

ANNOTATION

dissertation for the degree of Philosophy Doctor (PhD) in the specialty 6D070700
– "Mining"

Sarybayev Nurzhigit Omarovich

CREATION AND TESTING OF RESOURCE-SAVING TECHNOLOGIES FOR FINALIZING MINING OF DEEP IRON ORE OPEN PIT MINES OF KAZAKHSTAN

Relevance of the topic.

Scientific research on the creation and testing of resource-saving mining technologies aimed at reducing the flattening of pit sides at deep horizons ensuring maximum extraction of near-contour ore reserves and reducing the cost of the process of preparing rocks for excavation, especially when using combined motor-conveyor transport is of great importance due to the decrease in ore production volumes in the zone of completion of mining operations in deep iron ore open pit mines.

The quality of crushing of rock mass is estimated by the diameter of the average rock piece or by the size and value of the prevailing fraction, i.e. by the mode and modal value of the statistical distribution of rock pieces in a given volume.

There is such a granulometric composition of the rock mass for each mining and geological conditions, in which the minimum total costs for the extraction and processing of rock minerals are achieved. However, it is very difficult, almost impossible, to create a universal physical model of the stress field formation in a rock mass that allows determining the degree of its crushing under various methods of drilling and blasting operations in unstable mining and geological conditions. This explains the interest of researchers and practitioners in statistical research methods in applications to real cause-and-effect situations at all stages of the development of mining operations. The control of the fracturing of the rock mass using an automatic device ensures the representativeness of samples, which is the most important condition for compiling a statistical distribution of its natural blockiness. The quantitative assessment of the ability to crush a rock mass according to the comparison of the volumes of substandard fractions contained in it before the explosion and after in the resulting rock mass is characterized by novelty and practical relevance.

The application of the method of optimization of the DAB complex according to the criterion of minimum total costs for the entire cycle of mining operations will increase the technical and economic indicators of these works without additional funds. Therefore, determining the optimal allocation of resources for drilling and blasting operations in various blasting conditions is relevant and significant in perspective.

Purpose of the work is the creation and testing of resource-saving technologies for finalizing mining of deep iron ore open pit mines.

The idea of the work is to establish the possibility of reducing the flattening of the open pit sides in the deep part in the zone of completion of mining operations due to a natural reduction in ore production and an increase in the completeness of extraction

of ore reserves, taking into account the maximum involvement of near-contour ore reserves.

Tasks of the research. In accordance with the purpose of the work, the following tasks that were solved in this work are defined:

1. To develop a methodology for calculating the parameters of completion of mining operations involving near contour ore reserves;
2. To improve the scheme of completion of extraction of deep mineral reserves;
3. To develop a mathematical model for optimizing the process of preparing rocks for excavation during mining of the remaining reserves of the deep zone of open pit mine.

Scientific statements submitted for defense:

1. The completeness of the extraction of ore reserves of steeply falling deposits will be ensured by the developed methodology for optimizing the final and current contours of deep open pit mines based on the introduction of two new parameters: the projection of the contour line of the ore deposit lying sideways on the surface in the final and current position, characterizing the relationship of the contours of the ore deposit and the dynamics of the formation of the working zone of the open pit mine.

2. Leveling the flattening of the sides of deep open pit mines due to the creation of concentration horizons for overloading the rock mass to the crushing and conveyor complex will be provided by a scheme with the elimination of transport pillars in the zone of completion of mining operations through the use of mobile reloading devices without dismantling them.

3. Resource saving in the deep zone of ore open pit mines when optimizing the preparation of rocks for excavation is achieved through comprehensive accounting and minimizing the costs of excavation and loading operations and, if necessary, primary crushing.

The main results of the research and their practical significance:

1. A methodology has been developed for selecting appropriate means of transport for the deep zone of open pit mine, depending on the parameters of completion of mining operations. It was established that during the selection of a means of transport for the completion of mining operations, preference should be given to one that will provide the minimum or permissible cost of mining, its maximum amount of completion, the necessary production capacity.

2. A method has been developed to substantiate the spatial position of the phased contours of steep-slope layers on round-shaped open pit fields based on the differentiation of the concepts of the contour and deep zones of deep open pit mines and the introduction of two new parameters of the relationship between the contours of the ore deposit and the dynamics of the formation of the open pit mine, while the value of the first affects the choice of the appropriate position of the design contours of the open pit mine, and the value of the second changes with the development of mining operations and affects the current position of the contours of the open pit mine.

3. An economic and mathematical model has been compiled, including the target function of the total costs of drilling and blasting, loading and transport operations and mechanical crushing, as well as a system of restrictions that exclude incorrect solutions.

The optimization method allows to control the parameters of drilling and blasting operations at each stage of mining a rocky mineral deposit.

The objects of the study are deep iron ore open pit mines of Kazakhstan and CIS countries.

The subject of the study is the technology of completion of mining operations in deep open pit mines, namely the transport schemes used during the completion and the method of optimization of the DAB in the mining of ore reserves of the deep zone.

Methodological base of research. the following scientific methods were used to solve the problems of the work: system analysis; economic and mathematical modeling; the use of integrated mining and geological information systems; the method of statistical processing of the natural blockiness of rock and the quality of its crushing by explosion energy; statistical studies of the main indicators of the process of mechanical crushing of rock mass of various sizes and strength of its constituent pieces.

Scientific novelty. The scientific novelty of the work is as follows:

1. It was found that the statistical distribution of natural blockiness closely correlates with the gamma distribution based on the proposed option of changing the parameters of the differential function of the accepted gamma distribution in relation to the predicted granulometric composition of the rock mass;

2. The calculation of the parameters of completion of mining operations is carried out by establishing the final and current contours of the open pit mine, depending on the position of the ore deposit, ensuring the completeness of the excavation of ore reserves of the deep zone of an open pit mine;

3. A scheme for completing extraction of deep ore reserves with minimization of the flattening of the pit sides of deep open pit mines is proposed.

Compliance of the work with the directions of development of science or state programs

The work was carried out within the framework of the program-targeted financing project "Modernization of technologies and productions in Mining and Processing of Mining products of the Republic of Kazakhstan", section "Creation of a methodology for designing the process of transition to cyclic and continuous technology (CCT) in deep open pit mines with motor and rail transport".

Publications and testing of the scientific work. In the course of this work, 4 articles were published in the scientific journals "Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu", "E3S Web of Conferences", "Mining of mineral deposits" and "Mining Information and Analytical Bulletin" included in the Scopus database. Within the framework of the international conference International Multidisciplinary Scientific GeoConference SGEM 3 works were presented, within the framework of the international conference "Satpayev readings" 2 works were presented. A chapter in the international monograph "Sustainable development of resource-saving technologies for mining and processing of minerals" was published.

Structure and volume of dissertation: The dissertation consists of an introduction, 4 chapters, a list of references from 45 titles and contains 88 pages of typewritten text, 24 figures, 4 tables, 52 formulas, three appendices.

Conclusion

1. It has been established that the most effective mining and transportation scheme for the mining in conditions of low production capacity is a scheme using a wheel loader as a winning equipment and, partially, a transport. The cost of transporting 1 m³ of ore under this scheme will be 0.56-0.88 USD. It is advisable to give preference to a scheme using a dump bridge and a dumper in combination with motor transport with high productivity of the ore open pit mine. The cost of transportation under this option will be 0.52-1.16 USD/m³.

2. It is determined that dump trucks with a load capacity of up to 90 tons or wheel loaders with a reduction in the width of transport berms by 4 – 7 m should be used as a means of transport of the first link when completing extraction of minerals in the deep zone of the open pit mine. Their reduction will allow involving in mining of an additional volume of minerals of the deep zone of the deposit (up to 5-7%) by increasing the slope angles of the lower zone of the pit sides to 48 – 52 degrees.

3. It was found that the introduction into production of a device for unloading rocks to a storage bunker with a through passage of dump trucks in the conditions of iron ore open pit mines in Kazakhstan will allow to obtain a total economic effect of 30 - 160 million USD when using dump trucks with a load capacity of 136 tons.

4. It was determined that the use of the developed device for transfer of rocks to railway transport will reduce the loading area by 25-30 m, thereby reducing the volume of excavation of overburden rocks to 250-280 thousand m³, allow to rationally use the excavation and loading and transport equipment in one line with a reduction in the loading time of dump trucks and dump formation.

5. The analysis of the schemes for the completion of mining the near contour mineral reserves in the transport pillars allows concluding that at great depths of the mining iron ore seam deposits it is impractical to carry out the flattening of the pit side. In such conditions, a more effective solution is the elimination of transport berms with an increase in the resulting angle of inclination of the pit side and the transition to a cyclic and continuous technology for transporting rock mass.

6. It was proved that the construction of transfer points with a through passage over the bunker on the deep horizons of the open pit mine will reduce the volume of excavation of rocks, which will lead to a reduction in the cost of mining by 10 - 30 million USD. In addition, by reducing the cycle time for unloading dump trucks, diesel fuel consumption will be reduced by 100 - 200 thousand liters/year.