, which means it reduces the force of friction that keeps teeth. As a rule, wear surface rolling cutter 2 - 3 mm, reduced to failure of bit and total replacement tool.

Analysis of recent research and publications. Analysis of recent publications showed that there are many varieties of teeth (Fig. 3) [1]. At the same time analysis of modern research shows that it is necessary to improve performance of rock cutting tools. Given the complexity of the design of three rolling cutter bits and the process of drilling going on during intense, heavy duty, because we can make the following conclusions:

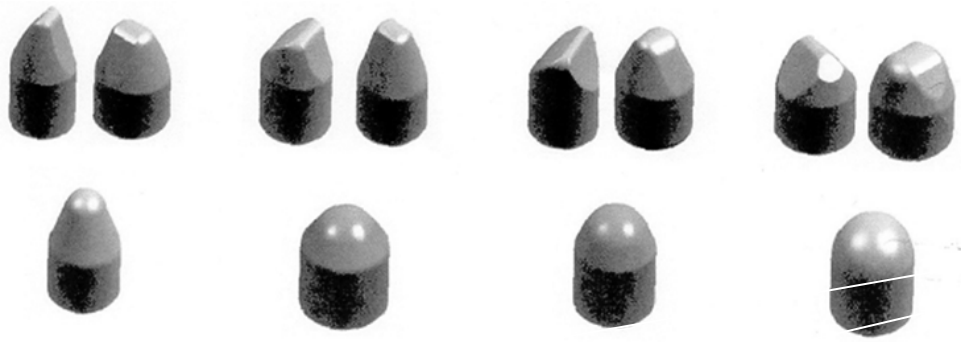

Fig. 3. Different forms of teeth of hard alloy

– when change design's parameters, then we can increase reliability (incline's angle of the rolling cutter, shape of teeth and their location, the dimension of the tension in pressed, diameter's teeth);

– when change parameters of technological methods for rock cutting elements, then we can increase reliability (technology of making, change coverage, replacement material, precision shape and size of teeth and precision shape and size of apertures, effort in pressing and speed);

– we could improve the stability of instrument if we change the assembly in technology;

– fundamentally other design of the boring tool, that would improved indicators of efficiency with enough economic impact.

The analysis showed that the greatest potential for increasing the longevity of a hard alloy teeth if we change the design's parameters.

Formulation purpose of research. One of the directions of improvement tool for mining drilling rigs is to create a combined bits that have elements and cutter of rock cutting for destruction. The level of effectiveness of such bits is highly dependent on their configuration, scilicet rolling cutter and cutting elements arranged on the body bits. The purpose of this work is to improve the patency of the bit and increase the stability of rolling cutter if we change the design of rolling cutter bits. On the basis of 3D models and calculation of CAE system we need to define the allowable stress in the cutter according to the axial force, torque is acting on the tool. Magnitude of tension teeth in the rolling cutter clarified at pressed and the impact of landing hard alloy teeth determine in rolling cutter.

The main material of research. Drilling bit exposed significant static and dynamic axial load, and the effects of torque at work. The design of the bit to be calculated at reasonable lifetime, because it is a single-use instrument. Restore the bit is not advisable bacouse economically expensive in modern design and technology. Currently tries create a variable bit with work items do not give positive results.

In this paper, 3D model of the rolling cutter of hard alloys teeth was established (Fig. 4) and explored how design changes affect the tension in the rolling cutter [2].

The most common method of fastening teeth of hard alloy in the apertures of hull of rolling cutter is cold pressing of tension (Fig. 4). There are different technology production apertures in the rolling cutter [4, 5].

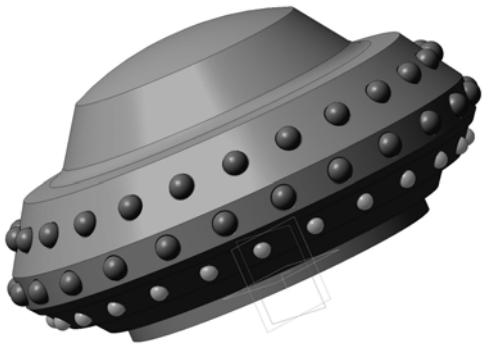

Fig. 4. 3D model of rolling cutter with hard alloys teeth

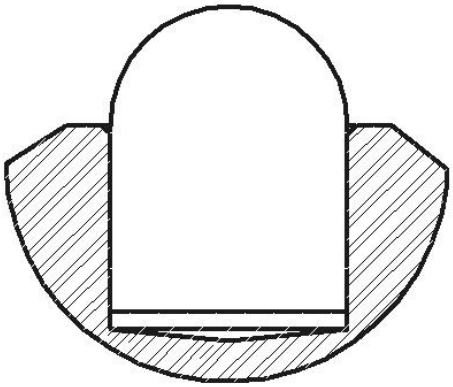

Fig. 5. Placement teeth of hard alloys in the aperture

The main disadvantage of this typical pressing - is a problem even distribution of stresses in the side walls of the apertures. They don't solve a problem the formation of cracks on the surface of the rolling cutter with high marginal values of tension and as a result of loss of teeth if insufficient magnitude lower limit values of tension. Thus a problem is preferment of the stability for protruding parts of hard alloy's teeth.

Drill bit was built in CAD / CAE System Compass - 3D V14 as a pro'type, stress distribution shown on it (Fig. 6). During work the stress arise in the rock destroying element, as shown in Fig. 5. Tooth (material VC-8) is loaded with the total force of 25,000 N, tension arises in p. 1 is equal to about 144 MPa (Fig. 6).

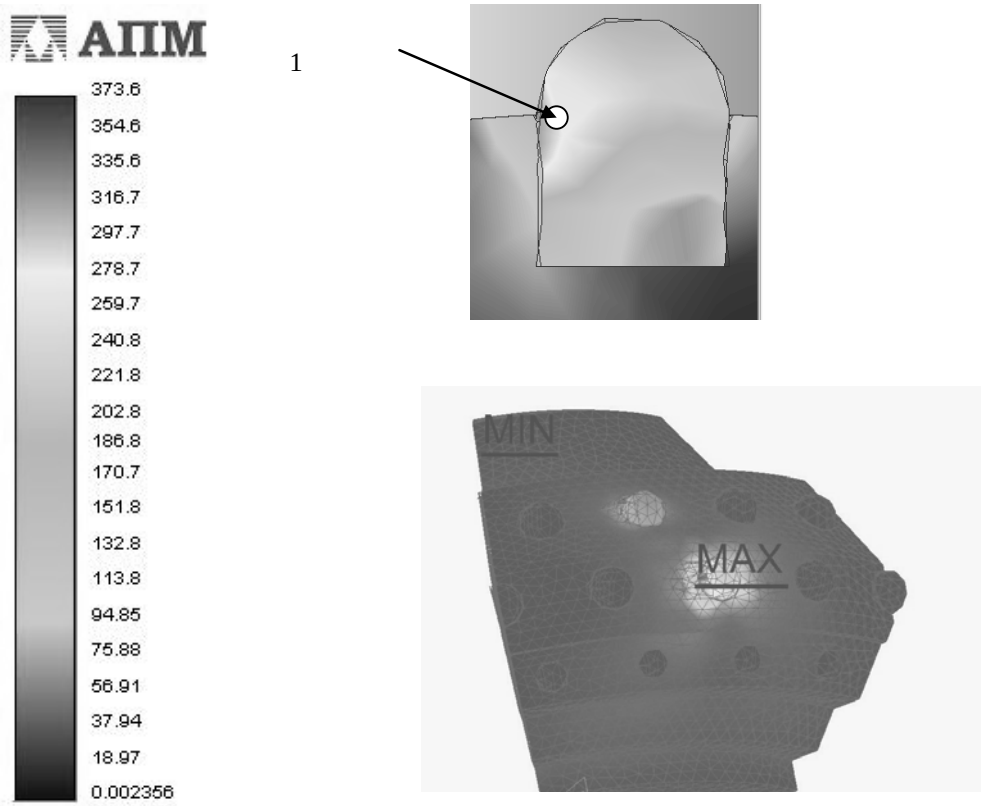

Рис. 6. Розподіл напруження у шарошці та зубці за допомогою АРМ модуля Компаса – 3D V14

Design proposed and shown in Fig. 7 a, it partially solves the problem of preventing the formation of cracks on the surface of rolling cutter at the limiting meanings tension due to changes fit tooth in rolling cutter. The technical result of the proposed design is to enhance the reliability of fastening of hard floatable teeth in the housing of rolling cutter and improve the stability of most of the teeth and shell of rolling cutter.

The resulting effect achieved because hard alloy teeth pressed in the body of rolling cutter at the drill bit. Stipes of teeth has cylindrical form and it placed in a cylindrical aperture below the outer surface of the crown on the value that can be equal to about 0.1 height of the spherical head of tooth (research conducted specifically for this case) (Fig. 7).

5. Conclusion. New design has a better stress-strain state of the surface layer around of all contour of the aperture than traditional connections, and most importantly, where there are usually born micro-cracks that after cyclical, alternating loads on the protruding portion of the tooth turn into macro-crack by pressing teeth. The proposed design has a tension at the chamfer of aperture of rolling cutter which is almost 1.5 times less. In addition, tension is not from bent of connections in this area, and it is further more improves the stress state of rolling cutter in the zone concentrator of stresses.

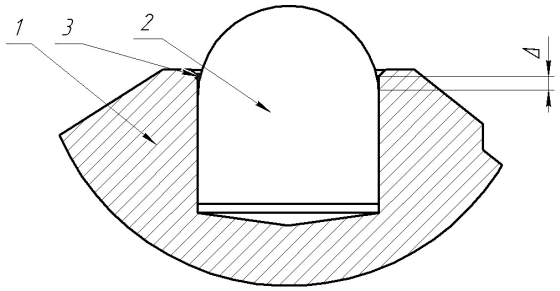

Fig. 7. The proposed location of hard alloy tooth in rolling cutter
1- casing of rolling cutter; 2 – tooth; 3 – width of space Δ in which no contact

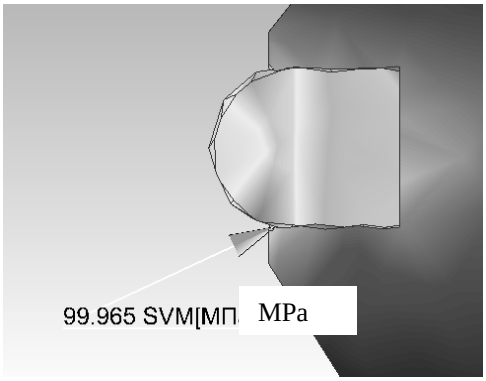

Fig. 8. The distribution of stresses in rolling cutter and teeth

Upper part of the surface's of the tooth of rolling cutter at the entrance apertures returns to its original state by elastic deformation of the tooth after pressing. This protrusion (Fig.7 pos.3) estimably increases the reliability fixing teeth in frame of the rolling cutter even without increasing the total value of the bent. Proposed options fixing hard alloy teeth in the body of rolling cutter can improve the reliability of drill bits with hard alloy equipage.

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THERMODYNAMIC PATTERN OF THE WORKPIECE MACHINING BY THE RHEOLOGICAL IMITATION MODELLING IN DEFORM-3D SYSTEM

Аналіз теплофізичної реологічної картини різання, реалізованої в системі DEFORM 2D (3D), дає змогу зробити висновок про те, як динамічні показники температурних деформацій впливають на якість оброблюваної поверхні та дослідити вплив термодинамічних показників на напружено-деформований стан заготовки та інструмента. Доведено, що найбільша кількість теплоти, що утворюється внаслідок деформації, залишається у стружці (60–80 % усієї теплоти різання, а за швидкісних режимів різання понад 90 %) і частково поглинається оброблюваною деталлю (до 20-40 % усієї теплоти). І лише 3–5 % теплоти спрямовується в інструмент/

Analysis of thermal physical rheological model of cutting system implemented in software DEFORM 2D (3D), makes it possible to investigate the effect of dynamic parameters on the stress-strain state of the workpiece and tool. It is shown that most quantity of the heat cutting, which formed as a result of chip deformation (60-80 % of the heat cutting and for the ultra-speed cutting conditions for more than 90 %) remains in the chips and partly absorbed machined workpiece (up to 20-40 % of the heat).

Problem statement recent research and analysis. Thermal effects, arising as a result of cutting process, are one of the most important factors determining the stress-strain state in the zone of the chip formation and part surface forming. Heat laws explain phenomena associated with support of the cutting process parameters, tool life and surface finish quality. Thermal rheological cutting process pattern is necessary to build an effective structure and parameters of technological process model. Then we can analyze how dynamic performance thermal deformation affects to the workpiece quality and to investigate the influence of thermodynamic parameters on the stress-strain state of the workpiece and the tool.

The cutting process heat Q_Σ is formed by the [7]:

1) internal friction between particles of treated metal during deformation process - Q_1;
2) external friction at the chip to the face of tool - Q_2;
3) external friction of the cutting surface and machining surface to the back of tool - Q_3;
4) separation, chip deformation and chip dispersion Q_4.

$$Q_\Sigma = Q_1 + Q_2 + Q_3 + Q_4 . \quad (1)$$