ABSTRACT

of the dissertation for the degree of Doctor of Philosophy PhD
in the specialty 6D070700 – "Mining"
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«INVESTIGATION AND SUBSTANTIATION OF THE PARAMETERS OF THE TECHNOLOGY FOR THE DEVELOPMENT OF SOLID MINERALS USING DESIGN SCHEMES AND CONTROL SYSTEM OF THE ROTARY ASSEMBLY OF THE SCRAPER CONVEYOR»

The thematic justification of the research. The mining industry of the Republic of Kazakhstan has skillfully overcome organizational and technological problems over the years. Reserves lying in complex hard-to-recover areas of solid mineral deposits (coal, potash salts, valuable ores) make up at least 30% of the total, and off-balance reserves, for example coal, make up more than 50%, but there are no effective technologies for their development. To develop such reserves, technological systems of short-hole excavation based on chamber and short lavas capable of bypassing geological disturbances will be developed.

The disadvantage of such systems is the lack of rotary conveyors capable of changing the direction of transportation by an angle of up to 90 degrees. The analysis of solutions with rotary conveyors shows their high efficiency in modern conditions and at the same time the insufficiency and the need to improve technical and technological solutions. With such technologies, the architecture of the workings at the face changes significantly. There are features of the manifestation of rock pressure and the stability of workings. Therefore, along with the constructive modeling of the features of the movement of the traction body and the stave of the rotary assembly of the conveyor, it is necessary to develop a simulation model of the interaction of the formation- lateral rocks-support system, as well as an assessment of the effectiveness of the schemes being developed.

The issues of interaction of mechanized supports with lateral rocks require improvement in taking into account the factors of disintegration of the formation, taking into account the features of displacement and collapse of the roof, taking into account the length of the face and especially for chamber excavation.

The goal of this research. Research and substantiation of the parameters of the chamber short-hole technology and the rotary assembly of the scraper conveyor, which will ensure an increase in the efficiency and safety of the mineral extraction process in difficult mining and geological conditions.

Research objectives:

- analysis of the technology and design features of the development of minerals occurring in complex geological conditions;
- influence of formation and rock disturbance on working conditions;

- development of basic design schemes for the interaction of the formation, rocks and supports for technologies of short-hole (chamber) excavation.

The idea of the work is to substantiate the parameters of rock stability during short-hole chamber excavation using a rotary conveyor based on finite element modeling.

The object of research is a technology with a rotary conveyor.

The following methods were used in carrying out research and scientific and technical work:

- system analysis of technological schemes of excavation, and features of production operations at the interface, fastening means and features of modeling and calculating the formation of rock pressure, features of the impact of violations and their structure on the operation of the faces;
- linearization of equilibrium equations and finite element technologies in Adams and mechanical APDL (Ansys) packages, taking into account the features of displacement and collapse of rocks, formation disintegration and block structure of chamber face simulation models with the division of the support into downhole and stationary-portable;
- experimental and bench studies using modern recording equipment: hydro sensors, an oscilloscope, load devices and elements simulating the movement of a conveyor for combines taking out a camera with a video recording of the procedures under study with a changing architecture of workings.

The main provisions submitted for protection:

- regularities of the stress-strain state have been established for various collapse schemes, including gradual cantilever collapse, smooth closure of rocks up to the earth's surface over layers of collapsing immediate and main roofs, and during vaulting;
- the developed technological schemes of short-hole, chamber excavation in conditions of difficult-lying areas can significantly reduce the volume of installation and dismantling work;
- the use of 3D modeling in conditions of a short-face excavation allows you to simulate emergency situations in the treatment face and, in particular, discontinuous violations due to the creation of extended cavities in the area of the violation and changes in the physicomechanical properties of it, as well as to simulate the influence of rigid or malleable targets of different widths from the sides of the chamber, take into account the abnormal differentiation of the resistance of hydraulic pillars, and changing architecture of workings.
- the position of the rotary conveyor when moving into the chamber, when using the specified technology of turning at an angle of up to 90 degrees, takes an unambiguous position corresponding to the calculation in the development and chamber.

Scientific novelty

Development and substantiation of interaction schemes of downhole and stationary transfer support, taking into account the peculiarities of the displacement and collapse of the roof with cantilever collapse, smooth closing of layers to the ground surface and arching, for short-hole technologies using a rotary conveyor;

Development of a technique for simulating the calculation of the stress-strain state in a chamber, short-hole excavation in 3D, taking into account the schemes of disintegration of the formation, changes in the architecture of the workings during the block construction of the model structure;

Methodology and creation of a theoretical and simulation model, conducting experimental studies of turning a rotary conveyor into a chamber when pulling behind a tunneling combine.

Development of technological schemes at the entrance to the chamber, circumvention of violations, analysis of their prediction using theoretical calculation, experimental studies, simulation modeling based on the Adams dynamic analysis package.

The personal contribution of the applicant consists in direct participation at all stages of the process: independently designated scientific task and the search for methods of solving research problems, in direct participation in the receipt, processing, statistical analysis of the data obtained, in the development, implementation and testing of research results, as well as in the preparation of major scientific publications on the work performed in co-authorship.

Practical effect of the research. The developed methods and programs of simulation modeling, methods of theoretical calculation and bench tests of the rotary conveyor, taken into account in the task for the development of the stand – scraper rotary conveyor in full-size design with asynchronous motor and hydraulic drive of the tensioner, which is the basis for the creation of a prototype, for chamber excavation, as well as for the transportation of materials along curved workings.

Based on the results of the conducted research and constructive development of the technology of short-face excavation, three Eurasian patents for the invention were obtained, a conveyor stand was developed, manufactured and tested to create pilot industrial rotary conveyors with a 90o turn starting from any zone of the stave in both directions from its axis.

Technological schemes of short-cut, chamber excavation for mining of hard-lying layers of solid minerals have been developed, methodological foundations for calculating the economic efficiency of technologies have been created, tested on one of the schemes, while the payback period was less than 1 year.

The results of the conducted research are also used in the educational process for disciplines related to the design of technological machines and, in particular, for bachelor's degree disciplines: "Design and construction of mining machines", master's degree disciplines "Special computer course. Modern application programs for modeling mining equipment", "Tools and systems for simulation of mining equipment".

The validity and reliability of scientific statements, conclusions and recommendations is determined by the application of methods of sequential accounting of new elements in model and experimental studies with a wide visualization of their use in the application of proven and tested modern recording equipment, discussion of existing problems at scientific and practical seminars and the use of modeling packages that have already proven their capabilities as systems accelerating the introduction into industrial production with the publication the results of peer-reviewed journals and obtaining Eurasian patents.

The coincidence of the obtained research data with the results of bench and factory tests, as well as the achievement of the planned parameters of simulation modeling and its analysis with the results of the analysis of mine observations and interpretation of their results in model experiments, as well as the operability and achievement of the design parameters of the stand conveyor when simulating the process of turning and stretching it into the chamber.

Compliance with the directions of science development or state programs

The topic of the dissertation corresponds to the direction of the implementation of the Message of the President of the Republic of Kazakhstan "The third modernization of Kazakhstan: global competitiveness", the development of reserves that are currently being written off as economically impractical, through the use of chamber, short-hole technology of coal extraction.

During the dissertation part of the research work was carried out at the Department of "Development of mineral deposits" of Karaganda Technical University named after Abylkas Saginov.

Approbation of the work.

The content of the work was reported at international conferences and seminars:

1. O S Reshetnikova, Z N Nokina, I V Teliman and D K Asmagambet New technologies of mining stratal minerals and their computation. IOP Conference Series: Materials Science and Engineering

2. Nokina Zh.N. Beisembayev K.M. Model of rotary conveyor movement (Saginovsky readings No. 14) June 16 -17, 2022 pp. 232 – 234

3. Beisembayev K.M., Mendikenov K.K., Nokina Zh.N., Akizhanova Zh. T. Improving the excavation of rock layers using rotary conveyors Collection of Works XV Inter. Science-tech. Conf. "Readings in memory of V.R. Kubachek" Technological equipment for mining and oil and gas industry, April 12-13, 2018. Yekaterinburg, Russia, pp.24-27

4. Beisembayev K.M., Yurchenko V.V., Nokina Zh.N., Makukhin O.S., Lapushkin A.A. Feedback and identification of mining processes. In the collection of Technological equipment for the mining and oil and gas industry. Proceedings of the XVIII International Scientific and Technical Conference "Readings in memory of V. R. Kubachek", held within the framework of the Ural Mining Decade. Yekaterinburg, 2020. pp. 231-234.

The scope and structure of the work. This dissertation work consists of the following parts - introduction, 5 main sections, conclusion, list of sources used and 5 appendices. The dissertation is presented on 149 pages of typewritten text, contains 34 figures, 14 tables and a list of references consisting of 95 titles.