

ANNOTATION

for a dissertation for the degree of Doctor of Philosophy (PhD) – 6D070700
“Mining Engineering”

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JUSTIFICATION OF PARAMETERS AND DEVELOPMENT OF ENERGY- SAVING TECHNOLOGY FOR THE OPERATION OF LOW-POWER ORE BODIES

Assessment of the current state of the solved scientific and technical applied problem. The trend of depletion of mineral reserves leads to the use of new mining methods using machinery and technology and their effective application. At the same time, difficult mining and geological conditions complicate the operating conditions of the equipment and place increased demands on its performance. The need to perform this research work is dictated by the availability of opportunities and the need to increase the efficiency of the drilling machine, by increasing labor productivity, reducing losses and dilution of minerals due to the possibility of drilling parallel and parallel coupled wells to create a cut-in cavity.

Currently, underground mines, as a rule, mine low-capacity ore deposits with different angles of incidence using various mining systems. In addition, it is known that with the deepening of mining operations, the capacities of ore bodies decrease, along with this, the metal content in the ore decreases. In modern conditions, there are mines in the Republic of Kazakhstan, for example, the Akbakai mine, which is a vein deposit, but despite this, the mine has completely switched to working out veins with an underground mining system with ore extraction by fan or parallel wells. This makes it possible to increase the productivity of ore extraction several times compared with the use of portable equipment. Thus, the use of high-performance machinery and technologies leads to the intensification of production in a fundamental way. At the same time, when using high-performance equipment in difficult mining and geological conditions, for example, steeply falling ore bodies with low power, it is necessary not only to increase productivity, but also to reduce losses and dilution of ore. It is known that the lower the capacity of ore bodies, the greater the loss and dilution of ore.

When working off low-power steeply falling ore bodies, several increased requirements are imposed simultaneously, consisting in the fact that, on the one hand, well drilling should be carried out in such a way as to eliminate losses and dilution, and on the other hand, the parameters of the borehole breakout should meet the requirements for breaking low-power ore bodies.

In this regard, carrying out theoretical and experimental studies on the development of a new energy-saving technology for the operation of low-power ore

bodies using a drilling rig with an expansion of their diameter, which ensures increased productivity and safety of miners, is an urgent scientific and practical task.

The purpose of the dissertation - increasing the efficiency of developing thin ore deposits by creating and substantiating the parameters of energy-saving technology and means of conducting mining operations.

The main idea - consists of the development and scientific substantiation of a new set of technical and technological solutions for the efficient development of thin ore deposits.

Research objectives:

1. Analysis of technologies and systems for developing thin ore deposits with borehole breaking;

2. Justification of borehole breaking parameters that ensure complete extraction of minerals;

3. Development and justification of parameters for creating cut cavities when driving raise workings with expansion of the diameter of boreholes located in different parts of it.

4. Creation of an energy-saving technology for developing steeply dipping ore deposits with blasting of hanging wall rocks by separating a single blast of boreholes.

Research methods. The main research method is an integrated approach to identifying and assessing the state of technology for the operation of low-power underground ore deposits of mineral deposits, including: theoretical analysis and generalization of well-known methodologies and methods for evaluating the effectiveness of drilling wells with submersible pneumatic hammers used in industrial conditions, taking into account current regulatory documentation; experimental and theoretical justification for the application of the criterion of volumetric destruction of rocks, taking into account comparative tests of submersible airstrikes; testing at mines of the developed methodology for evaluating the energy efficiency of the well drilling process with submersible pneumatic hammers, taking into account the physical and mechanical properties of rocks. Modern Microsoft Excel and MATLAB application software packages were used as modeling tools.

Scientific provisions submitted for protection:

1. Determination of the lines of least resistance and parameters when drilling blastholes with expansion of their diameter sections at the bottom and along the length, ensuring complete extraction of minerals.

2. A new method for creating a cutting cavity when driving raise workings differs from existing ones by the use of narrow cracks and drilling parallel conjugate holes, which allows for a significant reduction in the volume of drilling operations.

3. Higher rates of crushing and grinding of rocks when developing thin ore bodies can be ensured by implementing the developed improved method of

separating a single blast (SBS), in which charges in a long borehole with an expansion of the diameter of the divided into two parts are blasted with two different time delays, long enough to avoid overlapping of stress waves from both parts, while the amount of explosive at each moment of the delay can be reduced.

The main results of the study:

1. A method for assessing the energy efficiency of drilling wells with the expansion of their diameter sections has been developed based on the determination of the lines of least resistance, considering the minimum energy intensity of rock destruction.

2. The parameters of a new method for creating a cutting cavity during the exploitation of thin steeply dipping ore deposits using a special device for drilling parallel conjugate wells have been scientifically substantiated.

3. The single blast separation method (SBS) has a great advantage, in addition to safety and a higher degree of extraction. This method has shown that with SBS, a finer fractional composition of the rock mass is obtained compared to the standard blasting method. This advantage lies in the fact that fans with SBS have a higher degree of extraction due to a larger number of partially free areas, as well as a higher concentration of energy stress in their upper parts. Such a high swelling coefficient leads to lower dilution.

Scientific novelty consists in:

- development of the method of establishing the parameters of drilling and blasting operations when drilling an array of dispersed fans with a special device with an expander, taking into account the dependence of the size of the expanded sections of the cavities of borehole charges, which allows to significantly reduce the volume of drilling.

- determination of the values of the speeds of displacement of the medium under the influence of compressive dynamic stresses for each pair of borehole charges in the fan, when establishing the parameters and volumes of the expanded sections of the cavities of blast holes;

- development of a method for making a cutting cavity and drilling parallel conjugate holes with a special device that ensures the passage of cut-off and other raises in one blast from 15 to 30 m. both from the bottom up and from the top down;

- in increasing the percentage of ore extraction and reducing lumpiness, this allows to significantly reduce operating costs not only for loading and delivery equipment, but also for crushing and sorting operations.

Practical value:

- Methods for recording parameters of the drilling process in production conditions have been developed, based on frequency-amplitude analysis of acoustic signals generated during machine operation, allowing to evaluate the energy efficiency of rock destruction;

- A method for evaluating the energy efficiency of drilling wells with downhole pneumatic hammers with expansion of their diameter in production conditions has been developed, allowing to select drilling modes with minimal energy intensity of rock destruction and wear of the drilling tool;

- An improved system of blasting fan holes during the development of thin ore deposits has been developed by separating single blasts to increase the percentage of ore extraction and reduce lumpiness.

- A method for technical and economic assessment of the proposed methods for developing underground steeply dipping thin ore deposits has been substantiated;

Approbation of the work. The work was carried out within the framework of program-targeted financing of the Ministry of Education and Science of the Republic of Kazakhstan under the PCF programs:

1. BR21881939 - "Development of resource-saving energy-generating technologies for the mining and metallurgical complex and the creation of an innovation-engineering center" using the software of the laboratory of digital, computer modeling of technologies for extracting ores from complex structural blocks of the Innovative Engineering Center for Energy-Generating Technologies for the Mining and Metallurgical Complex at Satpayev University.

2. BR05236712-OT-20 - Technological modernization of mining industries based on the transition to the digital economy. Branch of the Republican State Enterprise on the right of economic management "National Center for Integrated Processing of Mineral Raw Materials of the Republic of Kazakhstan" of the Committee for Industrial Development and Industrial Safety of the Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan "D.A.Kunaev Institute of Mining" 01.01.2018.

3. 5AP09260303 - The creation of highly adaptive and safe technologies for the reworking of targets in sloping and inclined panels and areas of man-made collapses. Branch of the Republican State Enterprise on the right of economic management "National Center for Integrated Processing of Mineral Raw Materials of the Republic of Kazakhstan" of the Committee for Industrial Development and Industrial Safety of the Ministry of Industry and Infrastructural Development of the Republic of Kazakhstan "D.A.Kunaev Institute of Mining" 2021-2023.

4. AP14870938 - Development of new safe technologies for the re-mining of stratified ore deposits by underground method. Branch of the Republican State Enterprise on the right of economic management "National Center for Integrated Processing of Mineral Raw Materials of the Republic of Kazakhstan" of the Committee for Industrial Development and Industrial Safety of the Ministry of Industry and Infrastructural Development of the Republic of Kazakhstan "D.A.Kunaev Institute of Mining" 2022-2024. Competition for grant funding for scientific and (or) scientific and technical projects for 2022-2024 (MES RK).

Publications. Based on the materials of the dissertation, 14 publications were published, of which three were published in publications included in the Scopus database with a percentile of 41, 18 and 18, respectively, three articles in publications recommended by the Committee for Control in the Field of Science and Higher Education of the Republic of Kazakhstan. The main provisions and research results of the dissertation were reported and approved at 7 international scientific and practical conferences. In addition, as part of the work, patent research was conducted and one patent for an invention and one for a utility model were obtained.