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Increasing the Effectiveness of Blasting in Underground Mines

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ABSTRACT: This article describes a new alternative technology of blasting using ampoule technology of column charge dispersion. This technology ensures the quality of blasting of a rock mass and an increase in the effectiveness of blasting in development and slope operations in ore deposits.

1 INTRODUCTION

The main technological process in underground ore body development is the blasting process. During development and sloping processes, drilling and blasting operations take up 50-70% of all the process and volume. The quality and the cost of development depend on the effectiveness of the drilling and blasting operation. The duration and laboriousness of drilling-blasting operations mainly depends on the physio-mechanical properties of the blasted rock, the cross-section of the development, the blasting parameters and also the blast hole and hole charge construction.

2 INCREASING THE EFFECTIVENESS OF BLASTING

One of the ways to increase the effectiveness of drilling and blasting operations is the improvement of blast hole design and column charges in hard rock blasting operations.

Analysis of the existing design of explosive charges used the blasting of rock masses in mining enterprises provides an opportunity to see that along with widespread solid cylinder columns of explosives, there are various more effective designs for a better control of the heat of explosion under rock mass destruction. The basis of this design is the application of a wide range of factors, such as decreasing of the initial pressure of the explosion product, increasing of the time of influence upon the rock mass, the creation of several groups of detonation waves in a charge. However, in spite of the advantages of dispersed charges İn comparison with solid charges; they are not so widely used because of their cost and the time necessary for the charging of blast holes.

With a solid, full column charge of explosives, the greatest part of the heat of explosion is spent in excessively strong fragmentation and grinding of the rock, while much of the heat is absorbed because of the viscosity of the rock and its heating. The remainder of the heat of explosion energy is utilized for displacement of the pieces of rock over a significant distance. As a result of such heat or energy losses in the explosion, the efficiency of the process sharply decreases.

An essential increase in the efficiency of the explosion and decrease in the plastic deformation zone, over grinding of the rock and increasing the area of harder influence of the explosion to the rock can be achieved by increasing the time of the explosion influence for the file, decreasing the "peak" of the pressure and strengthening the interaction of the Shockwaves and gas flows due to the air intervals remaining in the cavity of the column charge.

At synchronous blasting of the parts of dispersed charge from the thread of the detonating cord or from additional initiators, intense collision of gas flow and shock waves occurs İn each part of the charge several times increasing the pressure İn the air gap limit. This sharply increases the seismic influence upon the roof and walls of stopes and m developing negatively influences the stability of the massive rocks found m the contour. Therefore, during initiation of the dispersed charge, based on the transmission of detonation inside the blast hole from one part of the charge to another through an air gap without initiation system supply, which does not involve the collision of gas flows and shock tubes, the seismic influence of the blast upon the massive rocks in the contour is decreased and its stability increases. Moreover, the influence time of the blast gasses is increased and this raises the heat of the explosion use ratio.

In respect of the statement above, the creation of air intervals by using ampoule technology of the dispersion was designed (Bitimbayev, Bekbayev, Raskildinov, 1987; Raskildinov, 1991; Raskildinov, Alzamarova, 1995; Raskildinov, 1995; Raskildinov, 1994). Compared to other methods, it İs more practical; it simplifies the technology of blasting operations because it does not need any additional time for charging. Ampoules are filled with air and are placed between the parts of the dispersed charge of explosive. This method completely avoids the installation of detonating cord in the blast hole charge because air is an ideal sphere for transmission of detonation by influencing between separate parts of dispersed charges. The proposed construction provides the opportunity to decrease the seismic influence of the explosion upon the roof and walls of development and slopes, and to minimize with this sticking of rocks of out contour massif and to obtain quality fragmentation of the rock mass, reducing the yield of over-fragmented ore fines.

Detonation from the active part of the dispersed column charge to the passive part is transmitted by shock-wave influence. The main factors influencing the transmission of detonation through such influence are: impulse (J), pressure of the detonation product (P), velocity of the shock wave (U), and the temperature of detonation formed by initiation of the active part of the column charge.

The parameters of the factors above mainly depend on weight, the type of explosives, the VOD of the active charge, the physicochemical properties of the passive part of the charge and its density, and also the sphere where the dispersed column charges are placed. For the passive part of me charge of the explosives with no clear period of burning, the detonation occurs toward the zone where the parameters of the detonation products (J, P, U) of its active part will be big enough. If a shock wave of lower value comes to the passive part of the dispersed charge, the burning period precedes the detonation. The stimulating ability of the passive part of the dispersed column charge to detonation through the influence is determined by the weight and construction of its active part.

Expérimenta! blasts for determination of the distance transmission of detonation between the active and passive parts of the dispersed column charges were held in underground mines in the Irtysh, Belousov and Mirgalimsaisc fields. The blasts took place in a breakage face with two outcrop planes with a strut of room boards. The distance from the column charge to the free surface was 400-600 mm. Blast hole charges with a diameter of 40 mm and depth of 4 m were dispersed between the active and passive parts of polyethylene ampoules filled with air. The research was carried out with different types of explosives, with the active part of the dispersed column charge placed in the collar of the blast hole (direct initiation).

There were three blasts for each type of weight of active charge and exact distance. The results for transmission of detonation through influence were considered positive only if stimulation of detonation in the passive part of the charge through the air gap occurred in all three attempts. Experimental blasts were carried out with the weight of the active part ranging from 0.050 kg to 0.500 kg and the size of the passive charge being no less man 1.00 kg.

The results of the experimental blasts determined the critical distance between the active and passive parts of the dispersed column charge through influence. However, when forming the dispersed column charge without using additional initiators or detonating cord (DC), it is necessary to know the distance of stable transmission of detonation through the influence of die active part to the passive. If the passive part of the charge is not subject to enough shock-wave influence, the size of which depends on the detonation parameters of the active part of the charge and the distance between them, the explosive in the passive part will not detonate or will detonate with a very low velocity, causing burning-out of the explosive. This will affect the quality of explosive, which is not desirable during blasting operations, deadlock excavation and breakage. Thus, İn order to set the distance of stable detonation in the passive part of the charge, we carried out these blasts in the underground mines mentioned above.

During the experimental blasts for determination of the VOD of the explosives, the active and passive parts of the charge were placed in steel tubes with diameters of 36-100 mm and with walls of 10-20 mm thick.

Mathematical treatment of die data from the experimental blasts for determination of the distance of transmission of stable detonation in the passive part of the charge through influence led to empiric dependence as follows:

$$L_{SD}^{S} = \left(-0.15 + 4.05 Q_{AC}^{2}\right) \Big/ \sqrt{\frac{D_{ST}}{D_{EX}}}\ , \text{(m)} \qquad (1)$$

at $0.050 \leq Q_{AC} \leq 0.500$ kg,

where $L^S SD$ - the distance of the transmission of detonation in the passive part of the charge, m; $Q_A c$ - weight of active charge, kg; and $D_S T$, DEX - velocity of detonation of standard {Ammonite 6 GV) and used explosives, m/s.

During the experimental blasts, detonation in the passive part of the dispersed column charge was considered stable if its velocity was not less than 0.8-0.9 of the VOD of the active part of the charge.

The experimental blasts showed that the distance of transmission of stable detonation through influence depends on the weight of the active part of the charge, but it is considerably less than critical. For example, when the weight of the active charge is 0.200 kg, the stable distance is 0.600 m.

The dependence (1) makes it possible to set the possible distance of transmission of the detonation through influence inside the blast hole which will give a stable VOD in the passive part of the dispersed column charge.

Therefore, the results of the experimental blasts, by definition of the distance of transmission of detonation and velocity of detonation in the passive part of the charge with stimulation through influence due to the shock-wave effect, confirm that when forming the column charge dispersed by air gaps of polyethylene ampoules filled with air, additional initiators or DC installation, which make the blasting process complicated and expensive, are not necessary in either deadlock excavation or breaking.

The physical essence of charges separated into lengths by cylinder ampoules filled with air without DC installation between the parts lies in the fact that after initiation of the active charge inside the column charge, the shock wave occurs with certain parameters, typical for a given mass of the charge and type of explosives. It was determined Üiat air is a favorable sphere for transmitting detonation over a distance, which is why the effect of the shock wave stimulates detonation in passive charges. In addition to this, explosion products, expanding relatively fluently during an artificial interval created beforehand, initially decrease the peak pressure of detonation products and increase the time of influence upon the blasted rock mass. Part of the heat of the explosion is retained, and is used in plastic deformation and regrinding of the rock. Next, the retained part of the heat of the explosion is usefully spent in destruction of the sphere in great volume, which finally increases the general ratio of the heat of explosion application.

On the basis of the research, the construction of dispersed column charges and blasting technology as a whole, both for preparatory development and breaking in underground ore deposits, was designed.

The blasting technology and its rational parameters of blast hole blasting in preparatory development operations using the recommended ampoule technology of dispersed column charge were tried in different mining geological conditions in the Irtysh, Belousov, Mirgalimsay, Aksay and Shalkiin fields. The number of blast holes during the commercial trials with dispersed charges was equal to the number of blast holes blasted during solid charge construction as any reduction in the number of blast holes under the dispersion led to a sharp decrease in heading advance per round to shot hole length ratio. The results of the experimental blasts were evaluated in accordance with this ratio, the deviation of the rock mass contour and the powder factor of the explosives. The rational parameters were those parameters which allowed minimum deviation of the rock mass contour and the minimum powder factor of the explosives and heading advance per round to shot hole length ratio not less than that used with solid charge construction.

During the blasting of development and breaking faces with dispersed charge, active and passive parts of the charge with interchange of explosives and ampoules filled with air were formed inside the blast hole. The size of die air gap (la) in one stage of dispersion consisted of 1-2 ampoules. The air gap between separate parts of the dispersed column charge did not exceed the permissible stable distance of transmission of detonation through influence.

The experimental blasts showed that the ampoule technology for creating and blasting the dispersion charges during the preparation works decreased the additional quantity of rock from behind the contour from 16.0-18.0 to 0.5-1.0% and decreased the specific charge of the explosives up to 15-20% at breakage and up to 35-40% at contour boreholes. Using the results of the trials and obtained dependence, ways of forming the blast hole charges and methods of rock blasting for deadlock excavation and breaking operations were examined (Raskildinov, Alzamarova, 1995; Raskildinov, 1995).

The application of the designed technology of the blasting and breaking of ore deposits underground enabled (Raskildinov 1995; Raskildinov, Usupov 1992; Raskildinov, Usupov, 1996):

- qualitative rock mass fragmentation with the minimum yield of small ore (15-18% instead of 50-60%) working with overhand stopes with two and three exposure levels, decreases of 3-4 times in operational losses and dilution, and a 35-40% decrease in the powder factor of the explosives;
- decreases in the yield of non-standard quality ore from 8-10% to 2-3%, the yield of small ore from 48-50% to 18-20% and operational dilution from 8-10% to 2-3%, and a decrease of 15-20% in the specific charge of the explosives in room mining with hole ore breakage.

3 CONCLUSIONS

The recommended technology for blasting operation in development and face-entry operations and breaking of ore deposits using the ampoule technology of formation of dispersed blast hole charges, compared to current methods, decreases the seismic influence of the explosion to the rock of the out contour file. The explosives become harder and more resistant and the effectiveness of contour blasting increases, allowing qualitative fragmentation of the rock mass and reduction in the yield of small ore.

REFERENCES

Bitimbayev, M., Bekbayev S., Raskildinov B. 1987. Choice of rational parameters of blast hole blasting at excavation of flat seams. *Mining Journal.* 7.

Raskildinov B- 1991. Determination of distance of transmission of detonation between the parts of the column charge dispersed by the air gaps. *Gas-dynamic of Blast and Shock Waves of Detonation and Supersonic Burning: All-union Symposium Thesis.*

Raskildinov B., Alzamarova E. 1995. *Method of Blasting the Ore Massif (Patent 2298 PK)* 3.

Raskildinov B. 1995. *Method of Blasting the Ore Massif (Patent 2298PK)* 3.

Raskildinov B. 1994. Perfection of the Construction of Dispersed Column Charges. *Actual Problems of Modern Science and Technique.*

Raskildinov B-, Usupov H. 1992. Way of Blasting of Steeply Falling Thin Veins.

Raskildinov B., Usupov H. 1996. Way of Blasting of Steeply Falling Thin Veins.