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Analysis of technological processes of excavation of low-powered floor and inclined residential deposits

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ABSTRACT: For the further development of underground mining, the application of modern high-performance technologies is envisaged. This requires, respectively, the improvement of methods for the extraction of minerals, the qualitative change in the technology of mining, primarily drilling and blasting complex, ore delivery and management of mining pressure.

KEY WORDS: breaking, drilling and blasting method, bore hole, ore body, cost price, destruction, incisors, blow, cones, flat, steeply dipping, ultrasonic, laser, hydraulic impulse.

I.INTRODUCTION

As we know, currently (and in the future) technologies include the following main mining operations: ore breaking, ore delivery and rock pressure management.
Practice shows that regardless of the class of the system used, all processes are highly labor-intensive. Particularly labor-intensive are systems for the development of inclined veins, the processes of breaking and delivering ore. However, with a decrease in the strength of the enclosing rocks, the labor intensity of rock pressure control increases and labor costs for ore breaking down are reduced.
Breaking is one of the main processes of mineral extraction and has a decisive impact on its technical and economic indicators. This especially applies to the development of deposits of hard ores, where the labor intensity of destruction is 10 ... 45%, and sometimes reaches 60%.
There are the following methods of destruction of rocks in the development of mineral deposits.
The drilling-and-blasting method of ore breaking, despite the low efficiency of explosive energy use (3>15%), is widely used in the mining industry. Up to 70% of the total volume of minerals is extracted using drilling and blasting operations.

II. SIGNIFICANCE OF THE SYSTEM

The bore hole is most widely used in the development of low-power fields. The use of this method is associated with the need for accurate delineation of the face, especially with a complex shape of the ore body for maximum completeness of excavation, vein and minimum dilution of the extracted ore during breaking. This is the most important advantage of the borehole breaker.
According to the data of domestic mines, the labor intensity of blast-hole breaking is 40 ... 60% of the total labor intensity of the cleaning work, and the prime cost is 65% of the total cost of the production excavation.
Extensive experience in the use of the small-hole method of breaking both inclined and steep veins revealed the following disadvantages:
- low labor productivity, especially with manual perforating drilling;

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- significant seismic impact from the blasting of explosive charges on the enclosing rocks, which contributes to the formation and clogging of the ore;
- the cyclical nature of work due to the impossibility of combining the processes of breaking and delivering ore;
- finding people in the treatment area, which poses an increased danger to them.

The efficiency of borehole hammering can be increased by creating small-size drilling carriages equipped with at least two perforators and capable of working more efficiently, in comparison with manual perforating drilling, in a narrow clearing space with an inclined fall of veins. Blasting is especially effective when developing veins with complex morphology, and good crushing of ore allows using conveyor delivery.

III.METHODOLOGY

One of the possible ways to reduce the circumferential destruction, as shown by the studies of Soviet and foreign scientists in 70-80. last century, is the use of small-diameter boreholes (d = 28-32 mm). However, for a number of reasons beyond the control of researchers and designers, ore breaking with small-diameter boreholes has not become widespread. The purchase of bits and drill rods abroad is quite expensive.

It is promising to use flat beams of parallel-sided wells, which, due to the redistribution of the explosion energy, significantly reduce the contour destruction of rocks and more than three times reduce the mixing of waste rocks. At the same time, the walls of the mined-out space have a much smoother profile than when breaking off ore with mono charges, which creates favorable conditions for reducing the secondary dilution of ore and reducing the loss of ore fines on the recumbent side of the treatment space. A significant decrease in the specific consumption of drilling and explosives, as well as the yield of fines when drilling in parallel with adjacent wells, indicates a more rational use of the explosion energy. In the process of testing and implementation, it was also found that the deconcentrated charge effectively works with a clearing space width of up to 2.5 m. With a higher extraction power, the completeness of breaking off the reserves of the next layer quickly decreases. In this case, it is necessary to use borehole bundles of a different design (flat from three or more charges) with an in-row slowdown. This method is of undoubted interest for sloping and inclined veins, since the noted increase in the average size of a piece and a decrease in the fine fraction can expand the field of application of delivery by the force of the explosion. There is also a positive experience in the use of flat beams of parallel adjacent wells in open pits and in underground mining of powerful deposits.

The advantages of borehole breaking are also the high safety of the workers in the drill workings, the possibility of creating a cyclical-flow technology by combining the processes of drilling, loading and delivery in time. Downhole breaking is also characterized by disadvantages - somewhat increased, in comparison with hole breaking, losses and dilution. They are especially significant at high; the variability of the vein both in dip and strike, which is the main limiting factor in the use of borehole cutting.

Mechanical destruction with cutting heads, impact, abrasion wheels, separation, has passed extensive tests both on tunneling and shearers. Their prospects are obvious, as well as physical methods of destruction (thermal, electrical, ultrasonic, hydro-pulse, laser, plasma, etc.). However, due to the limited area of their application in terms of strength, high material and energy costs, they will not find industrial application in the development of hard ores in the coming years.

Labor costs for the delivery of ore from the total labor intensity of extraction through the system at mines developing vein deposits amount to 20 ... 62%. This is due to the complexity of mechanization of work in the cramped conditions of the treatment space. When mining veins with an angle insufficient for the gravity movement of ore, forced delivery methods are used: scraper haul, using the force of an explosion, hydraulic, self-propelled equipment, conveyance.

IV.EXPERIMENTAL RESULTS

Research and experience have shown that with an inclined and flat bedding of low-power deposits (less than 3 m), a combined delivery of ore is effective: in the treatment space - by the force of the explosion and water washout of the remaining fines, on the sublevel - by a self-propelled LHD. The efficiency of combined delivery is achieved by the fact that when using the same equipment, there are no costs for demolition of enclosing rocks, which is necessary for the placement and operation of self-propelled equipment in the treatment space:

To increase the efficiency of the LHD application at low-power housing deposits, sublevel delivery gates are minimal. The advantages of delivery of ore by self-propelled LHDs are high labor productivity and the ability to use the machines in roadway driving.

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The disadvantages of loading and hauling machines include their high cost, significant wear of tires and a supply cable, an increased concentration of harmful impurities in the mine atmosphere when using a diesel drive, an increased volume of preparatory and cutting operations compared to scraper delivery.

When mining low-power shallow and inclined veins, delivery of ore by self-propelled machines is promising when it is used together with the delivery by the force of an explosion, water washout or scraper cleaning of ore fines.

Rock pressure control is understood as the implementation of special measures in order to reduce or release the stress state of individual sections of the ore massif and enclosing rocks for safe and normal cleaning work.

When developing shallow and inclined shallow ore deposits, this process takes from 10 to 50% of labor costs for stope excavation. The high labor intensity of rock pressure control is due to its additional manifestation at flat and inclined bedding (in comparison with steeply dipping deposits), as well as due to the low intensity of mining and the presence of blasting operations. Consequently, the development efficiency significantly depends on the correct choice of the rock pressure control method.

Management of rock pressure in the mined-out space is carried out: by leaving ore or rock pillars, fastening, laying the mined-out space and collapse of the enclosing rocks.

Maintaining the roof of the mined-out space with ore pillars is a simple and economical way. However, its use in valuable and sometimes average value ores is impractical due to significant losses of ore (up to 30 ... 40%). Even if the pillars are subsequently worked out, the extraction from them does not exceed 40 ... 60%. Maintaining pillars becomes unacceptable at a large depth of development.

Supporting the worked-out space with support is widely used in mines. Wood is most often used as a material for lining. There are the following designs of wood lining of cleaning workings: spacer lining, campfire, fastening frames, easel support.

A promising direction is the use of supports based on pneumatic cylinders. This new type of attachment has been developed and implemented to replace the existing fires. The main advantage of pneumatic balloon supports is: low weight of fasteners, elastic contact and good adaptability to the unevenness of side rocks, wide range of extensibility, absence of oil from high pressure stations and other expensive equipment. They work on compressed air at a pressure of 3 ... 6 atm. Currently not produced by the industry.

Arch lining, including other structures, is widely used in mines for lining both winnings-entries and walls.

Maintaining the mined-out space with backfill consists in filling it with backfill material: waste rock, hardening mixtures, tailings of the processing plant, etc.

The experience of the mines shows the high cost of the solidifying backfill (up to 30-40% of the production cost). Therefore, it is used mainly in the development of valuable ores and at significant volumes, when it is economically profitable to build stowing complexes of high productivity. In this regard, the hardening backfill can find limited use in the development of thin vein deposits, for example, in unstable host rocks.

The method of rock pressure control by the collapse of overlying rocks is used in the case when rock pressure increases so much that the support collapses not only at a distance from the face, but also directly in the working space. As a result of the collapse, a redistribution of stresses occurs from the face space deep into the massif.

The method of controlling rock pressure by the collapse of the roof of a mined-out space is characterized by relatively low costs and is effective in the development of deposits with medium and lower stability of the enclosing rocks.

However, in recent years, in connection with the development of drilling and blasting technology, forced planting of the roof by massive blasting of wells is also recommended for developing deposits with stable and higher enclosing rocks.

V. CONCLUSION

As a result of the analysis of the main technological processes of mining low-power flat and inclined veins, the following was established:

Efficient and safe mining of such deposits is achieved not only due to high labor productivity, but also due to the completeness and quality of extraction of minerals. The following principles are proposed for constructing a new geotechnology for the development of low-power flat and inclined veins, which provides a significant increase in its efficiency:

- the use of a development system with a continuous notch or chamber-pillar without leaving inter-chamber pillars;
- the use of small diameter boreholes or boreholes in parallel for ore breaking;
- the use of a combined delivery of ore (by the force of an explosion in the developed space, self-propelled LHDs along sublevel workings with ore cleaning with a high-pressure hydraulic washout or vacuum installations);

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- rock pressure management by maintaining the face space with explosion-proof hydraulic props and fully grouted roof bolting, and the worked-out area - by forced collapse of the enclosing rocks or by supporting it with crib timbering or chock-type support;
- the use of rational parameters of structural elements of the chamber-and-pillar development system, determined taking into account mining and geological, mining and technical conditions and the natural stress state;
- ore roughing (in a mine or on the surface) with X-ray radiometric separators or sorting on screens the discarded rock mass prepared with deconcentrated charges.

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