SOCAR

SOCAR Proceedings

Well driling

journal home page: http://proceedings.socar.az

INDEXED IN EMERGING SOURCES CITATION INDEX THOMSON REUTERS

Scopus

RESULTS OF PRODUCTION TESTS OF AN EXPERIMENTAL DIAMOND CROWN DURING EXPLORATORY DRILLING IN KAZAKHSTAN

B. T. Ratov*[1], I. A. Chudik[2], B. V. Fedorov[1], A. K. Sudakov[3,4], B. R. Borash[5]

[1]*Satpaev University, Almaty, Kazakhstan*

[2]*Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine*

[3]*National Technical University, Dnipro, Ukraine*

[4]*National University, Lviv, Ukraine*

[5]*Yessenov University, Aktau, Kazakhstan*

ABSTRACT

The work is devoted to the results of production tests of a multilayer diamond crown with a comb profile of all impregnated layers separated by diamond-free layers of lower hardness. A distinctive feature of the crown is the placement of diamond-containing layers on a three-way screw surface with a small step. This makes it possible to involve in the process of deepening the fungus into a partially cracked zone the rock lying under the zone of diamond grains introduction. The zone of theoretical justification of the effectiveness of the profile of the matrix. The above-mentioned patent crown under the abbreviation KSB-3M (HQ) has passed production tests at the helogical facility of the Kazakh company. Rocks are mainly represented by carbonaceous-siliceous metagalium of the XIII - IX and partial X-th category. Drilling was carried out with the use of projectile with removable core receiver. 389 wells were drilled with one experimental crown, and most of the footage falls on the IX–category rock, which indicates the great durability of the tool. The mechanical drilling speed varies from 5.5 to 3.5 m/h depending on the rock quality. It was decided to continue experiments with KSB-3M crowns on other geological sections with harder rocks.

Keywords: production tests; multilayer immigrated crown; distribution drilling; high rock resistance.

The Kazakh National Research Technical University (KazNITU, Almaty, Kazakhstan) [1-3], the Institute of Superhard Materials (ISM, Kiev, Ukraine) [4, 5], the Ivano-Frankivsk National Technical University of Oil and Gas (Ivano-Frankivsk, Ukraine) [6-8], the National Technical University (Dnipro, Ukraine) [9-13], the Dnipro National University named after Oles Honcha (Dnipro, Ukraine) 14-18] are conducting research and development aimed at creation of effective diamond tools for drilling medium and high hardness rocks. As a result, several modifications of drill bits have been created, depending on the properties of the drilled rocks. One of such modifications is the experimental crown KSB-3M, patented by us.

The theoretical basis for the creation of a diamond multilayer crown is the feature of the destruction of solid rocks under the action of diamond grains, which consists in the following: under the action of axial force, the diamond grain is pressed (embedded) into the rock; below the zone of penetration, there is a zone of pre-destruction, representing a rock broken by cracks, weakened in strength [19]. The power of the pre-destruction zone H_{pr} of solid rocks is subject to the dependence:

$$H_{pr} = kh_b \qquad (1)$$

where k – coefficient equal to for hard rocks 8-12, т.е. $k = 8 \div 12$, h_b – diamond grain penetration depth, usually $h_b = 0.1 \div 0.15$ mm.

In order to use the pre-destruction zone and involve it in the process of deepening the bottom of wells, the crown KSB-3M was created. Its main structural difference from the well-known crown with the arrangement of diamond-containing layers on a three-way helical surface [20] is that the impregnated layers have a shape, representing conical annular protrusions and depressions. This form of diamond impregnated layers is most effective, based on the following considerations (fig. 1) [19].

The force P_0, per unit length of one wedge-shaped diamond-bearing protrusion of the matrix of the average radius $P_{mn}(P_w < P_{mn} < P_h)$ and acting on the bottom of wells, causes normal reactions N_0 from the rock to the lateral surfaces of the protrusion (fig. 1b). The relationship of the forces P_0 and N_0 is determined by the formula:

$$P_0 = P / m\pi\left(R_o + R_i\right) = 2N_0 \,\mathrm{Sin}\frac{x}{2} \qquad (2)$$

where P – axial load on the crown; m – number of wedge-shaped protrusions; R_0, R_i – accordingly, the outer and inner diameter of the crown matrix (fig. 1a); – angle of sharpening of diamond-bearing layers (fig. 1b).

The mechanical drilling speed v_m with diamond impregnated crowns is determined by the formula [21]:

$$v_m = 0.4nPf_0/d_w\sigma_s(1\text{-}\beta) \qquad (3)$$

E-mail: b.ratov@satbayev.university

http://dx.doi.org/10.5510/OGP20230200842

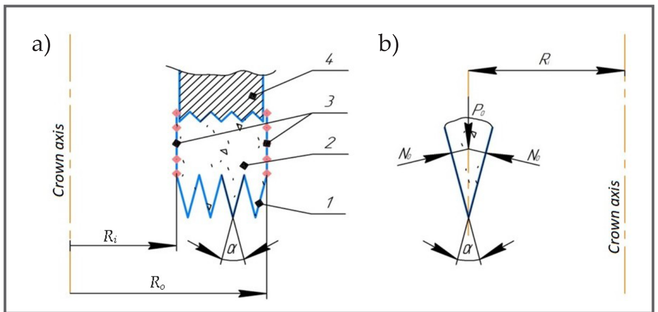

Fig. 1. Schemes of the longitudinal section of the diamond crown matrix with a profile: a) scallop profile, b) forces acting on the annular wedge-shaped protrusion of the profile: 1 – diamond-containing annular conical protrusions of the matrix; 2 – diamond-containing ring matrix; 3 – undercut diamonds; 4 – crown ring

where n – crown rotation speed, rpm; f_0 – coefficient of friction at the diamond grain - rock boundary; d_w – диаметр скважины, cm; σ_s – compressive strength of rock, H/cm^2; $\beta = d_k/d_w$ – ratio of core diameters d_k and wells d_w.

Total friction force $F_{friction}$, arising at the contact of the comb end of the matrix is determined by the formula [19]:

$$F_{friction} = Pf_0 / \sin\frac{x}{2} \tag{4}$$

Comparing formulas (2) and (3), we come to the conclusion that the drilling speed is proportional to the friction force. This is due to the fact that when using diamond impregnated crowns, the rock is destroyed by micro-cutting and to a large extent by abrasion, and the intensity of these processes depends on the friction force between the rubbing surfaces.

Thus, with a decrease in the angle of drilling of x wedge-shaped diamond-bearing protrusions, the productivity of destruction of the bottom of the well is significantly increased. This conclusion is confirmed by experimental studies [22-46].

In addition, the mentioned profile of the diamond-bearing end face of the matrix wedges the formed annular projections of the face. However, when reducing the angle of sharpening of diamond-bearing layers, the necessary strength of fixing diamond grains in wedge-shaped protrusions should be taken into account.

At each approach (fig. 2), the same number of diamond-bearing sectors of the matrix are placed (in this case, three in fig. 2b). The lifting angle γ of each helical surface is determined from the dependence

$$\gamma = arctg\frac{3h_p}{\pi D_{mn}} \tag{5}$$

where D_{mn} is the average diameter of the matrix end face.

When working at the bottom of the well, each of these sectors of the crown, acting on the rock with the highest conical annular projections of the diamond-containing layer and passing 1/3 of the circumference of the face, forms similar-shaped conical annular depressions, and under them – a zone of pre-destruction (fig. 2).

With further rotation of the crown, each group of sectors located on one approach of the helical surface moves to a part of the face prepared for deepening in front of the working group of sectors located on the adjacent approach. Thus, after 1/3 of a revolution, due to the annular zone of pre-destruction formed at the bottom and the action of a constant axial load, the matrix sectors, displacing the fragmented rock, move down by an amount close to the thickness of the pre-destroyed layer, perform layer-by-layer removal of the latter. The ring protrusions formed on the fence are destroyed as a result of vibrations.

As a result, taking into account the above considerations and the formula of the innovative patent, working drawings were developed, according to which an experimental batch of diamond multilayer crowns KSB-3M was made, (fig. 2).

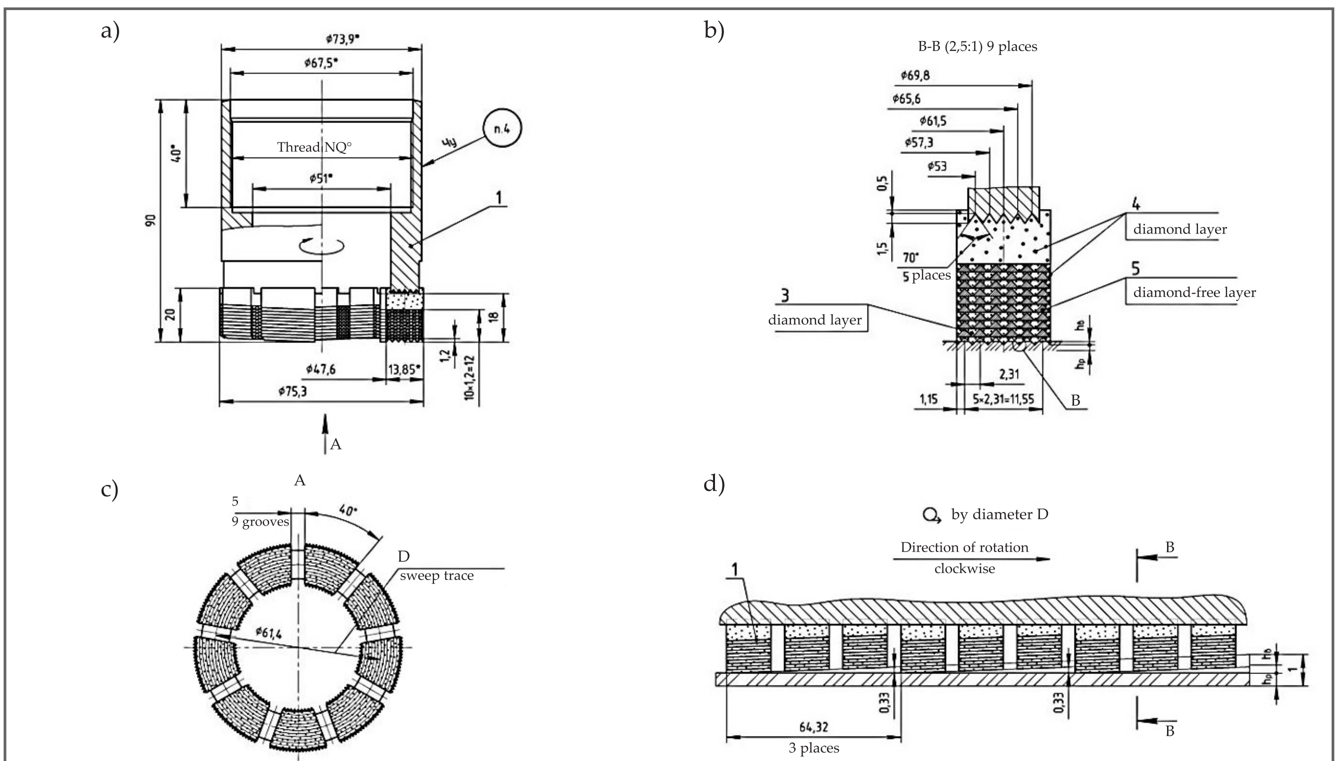

Fig. 2. Diamond multilayer impregnated crown with placement of diamond-containing layers on a three-way screw surface: 1 – body, 2 – diamond bearing matrix. a) general view; b) view from the end (by the arrow A); c) on an enlarged scale, the longitudinal section of the matrix; d) scanning of the matrix by the average diameter

The main technical data of the crown are as follows: the outer diameter is 95.6 mm, the inner diameter is 63.5 mm, the thickness of the matrix is 18 mm, the number of diamond impregnated layers in the thickness of the matrix is 5, the number of diamond-free layers is 4, the number of radial flushing channels is 9, the number of visits of the helical surface on which diamond and diamond-free layers are placed is 3, the pitch of the three-way screw surface is 1 mm, the number of diamond-containing sectors of the matrix placed on one approach of the screw surface is 3, the profile of diamond-bearing layers is combed with a sharpening angle of 600, a group of diamonds in the undercut layer is JNDT1,460/40, a group of diamonds in the bulk layer - JDMB 6020/30 MO, karatness: undercut layer – 7 carats, volume layer – 55 carats, твердость bezalmazny layers – VK-6.

Tests of crowns were carried out during exploratory drilling (The object of LLP exploration). The geological section of the well (fig. 3) is mainly represented by carbona-

Depth scale, m	Project geological column	Interval power, m	Core output, %	Brief description of the breeds	Category of rocks	Waiting intervals	Well design	Diameter and type of drill bit
3		3		PRS, clay of brownish gray color, plastic	II		0-2.5 PWT	PQ 122.3 м
7		4		Clay-sandy material of brown color, with the inclusion of fine detrital material. Fine-grained structure	III			
25		18		Carbonaceous-siliceous metaagrillites. The structure is fine-grained, the texture is vein-layered. Fracturing is strong (from 10 to 15 pieces per 1 linear meter). Crushing zones are traced in intervals: 7.0-8.1; 8.5-8.6; 9.0-9.1; 10.8-11.5; 12.2-12.4; 13.3-13.5.	VII-IX		0-25 HWT (PHD)	
50		30		Carbonaceous-siliceous metaagrillites. The structure is fine-grained, the texture is vein-layered. Fracturing is medium (from 4-10 pieces per 1 linear meter). Crushing zones are traced in intervals: 56.3-56.4; 57.1-57.2; 58.6-58.7; 61.3-61.7; 65.1-65.2; 70.1-70.2 м.	VII-IX			HQ 95.6 mm face wash bits
80		20		Carbonaceous-siliceous metaagrillites. The structure is fine-grained, vein-layered. Fracturing is strong (from 10-15 pieces per 1 linear meter). Crushing zones are traced in intervals: 75.0-75.5; 75.8-76.0; 76.3-77.0; 77.2-77.4; 77.9-78.3; 79.0-79.2; 79.8-80.1; 80.2-80.4	VII-IX			
100		20		Carbonaceous-siliceous metaagrillites. The structure is fine-grained, vein-layered. Fracturing is average (from 1-7 pieces per 1 running meter). Crushing zones are traced in intervals: 88.8-89.0; 91.5-91.6	VII-IX			
120		20	95%	Muscovite-siliceous metamorized tuff-siltstones. The structure is fine-grained. The texture is layered. Fracturing is average (from 5 to 8 pieces per 1 linear meter). Crushing zones are observed in the intervals: 100.3-100.4; 101.5-102.0; 102.3-102.7; 104.2-104.5 м.	VII-IX			
150		30		Muscovite-chlorite-siliceous metasiltstones with an admixture of volcanic material. The structure is fine-grained. Texture slate angle 30-40° c.o.k. Fracturing is average (from 5-8 pieces per 1 running meter). Crushing zones are traced in intervals: 125.7-126.0; 119.6-119.7 м.	VII-IX			
170		20		Muscovite-chlorite-siliceous metamorphosed tuff-siltstones. The structure is fine-grained. The texture is slate at an angle of 65-70°. Fracturing is weak (from 2-5 pcs. per 1 rm at an angle from 30° to 70°)	VII-IX			
200		30		Chlorite-siliceous metasiltstones with an admixture of dark gray volcanic material. The structure is fine-grained. The texture is slate at an angle of 60-70°. Fracturing medium (from 3 to 7 pcs. per 1 rm at an angle of 40-70°)	VII-IX			
220		20		Chlorite-siliceous metasiltstones with an admixture of dark gray volcanic material. The structure is fine-grained. The texture is slate at an angle of 60-70°. Medium fracturing (from 3 to 8 pieces per 1 running meter at an angle of 30-70°)	VII-IX			
240		20		Chlorite-siliceous metasiltstones with an admixture of greenish-gray volcanic material, due to uneven interlayers of chlorite up to 1 cm thick. Fine-grained structure. The texture is schistose at an angle of 75-80°. Fracturing is weak (from 2 to 4 pieces per 1 running meter at an angle of 65-70°, less often 35-40°)	VII-IX			

Section chief: ________________________________

Fig. 3. Geological by well

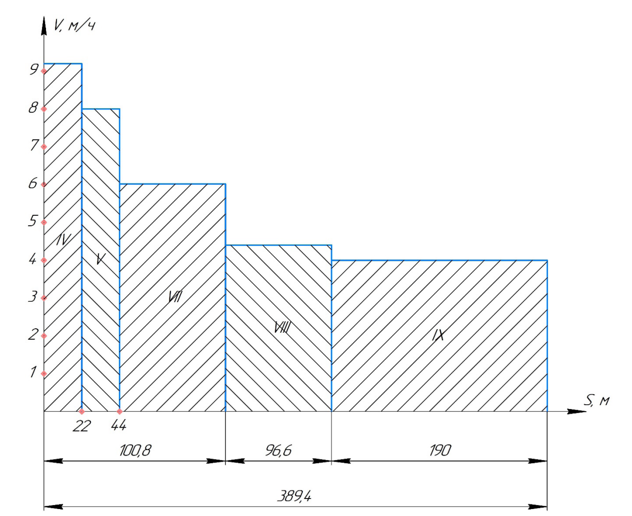

Fig. 4. Distribution of mechanical velocity by well footage and rock drillability categories (crown KSB-ZM (HQ))

ceous-siliceous mudstones, interbeds of quartz sandstones of the VIII-IX categories of drillability and chlorite-siliceous metamorphosed metaaleurolites of the VIII-X categories of drillability. As follows from the geological outfit (fig. 3) the main meter of the well is passed with diameters of 95.6 mm (HQ), and the mouth section is with a diameter of 122.3 mm (PQ) with a casing.

The wells were laid obliquely with an angle of 67°.

Drilling was carried out by a mobile installation UKB-6S designed by LLP. The installation includes a drilling rig Boyles C6, located on the highway trailer 4M3AP – 83981, and a flushing pump FMC, having a capacity from 25 to 250 l/min. The Boyles C6 drilling rig is equipped with a movable rotator with a feed stroke of 3.5 m, has a rotation speed from 125 to 1500 rpm and a feed force of up to 80 kN. The UKB-6C installation is capable of drilling inclined wells in the range of inclination angles of 55-90 °. To increase the cruise speed and overall drilling performance, a projectile with a removable Boyles core receiver was used. Bentonite, a polymer solution with a density of 1.1-1.25 g/m^3, was used as a washing liquid. [22-46]

KSB-3M (HQ) diamond impregnated bits of the same design, but manufactured by different manufacturers, were subjected to production tests: two bits were manufactured by the EPDDE plant and one by LLP.

The rational parameters of the technological regime were maintained in the following range: axial load on the crown – 12-14 kN; the rotation speed of the crown is 550-850 rpm, the flow rate of drilling mud is 45-55 l/min.

The tests showed that the bits made by the EPDDE plant showed a very small penetration in intermittent rocks of IV-VII categories (the first - 47 m, the second - 91.2 m) and went out of work for the same reason - the destruction of the matrix along the inner diameter. It follows from this that the mentioned plant showed weak technological discipline in the manufacture of experimental diamond tools.

The third crown KSB-3M manufactured by LLP was tested when drilling in two wells: №S – 49 and №S – 50. In well №S – 49, the crown drilled an interval of 285.4 m – 394.2 m in carbonaceous-siliceous metaargillites of category VII-IX with a mechanical speed of 6 m/h. During the transition to a softer rock, represented by siltstone of the III-VI category, the penetration rate decreased sharply and at 397.2 m the deepening stopped altogether. When examining the raised crown, it was found that the end of the matrix is covered with compressed fine sludge of the drilled rock and does not allow the diamond grains to be exposed. After cleaning from the sludge, it was decided to use the KSB-3MG crown when drilling harder rocks. At well №S 49, the penetration with the experimental crown was 111.8 m. Further tests with the crown of KSB-3MG were continued during drilling of well №S – 50. The drillable rocks are represented by carbonaceous-siliceous metargillites of the VII – IX category of drillability. The experimental crown drilled an interval from 44.6 to 322.2 m, the corresponding penetration was 277.6 m, and the total penetration through two wells №S – 49 and №S – 50 was 111.8+277.6=389.4 m.

The distribution of the footage of wells S by the categories of drillability and mechanical drilling speed V is shown in figure 4, from which it follows that approximately 60% of the footage belongs to rocks of the VIII – IX category of drillability.

Since all the tested diamond crowns are of the same design and must be made according to the drawings of the project executors, this indicates a different approach to manufacturing technologies and the responsibility of different performers to create experimental samples of diamond tools.

Conclusions

1. The experimental crown KSB-3M, with its technologically correct execution, shows very good performance and overall service life (durability) when drilling rocks of medium hardness and solid.
2. The next batch of experimental patented diamond crowns will be manufactured by the domestic organization LLP, taking into account the ISM recommendations on strengthening diamond grains in the crown matrix by adding various components to the charge in a low concentration. The mentioned crowns are recommended to be tested in hard abrasive rocks.

This study is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP AP14869271).

References

1. Ratov, B. T., Fedorov, B. V., Khomenko, V. L., et al. (2020). Some features of drilling technology with PDC bits. *Naukovy Visnik National Hirnohoho University*, 3, 13-18.

2. Ratov, B. T., Fedorov, B. V., Omirzakova, E. J., Korgasbekov, D. R. (2019). Development and improvement of design factors for PDC cutter bits. *Mining Informational and Analytical Bulletin*, 11, 73-80.

3. Kassenov, A. K., Ratov, B. T., Moldabekov, M. S., et al. (2016). The reasons of formation of oil seals when drilling geotechnological wells for underground leaching of uranium ores. In: *International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM.*

4. Ratov, B. T., Mechnik, V. A., Bondarenko, N. A., et al. (2021). Effect of vanadium nitride additive on the structure and strength characteristics of diamond-containing composites based on the Fe–Cu–Ni–Sn matrix, formed by cold pressing followed by vacuum hot pressing. *Journal of Superhard Materials*, 43(6), 423-434.

5. Ratov, B. T., Bondarenko, N. A., Mechnik, V. A., et al. (2022). A study of the structure and strength properties of the WC–Co drill insert with different CrB2 content sintered by vacuum hot pressing. *SOCAR Proceedings*, 1, 37-46.

6. Ivasiv, V., Yurych, A., Zabolotnyi, S., et al. (2020). Determining the influence of the condition of rockdestroying tools on the rock cutting force. *Eastern-European Journal of Enterprise Technologies*, 1(103), 15-20.

7. Chudyk, I., Raiter, P., Grydzhuk, Ya., Yurych, L. (2020). Mathematical model of oscillations of a drill tool with a drill bit of cutting-scraping type. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, 1, 52-58.

8. Chudyk, I. I., Femiak, Ya. M., Orynchak, M. I., et al. (2021). New methods of preventing crumbling and collapse of the borehole walls. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, 4, 17-22.

9. Sudakov, A., Chudyk, I., Sudakova, D., Dziubyk, L. (2019). Innovative technology for insulating the borehole absorbing horizons with thermoplastic materials. *E3S Web of Conferences*, 123, 1-10.

10. Sudakov, A., Dreus, A., Ratov, B., et al. (2020). Substantiation of thermomechanical technology parameters of absorbing levels isolation of the boreholes. News of the National Academy of Sciences of the Republic of Kazakhstan. *Series of Geology and Technical Sciences*, 2(440), 63-71.

11. Sudakov, A., Dreus, A., Kuzin, Y., et al. (2019). A thermomechanical technology of borehole wall isolation using a thermoplastic composite material. *E3S Web of Conferences. Essays of Mining Science and Practice,* 109, 00098.

12. Kozhevnikov, A. A., Sudakov, A. K., Dreus, A. J., Lysenko, K. Ye. (2014). Study of heat transfer in cryogenic gravel filter during its transportation along a drillhole. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, 6, 49-54.

13. Dzyubyk, A., Sudakov, A., Dzyubyk, L., Sudakova, D. (2019). Ensuring the specified position of multisupport rotating units when dressing mineral resources. *Mining of Mineral Deposits*, 13(4), 91-98.

14. Zhu, Y., Li, X., Zhao, C., et al. (2023). Decomposition characteristics of methane hydrate in porous media under continuous and intermittent microwave heating. *Fuel*, 332(2), 126230.

15. Dreus, A. Yu., Bondarenko, V. I., Biletskyi, V. S., Lysenko, R. S. (2020). Mathematical simulation of heat and mass exchange processes during dissociation of gas hydrates in a porous medium. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, 5, 33-39.

16. Cao, X., Kozhevnykov, A., Dreus, A., Liu, B.-C. (2019). Diamond core drilling process using intermittent flushing mode. *Arabian Journal of Geosciences*, 12(4), 137.

17. Bulat, A., Blyuss, B., Dreus, A., et al. (2019) Modelling of deep wells thermal modes. *Mining of Mineral Deposits*, 13(1), 58-65.

18. Bulat, A., Osnnii, V., Dreus, A., Osnnia, N. (2021). Mathematical modelling of thermal stresses within the borehole walls in terms of plasma action. *Mining of Mineral Deposits,* 15(2), 63-69.

19. Adamaev, M., Kuttybaev, A., Auezova, A. (2015). Dynamics of dry grinding in two-compartment separator mills. In: *New developments in mining engineering 2015: Theoretical and practical solutions of mineral. Resources mining.*

20. Pavlychenko, A. V., Ihnatov, A. O., Koroviaka, Ye. A., et al. (2022) Problematics of the issues concerning development of energy-saving and environmentally efficient technologies of well construction. *ICSF-2022 IOP Publishing. IOP Conference Series: Earth and Environmental Science, 1049 012031.*

21. Biletsky, M. T., Kozhevnykov, A. A., Ratov, B. T., Khomenko, V. L. (2019). Dependence of the drilling speed on the frictional forces on the cutters of the rock-cutting tool. *Naukovyi Visnyk Natsionalnoho Hirnychoho UniversytetuIssue*, 1, 21-27.

22. Buravleva, A. A., Fedorets, A. N., Vornovskikh, A. A., et al. (2022). Spark plasma sintering of WC-based 10wt%Co hard alloy. A study of sintering kinetics and solid-phase processes. *Materials*, 15, 10-91.

23. Huaping, X., Shuhai, L., Kaiwen, T. (2019). Experimental investigation of force response, efficiency, and wear behaviors of polycrystalline diamond rock cutters. *Applied Sciences*, 9(15), 133-144.

24. Liu, J., Zheng, H., Kuang, Y., et al. (2019) 3D numerical simulation of rock cutting of an innovative non-planar face PDC cutter and experimental verification. *Applied Sciences*, 9(20), 121-137.

25. Dong, G., Chen, P. (2018). 3D numerical simulation and experiment validation of dynamic damage characteristics of anisotropic shale for percussive-rotary drilling with a full-scale PDC bit. *Energies*, 11(6), 1326-1339.

26. Grydzhuk, Ja., Chudyk, I., Velychkovych, A., Andrusyak, A. (2019). Analytical evaluation of inercial properties of the range of the drill string in its rotation. *Eastern European Journal of Enterprise Technologies*, 1/7(97), 6-14.

27. Menezes, P. L. (2017). Influence of rock mechanical properties and rake angle on the formation of rock fragments during cutting operation. *The International Journal of Advanced Manufacturing Technology*, 90, 127-139.

28. Rasulov, S. R., Hasanov, G. T., Zeynalov, A. N. (2020). Acoustic testing of rheological properties of oil in borehole. *News of the National Academy of Sciences of the Republic of Kazakhstan Series of Geology and Technical Sciences*, 2(440), 141-147.

29. Sharapatov, A., Shayakhmet, M. (2017). Physico-geological basis of efficiency of application of aeromagnetic method in oil-gas Caspian lowland. *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences*, 3(423), 95-99.

30. Mechnik, V. A., Bondarenko, N. A., Kolodnitskyi, V. M., et al. (2020). Effect of vacuum hot pressing temperature on the mechanical and tribological properties of the Fe–Cu–Ni–Sn–VN composites. *Powder Metallurgy and Metal Ceramics*, 58(11-12), 679-691.

31. Novitskyi, I. V., Sliesarev, V. V., Maliienko, A. V. (2020). Method of identification of nonlinear dynamic control objects of preparatory processes before ore dressing. *Naukovy Visnik National Hirnohoho University*, 2, 42-46.

32. Aliyev, Ad. A., Abbasov, O. R., Aghayev, A. M., et al. (2022). Mineralogy, geochemistry and paleoweathering characteristics of Paleogene-Miocene oil shales in Azerbaijan. *SOCAR Proceedings*, 1, 24-36.

33. Veliyev, E. F., Aliyev, A. A. (2022). Comparative analysis of the geopolymer and Portland cement application as plugging material under conditions of incomplete displacement of drilling mud from the annulus. *SOCAR Proceedings*, 1, 108-115.

34. Sharapatov, A., Taikulakov, E. E., Assirbek, N. A. (2020) Geophysical methods capabilities in prospect evaluation and detection of copper-bearing localisations of western pre-Balkhash. *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences*, 3(441), 72-78.

35. Abdoldina, F. N., Nazirova, A. B., Dubovenko, Y. I., Umirova, G. K. (2021). Solution of the gravity exploration direct problem by the simulated annealing method for data interpretation of gravity monitoring of the subsoil conditions. *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences*, 1(445), 13-21.

36. Kryzhanivskyi, Ye. I. ,Vytyaz, O. Yu., Tyrlych, V. V., et al. (2021). Evaluation of the conditions of drill pipes failure during tripping operations. *SOCAR Proceedings*, 1, 36-48.

37. Vytyaz, O., Hrabovskyy, R., Artym, V., Tyrlych, V. (2020). Effect of geometry of internal crack-like defects on assessing trouble-free operation of long-term operated pipes of drill string. *Metallofizika i Noveishie Tekhnologii*, 42(12), 1715-1527.

38. Ihnatov, A., Koroviaka, Ye., Rastsvietaiev, V., Tokar, L. (2021). Development of the rational bottomhole assemblies of the directed well drilling. *E3S Web of Conferences: Gas Hydrate Technologies: Global Trends, Challenges and Horizons* – 2020, 230, 01016.

39. Femyak, Ya. M., Femiak, V. Ya., Kovbsiuk, I. M., et al. (2019). Evaluation of the influence of geological-technical factors on the durability of casing columns in oil and gas wells. In: *XIII International Scientific Conference «Monitoring of Geological Processes and Ecological Condition of the Environment»*.

40. Femyak, Ya. M., Riznychuk, A. I., Fedoriv, V. V., et al. (2021). Technical and technological solutions to prevent destruction of the walls of directional wells in the mining and geological conditions of Ukrainian fields. In: *XV International Scientific Conference «Monitoring of Geological Processes and Ecological Condition of the Environment»*.

41. Melnychenko, Y., Poberezhny, L., Hrudz, V., et al. (2021). Determination of preconditions leading to critical stresses in pipeline during lowering. *Lecture Notes in Civil Engineering*, 102, 241-252.

42. Kryzhanivskyi, E. I., Nykyforchyn, H. M., Student, O. Z., et al. (2020). Role of nonmetallic inclusions in premature stress-corrosion fractures of drill pipes. *Materials Science*, 55(6), 822-830.

43. Kovbasiuk, I. M., Martsynkiv, O. B., Femiak, Y. M., et al. (2020). Research of the stressed state of saline rocks of prykarpattia deposits under the influence of thermobaric conditions. In: *XIV International Scientific Conference on Monitoring of Geological Processes and Ecological Condition of the Environment.*

44. Ziaja, J., Stryczek, S., Jamrozik, A., et al. (2017). Sealing slurries limiting natural gas exhalations from the annular space of a wellbore. *Przemysl Chemiczny*, 96(5), 990-992.

45. Ovetska, O., Ovetskyi, S., Vytiaz, O. (2021). Conceptual principles of project management for development of hydrate and other unconventional gas fields as a component of energy security of Ukraine. *E3S Web of Conferences*, 230, 01021.

46. Fedorov, B., Ratov, B., Sharauova, A. (2017). Development of the model of petroleum well boreability with PDC bore bits for Uzen oil field (the Republic of Kazakhstan). *Eastern-European Journal of Enterprise Technologies*, 3(1), 16-22.

Результаты производственных испытаний экспериментальной алмазной коронки при разведочном бурении в Казахстане

***Б. Т. Ратов*[1]*, И. И. Чудик*[2]*, Б. В. Федоров*[1]*, А. К. Судаков*[3,4]*, Б. Р. Бораш*[5]**

[1]Satbayev University, Алматы, Казахстан
[2]Ивано-Франковский национальный технический университет нефти и газа, Ивано-Франковск, Украина
[3]Национальный технический университет «Днепровская политехника», Днепр, Украина
[4]Национальный университет «Львовская политехника», Львов, Украина
[5]Yessenov University, Актау, Казахстан

Реферат

Работа посвящена результатам производственных испытаний многослойной алмазной коронки с гребенчатым профилем всех пропитанных слоев, разделенных безалмазными слоями меньшей твердости. Отличительной особенностью коронки является размещение алмазосодержащих слоев на трехсторонней винтовой поверхности с небольшим шагом. Это позволяет вовлечь в процесс углубления коронки в частично трещиноватую зону породу, лежащую под зоной внедрения алмазных зерен. Зона теоретического обоснования эффективности «гребенчатого» профиля матрицы. Вышеуказанная патентная коронка под аббревиатурой КСБ-3М (HQ) прошла производственные испытания на геологическом объекте казахстанской компании «Казахмыс Барлау». Породы представлены в основном углисто-кремнистым метагалием XIII - IX и частично X-й категории. Бурение осуществлялось с применением снаряда со съемным керноприемником. Одной экспериментальной коронкой пробурено 389 скважин, причем большая часть из них попадает на породы IX категории, что свидетельствует о большой стойкости инструмента. Скорость механического бурения колеблется от 5.5 до 3.5 м/ч в зависимости от качества породы. Было решено продолжить эксперименты с коронками КСБ-3М на других геологических разрезах с более твердыми породами.

Ключевые слова: производственные испытания; многослойная иммигрированная коронка; распределительное бурение; стойкость горных пород.

Qazaxıstanda kəşfiyyat qazması zamanı sınaqdan keçirilən eksperimental almaz tacının istismar testinin nəticələri

***B. T. Ratov*[1]*, İ. İ. Chudik*[2]*, B. V. Fedorov*[1]*, A. K. Sudakov*[3,4]*, B. R. Boraş*[5]**

[1]K. İ. Satpayev adına Qazaxıstan Milli Texniki Tədqiqat Universiteti, Almatı, Qazaxıstan
[2]Ivano-Frankovsk Neft və Qaz Milli Texniki Universiteti, İvano-Frankovsk, Ukrayna
[3]«Dnepr Politexnik» Milli Texniki Universiteti, Dnepr, Ukrayna
[4]«Lvov Politexnik» Milli Universiteti, Lvov, Ukrayna
[5]Yessenov University, Aktau, Qazaxıstan

Xülasə

Məqalə daraq formal çoxlaylı almaz tacın istismar testinin nəticələrindən bəhs edir. Tacın bütün hopdurulmuş təbəqələri daha aşağı sərtliyə malik (almazsız) təbəqələr ilə bir-birindən ayrılmışdır. Tacın xüsusi özəlliyi ondadır ki, burada almaz təbəqələri üçtərəfli vint üzərində yerləşdirilmişdir. Bu sayədə quyudibinin qismən çatlı laylara doğru genişlənməsi əldə olunur. Təqdim olunmuş tac KSB-3M (HQ) adı altında patentləşdirilmiş və «Kazakmis Barlau» şirkətinin zavodlarında istismar testlərindən keçmişdir. İstifadə olunmuş süxurlar əsas etibarilə karbon-silisum metagalium XIII – IX və qismən X kateqoriyasına aid olmuşlar. Qazma işləri süxur nümunəsinin qəbuledicisi ilə təchiq olunmuş mərmi vasitəsilə həyata keçirilmişdir. 1 ədəd eksperimental tac ilə 389 ədəd quyu qazılmışdır, hansı ki bu zaman ən çox rast gəlinən süxur IX kateqoriyasına aid olmuşdur. Bu isə öz növbəsində tacın möhkəmliyinin göstəricisidir. Mexaniki qazma sürəti süxurun növündən asılı olaraq 5.5-3.5 m/s arasında dəyişmişdir. Qərara alınmışdır ki, KSB-3M tacının testləri digər geoloji seksiyalarda daha möhkəm süxurlarda davam etdirilsin.

Açar sözlər: istismar testləri; çoxlaylı tac; yüksək möhkəmliyə malik VIII-IX kateqoriyalı süxurların qazılması.