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Optimization of scheme of placing cutting structures on the cone drill bit

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Abstract. The paper considers the maximum facilitation of rock breaking at a predetermined optimum pattern placement of weapons and completeness of saturation by cutter teeth. The conditions for increasing the productivity of a newly established drill bit and obtaining the desired effect in the kinetic interpretation are given.

1 Introduction

Improvement of the efficiency of rock cutting tool in downholes is the task to identify and maximize the potential in the process of breaking rock. This includes questions of maximum facilitation of rock breaking at a predetermined optimum pattern placement of weapons and elements of saturation fullness (pick) cutters.

Since we are talking about designing scheme blade bits with spherical cone shape, the conditions for the destruction on the spherical surface of the bottom of the hole as much as possible is provided. It should also be taken into account the fact that the destruction of the rock is carried out in this case by cutting and shearing. And this tremendous advantage of constructional schemes blade drill bit as compared to other designs and modifications thereof, since there is no downhole stress concentration zones. But with a distinct advantage in the mechanism of destruction of rocks at the bottom of the well by one-cutter rock drilling bits in this embodiment, in comparison with similar modifications of similar tri-cone bits, what convinced and higher penetration rates, they had a significant disadvantage that wearing resistance cloves vertex crowns it had significantly lower life support assemblies (bearings).

2 Methods

Since vertex crowns such bits were always in contact with the rock. Here itself appears the question of designing blade bit with a stepped form of cone. But this experiment did not bring the desired result. But the fact that at that time not yet analytical deterministic model of the mechanism of interaction of cutting stuructures blade bits from bottom of the hole surface was built and, therefore, the optimal method schemes of cutting structures placed on their cutters.

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Since mathematical models tend to be generic, we adopted this technique and used in this work in full. The essence of it in this case is to reliably construct an algorithm for calculating the kinetic evaluation criteria weapons performance cutter in the form of relative unit of contact and volume of work of destruction in the form of

$$A_j^{'} = \frac{i \cdot S_j \cdot F_j}{\Delta S},$$
$$A_k^{''} = \frac{i \cdot \sum_{j=1}^{n} S_{j.k} \cdot z_j \cdot d_j \cdot F_j}{V_k}; \quad (1)$$

where - $A_j^{'}$ the specific relative contact work of destruction of teeth j-th crown, $\frac{kG \cdot mm}{mm^2}$

i - gear ratio cutters;
S_j - contact path j-th tooth crown, *mm*;
F_j - the power of resistance to movement of the teeth of j-rim in contact with the rock, *kg*;
$\frac{kg \cdot mm}{mm^3}$ - The specific relative volume work of destruction on to th annular downhole,;
ΔS - tooth tops playground cutter unit area, *mm²*;
$S_{j.k}$ - contact path j-th crown on the k-th annular downhole *mm;*
Z_j - the number of teeth per unit width j-th crown *pieces*;
d_j - the number of conventional single crowns on a real width j-th crown *pieces*;
N - number of crowns considered cutters*, pcs*;
V_c - volume of rock that falls on the destruction at the k-th annular downhole bit per revolution, *mm³*.

Not only which fits into the relative time equivalents in the form of drilling and penetration to the bit in the generalized criterion in the form of cost per meter, but also allow a comparative assessment of efficiency of drilling bits for the various designs of drill bits and their modifications.

Regarding the new and more effective armament design of blade bit, it obviously increased performance of the new (newly created) drill bit is guaranteed if one of the three following conditions below

$$\begin{aligned} &1.\ T_n > T_o \text{ at } V_n = V_o \\ &2.\ T_n = T_o \text{ at } V_n > V_o \\ &3.\ T_n > T_o \text{ at } V_n > V_o \end{aligned} \quad (2)$$

where T - resistance bits armament, *hour*;
V - mechanical drilling speed, *m / hour*;
N and O - codes designating, respectively, the "new", "old" (basic).

And as we know analogues of T and V, then the desired effect in the kinetic interpretation can ensure that you receive when you perform one of the following conditions [1-11]

$$\left.\begin{aligned} &A_{\max(n)}^{'} < A_{\max(o)}^{'} \\ &at \\ &A_{\min(n)}^{''} < A_{\min(o)}^{''} \end{aligned}\right\} \quad (3)$$

$$\left.\begin{array}{l} A'_{\max(n)} = A'_{\max(o)} \\ at \\ A''_{\min(n)} > A''_{\min(o)} \end{array}\right\} \qquad (4)$$

$$\left.\begin{array}{l} A'_{\max(n)} > A'_{\max(o)} \\ at \\ A''_{\min(n)} > A''_{\min(o)} \end{array}\right\} \qquad (5)$$

Condition (3) is interpreted as an increase in wear resistance cutters structures at equal speeds and magnitudes of mechanical resistance of the supports; Condition (4) - increasing the mechanical speed of drilling towers at equal durability of weapons; (5) - improving durability of weapons at a higher ROP.

With regard to cutting structures of blade bits, all these three conditions are feasible in preassigned borders $A'_{\max}$ and $\grave{A}''_{\min}$. This problem is solved in the process of varying these values. There are limitations and design possibilities. For example, can not be increased indefinitely $\grave{A}''_{\min} \sim \mathrm{V}_{\grave{\imath}}$, because and this is directly related to the number of cutting structures on the respective cone crowns, which is limited by design requirements, ie saturation of the crown of cutting structures above the norm is simply impossible. It should also be borne in mind the fact that the quantities $\grave{A}''_k$ (relative specific volume of work destruction) should be distributed on the surface of the well bottom by a well-defined pattern. For example, if the path of the cutter teeth contact will repeat the contact path on subsequent turns, the bottom hole will be formed in its entirety. And if none of the conditions (3), (4), (5) has no effect. And it can happen under the condition

$$i \cdot z_j = n{,}0 \qquad (6)$$

(Where i - gear ratio, z_j - number of cloves on j-th crown, n is an integer).

The physical quantity $i \cdot z_j = \lambda$ is the kinematic tooth pitch j-ro crown. This fact formerly was not taken into account when designing blade bit diameter 215.9 mm, which resulted in the drilling of these bits tight medium-hard even to breakdown pins. This occurred because a bottom hole formed pillars, which are then cleaved and wedged cone at the bottom [12-17].

3 Conclusion

Currently, this problem has been solved. This problem is now solved methodologically at two levels: the first decision can be seen at the level of numerical comparison of conditions (2.4), and at the second by taking into account the width of the blade is constructed of overlapping visual scheme stepped surfaces downhole for a few turns bits. If the cutting structures are optimally placed, then after three turns painting rational scheme of placement of weapons becomes apparent. In this case, you must bear in mind geometrical steps crowns on teeth, because on the surface of blade bits flushing grooves can be placed, resulting in geometrically multi-step placement cloves on stepped surfaces of the cones.

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