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Production of Drilling and Explosion Works at the "Yoshlik I" Mine Quarry with the use of Non-Electric Initiation System and Emulsion Explosives

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ABSTRACT: The article describes the use of a non-electric initiation system and emulsion explosives in drilling and blasting operations and the results of the experience in applying the "Yoshlik I" field in a quarry.

KEY WORDS: deposits, mining concession, JSC Almalyk MMC, diorites, open pit, open pit power, drilling, machine tools, blast hole charges, initiation, mine.

I.INTRODUCTION

When conducting drilling and blasting operations in mining enterprises, the choice of their main parameters and methods of controlling the explosion, to a large extent, depends on the properties of the rocks, the fracturing of the massif and the structural features of its occurrence. In making the calculations, the physical, mechanical, mining and technological properties of rocks are used. The main intention is to regulate the lumpiness of the rock mass while ensuring the safety of the ore preparation process at the quarry.

The purpose of the development of the "Yoshlik I" deposit is the extraction of copper-molybdenum ores. Structurally, the "Yoshlik I" deposit is being developed by a mining company, which is part of the Almalyk Mining and Metallurgical Combine Joint Stock Company, which is located in the city of Almalyk. Blasting operations are carried out in the daytime two days a week.

II. SIGNIFICANCE OF THE SYSTEM

Using the following drilling and blasting conditions, the required lumpiness of the rock mass is achieved and the possibility of ensuring the safety of the ore preparation process at the quarry is ensured. This will allow to achieving a more complete extraction of minerals from the bowels during mining.

III. LITERATURE SURVEY

The main ore-bearing rocks of "Yoshlik I" are syenito-diorites, to a lesser extent diorites and granodiorite-porphyries.

Taking into account the degree of fracturing, the rocks of the "Yoshlik I" mine are divided into three categories according to explosiveness:

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Category I - easily exploded rocks - highly fractured syenites and granodiorite-porphyries unchanged by secondary processes. Syenites, syenite-diorites and granodiorite-porphyry, altered by secondary processes.

Category II — medium exploded rocks — finely and moderately fractured with sulfide mineralization. Secondary quartzites, silicified granodiorite porphyries, altered syenites, syenite-diorites, secondary quartzites with syenites and syenite-diorites with sulfide mineralization.

Category III - hard-to-explode rocks - secondary quartzites, dense, coarse-grained, slightly fractured.

The “Yoshlik I” field has been developed open pit since March 2017.The projected ore mining capacity is 74 million tons per year.The fortress coefficient on the Protodyakonov scale is 10-15. The volumetric weight of the ore is 2.6 t / m^3, and the rocks are 2.44 t / m^3. The volume of mining in the career of the “Yoshlik I” deposit was planned for 2019 in the amount of 12 million m^3, which was completed.

IV. METHODOLOGY

Drilling operations are carried out by the mine, and blasting by the Explosive Materials Plant, which is also part of the Almalyk Mining and Metallurgical Combine Joint Stock Company.

The following maximum conditional piece size is determined by mining equipment: for rock (empty) it should not exceed 1500 mm (for the capacity of the shovel of the excavator), for ore -1000 mm (for the reception hole of the crushing plant of the copper processing plant). The permissible yield of oversized fraction is 1.5-2.0%. Oversized cutting is done with boreholes or with the use of special equipment (hydraulic rock breaker) and external charges.

Drilling and blasting preparation of them is more than 58%. Below the +700 m mark, open pit rocks are completely wet ground, and partially above, primarily, mainly due to precipitation and filtering of these waters along cracks. In general, the water cut of open pit rocks is 65-68%. Based on the existing mining and geological and mining conditions of the field being developed, the required degree of crushing of rocks and taking into account the many years of practice in quarries, the method of vertical borehole loosening charges with their multi-row arrangement and short-blasting explosion has been adopted as the main method of blasting.

Blasting of borehole charges on the ledges is carried out in the presence of several exposed surfaces and the number of rows of blast holes on the block up to 5, and in trench conditions - with one free surface. In order to quality crushing the rocks, as blast hole as to eliminate the harmful effects of the explosion (seismic and shock-air waves) during the explosion of borehole charges, a non-electric “Iskra” initiation system is provided. Non-electric initiation systems are used to transmit an initiating pulse from the primary initiator (detonator capsule or electric detonator) through a shock wave tube mounted in the system detonator to an intermediate detonator (for borehole charges) or an action cartridge (for boreholes). A non-electric initiation system, in comparison with traditional ones (using a detonating cord and an electric detonator), is due to higher reliability, safety and prospects for improving the management of explosion energy.

The reliability of the system is ensured by the presence of downhole retardation. In practice, this means that a charge explosion in the first blast hole of an explosive block occurs after a time determined by the parameters of the downhole detonator.

During this time, the initiating impulse along the surface network has either already passed through the entire network, or its passage through the network has outstripped the beginning of the explosion through the block blast holes by a considerable distance. Thus, the impossibility of breaking the surface explosive network by the explosion of a borehole charge is guaranteed.

Safety of system is achieved mainly due to:
- the impossibility of the reverse passage of the initiating pulse (from the shock wave tube to the detonator);
- the impossibility of unauthorized initiation of a detonation pulse in a shock wave tube from an external source (fire, shock, friction, stray currents, etc.).

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The method of blasting borehole charges with the help of the downhole detonator capsule ("Iskra-S") and Almanite fighters. The main method of blasting borehole charges is the non-electric "Iskra" initiation system, as blast hole as combined systems. Initiation of the capsule detonator is performed by a non-electric initiation system based on a low-energy type waveguide. Shock wave tube is designed to transmit the initiating pulse to a distance. It is used in "Iskra" systems to initiate from a safe place. The length of the shock wave tube can be selected any, depending on the distance of a safe place. Like other non-electric initiation systems, the "Iskra" system cannot be verified using instruments. Therefore, it is necessary to strictly observe a certain installation sequence so that it is enough to conduct only an accessible visual control.

The use of an orderly scheme is foreseen as the main schemes for split-second blasting. The selection of the split-second blasting scheme is carried out by the person of technical supervision in accordance with the mining conditions of this unit. The rational area of application of a particular split-second blasting scheme is determined mainly by the number of rows of borehole charges, the height of the step and the available means of split-second blasting. Drilling of blast holes is foreseen to be carried out by cone drilling machines with a bit diameter of 244.5 mm, and also to use these machines when drilling a cutoff stope. Taking into account the drilling coefficient (for rocks of VIII-IX groups - 1.03), the diameter of the blast holes will be 250 mm, respectively. Blast hole grids are used differently, depending on the category of rocks. In the rocks of the first category, the net is 9.5x9.0; second category - 8.5x8.0; third category 7x6.5m. Currently, 8x8m mesh is mainly used.

V. EXPERIMENTAL RESULTS

The quality of blasting operations is controlled at all stages of the production process. The following parameters of blast hole charges are subject to control:

- resistance on the bottom of the cutting depth;
- the distance between the rows of charges;
- the distance between the charges in the row;
- depth of borehole;
- the direction of drilling (angle of inclination of the charges);
- mass of charge;
- the stemming length (table 1).

Table 1

Parameters of borehole charges of relieving with a diameter of 250 mm in rocks of the II explosive category.

The height of the cutting depth, *m*	Line of resistance on the bottom of the cutting depth, *m*	Deep of overdrill, *m*	Deep of hole, *m*	The distance between the charges in a row, *m*	The distance between the rows of charges, *m*	Stemming length, *m*		Charge length, *m*		Charge mass, *kg*		The number of rows	Average rock yield from a hole, m^3	Design specific consumption of emulsion explosives, kg/m^3
						1 row	2 row	1 row	2 row	1 row	2 row			
10	7	2	12	7,5	7,0	6,9	6,9	5,1	5,1	372	372	2	525	0,71
12,5	8	2,5	15	8,0	7,5	7,2	7,7	7,8	7,3	568	532	2	750	0,71
15	10	3,0	18	8,5	8,0	5,5	8,1	12,5	9,9	905	724	2	1020	0,71
17,5	10	3,5	21	8,5	8,0	6,5	9,4	14,5	11,6	1056	844	2	1190	0,71
20	10	4,0	24	9,0	8,5	6,4	9,1	17,6	14,9	1278	1086	2	1530	0,71
22,5	10	4,5	27	9,0	8,5	7,2	8,2	19,8	16,8	1437	1222	2	1721	0,71

Note:
1. The average emulsion explosive capacity in 1 m of a hole is 63 - 68 kg for dry holes; 67-78 kg - for water holes, depends on the column of water in the hole and type of emulsion explosives.
2. The mass of blast hole charge during the preparation of the technical calculation of the explosion of each specific block is adjusted depending on the water cut and the parameters of the grid of blast holes.
3. The charge column is calculated at an average emulsion explosive capacity 1 per meter run – 72.5 kg.

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The average resistance of roller cutters is 350-360 m. Types of roller cutters for hard rocks are used. The proportion of drilling in the total cost of 1 m^3 of rock mass is about 20%. Rocks are drilled on a quarry with cones with hard-alloy teeth. Currently, the use of both non-waterproof and waterproof emulsion explosives is envisaged. The main type of explosives emulsion explosives of the Emulgite type - 30, 50, 60 and ANFO are used. Mixing and charging machines are used to charge blast holes with emulsion explosives. The specific consumption of explosives is on average 0.71 kg / m^3. The capacity of 1 per run meter of a borehole for explosives when using ANFO is - 50 kg, Emulgite-30 - 68 kg, Emulgite-60 - 78 kg. The average output of the rock mass from 1 per run meter of the well is 56-60m^3. When the height of the water column in the borehole is up to 0.5 m, it is charged with emulsion explosive Emulgite-30. When the height of the water column is more than 0.5 m. Loading is carried out with the emulsion explosive Emulgite-60, lowering the hose of the charging machine under the column of water.For militants, the cartridge Almanite is used. The mass of the fighter is determined by the depth of the well and the water cut, and is 1-3 kg.On the main loosening, a solid emulsion explosive charge column is used. Non-waterproof emulsion explosives are used to charge dry blast holes, and waterproof emulsion explosives are used to charge waterlogged blast holes. The charge density of emulsion explosives depends on the water cut and ranges from 1.16 - 1.33 g / m^3.

VI. CONCLUSION

The value of the rational slowdown time interval, taking into account the practical experience of the quarries of JSC Almalyk MMC at “Yoshlik I” Mine, is: 67, 109, 176 ms when using the non-electric “Iskra” initiation system.

“Iskra-S” borehole initiating devices are designed for downhole initiation with deceleration of borehole charges during blasting operations on the earth's surface at temperatures from minus 40º to plus 50ºC. According to the experience of blasting at the “Yoshlik I” quarry, the slowdown of downhole detonators should be 500 ms. Slow blasting of borehole charges can be carried out using electric detonators. Electric detonators are mainly used for non-safety, delayed operation, normal sensitivity to stray current and charges of static electricity. They are designed to initiate explosive charges during explosive work on the earth's surface. “Iskra” -S devices are susceptible to the initiating pulse from the “Iskra-P” detonator capsule, which is designed to slow down the transmission of the initiating pulse during explosive work on the earth's surface, detonating cords and electric detonators. The “Iskra-S” detonator capsule initiates (detonates) ammonium cartridges 6ЖВ, intermediate detonators T-400, Almanite. The length of the “Iskra-S” waveguide is: 10, 16, 21, 27 m.

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