ABSTRACT

Dissertations for the degree of Doctor of Philosophy PhD in the specialty: 6D070700 «Mining»

KAINAZAROVA AINASH

Development of technology, systems and facilities of active fastening of the mountain making taking into account the tensely deformed state of array of marginal breeds

The relevance of research Stable growth in the volume of underground coal mining is possible only with the use of effective and safe technology for conducting and maintaining operational workings.

Currently, more than 65% of all mine workings in the Karaganda coal basin are anchored, which makes it possible to expand the technological capabilities of underground coal mining.

The anchor system of fastening the coal-rock massif limits deformations and allows horizontal stress to hold the roof in place without its destruction. If the height of the stratified rock is below the anchoring level, the condition of the workings will be satisfactory, ensuring the stress of the rock unchanged. If the height of the stratified rock in the roof is higher than the first level of the anchorage of the workings, an increase in tension before the face will cause the roof to collapse. To maintain production, installation of longer anchors of the second level will be required. When used in practice, aimless development systems with direct-flow ventilation schemes, it is advisable to use the reuse of workings.

The improvement of anchor fastening technology, the expansion of the field of application of anchor fasteners is a priority in the mining industry, which allows to increase the stability of workings at high rates of carrying out and reducing the cost of their fastening.

The reuse of workings ensures a reduction in the volume of their implementation by almost two times, which until now are usually fastened with metal-welding malleable and organ-supporting fasteners, which is associated with high costs for their construction and does not guarantee their satisfactory maintenance. At the same time, there are problems with strengthening of the contour array with anchoring and injection of resins under pressure into the host rocks weakened by cracks with stabilization of the production contour.

In order to increase the effectiveness of strong fastening of the rock mass around the workings, targeted geotechnological impact on stressed and deformed zones with active manifestations of pressure around the workings based on the results of modeling of the system «Array of enclosing rocks – contour support» is necessary for its strengthening.

Therefore, one of the important scientific and applied research in the coal mining industry is the application of hardening technology using anchoring and stabilizing synthetic resins in weak enclosing rocks around artificial mountain

cavities supported behind the lava on the border with the developed space, taking into account the technogenic state of the adjacent rocks of the mountain range.

Objects of research these are underground mine workings of coal mines supported behind the front of the treatment works on the border with the collapsed rocks of the worked-out space.

The purpose of the work development of technology, systems and means of active fastening of mine workings behind the lava on the border with the worked-out space, taking into account the stress-strain state of the contiguous rocks, with justification of their optimal parameters depending on mining operating conditions.

The idea of the work It consists in the fact that, based on the assessment of the stress-strain state of the contiguous rock mass, a technology has been developed for consolidating, integrated into the array fastening system based on two-level anchor and injection hardening of the fractured contour around the workings supported behind the treatment face.

Methodology of work:

- monitoring of the state of the mining workings of the coal mines of the Sherubai-Nurinsky coal-bearing section of the Karaganda coal basin;

- carrying out mathematical modeling of the technogenic state of near-contour rocks;

- pilot testing of the developed technological solutions in mine conditions.

To achieve this goal it was necessary to solve the following. research objectives:

- to analyze the current state of the applied technological schemes for conducting and maintaining mining operations;

- to evaluate the use of anchoring technology of the contour array and resin injection for fixing and stabilizing unstable host rocks;

–to identify the patterns of formation of zones of inelastic deformations in the vicinity of the contours of workings based on mathematical modeling, depending on the mining and geological and mining technical operating conditions in the system "enclosing rocks - the contour of preparatory workings";

– to develop progressive technological schemes for anchoring and stabilizing the array with resins during the conduct and maintenance of mining operations with the creation of an effective and safe technology for fixing weakened rocks with low strength parameters;

- to test the developed technologies for stabilizing the host rocks around the workings in experimental industrial conditions for coal mines;

- to consolidate the intellectual property right;

- to conduct a feasibility study of the proposed technical solutions with the definition of the scope of technological and technical developments.

Scientific novelty:

- the relationship between the anchors of the second level fixed in strong roof rocks to increase the strength of the contiguous roofing rocks above the workings supported in the zone of increased reference pressure behind the treatment face, with a decrease in the load on the anchorage of the first level, is established;

– the regularities of the formation of zones of inelastic deformations in the vicinity of reused workings behind the lava are substantiated, depending on the physical and mechanical characteristics of the rocks and the position relative to the front of the advance of the cleaning work;

– the stress-strain state in the contour array was determined when attaching reusable preparatory workings with a two-level anchorage.

Practical significance The work consists in substantiating the parameters of a method for controlling the stress-strain state of a near-contour rock mass using two-level anchor and edged supports that reduce the convergence of the contours of the preparatory workings of coal mines while maintaining them behind the treatment face.

Comparison of the obtained analytical data with the results of mine observations allowed us to establish:

- the section of the preparatory workings behind the lava decreases and is – 9.8 - 10 m2, or 60-64% of the original (15.5 m2);

- deformations of roof rocks are limited– 0.3 - 0.4 m, which indicates the formation of a bridge-shaped anchored rock beam from siltstone-mudstone layers of the immediate roof;

- with the convergence of lateral rocks, the reference pressure zone in front of the lava extends to 100 - 120 m, behind the treatment face to 70 - 120 m, which determines the need for preventive reinforcement of the support of the preparatory work in these zones.

Participation in research and grant financing. as an executor:

– Research on the topic: No. AR05135535 "Development of contour technology for fixing workings with the management of the technogenic state of the coal-rock massif of the host rocks", grant funding of scientific research of the Ministry of Education and Science of the Republic of Kazakhstan for 2018 - 2020;

– Research on the topic: "No. AR05135203 "Development of intelligent information systems for calculating technological parameters of processes mining production", grant financing of scientific research of the Ministry of Education and Science of the Republic of Kazakhstan for 2018 - 2020.;

– Research and OCD on the topic: "Development and implementation of technology, systems and means of active fastening of mine workings taking into account the stress-strain state of the array of contiguous rocks", program-targeted financing of scientific research for 2018 - 2020, household. contract with KazNITU named after K. Satpayev.

The main scientific provisions put out for protection:

– an increase in the filling of wells in the interval of fixing workings with reinforcing two-level anchorage in the range from 40 to 100% leads to an increase in the bearing capacity of deformed rocks fixed with anchor rods by 50-85%, ensuring a reduction in roof displacements, respectively, no more than 200 - 100 mm;

– geomechanical model of fixing unstable rocks of the roof of a contiguous mountain massif with the creation of zones of hardened rocks with the formation of a reinforcing bridge of connecting bridge-forming rods of the first level and deep

anchors for attaching the arch of unstable rocks to strong;

- - the increase in the size of the stratification zone in the host rocks is subject to a logarithmic dependence with an increase in the level of the operating rock pressure, and more with a single-level than with a two-level fastening of the workings.

Scientific significance of the work consists in:

- establishment of parameters of deformation processes affecting the stability of workings fixed with anchorage.

– determination of the regularities of the development of the sizes of deformation zones and stresses around the workings, depending on the geological and technological parameters in the zone of reference rock pressure and with one- and two-level fastening.

The practical significance of the work it consists in the fact that according to the results of experimental research, analytical modeling and implementation work:

- progressive innovative solutions have been formed (at the level of patents of the Republic of Kazakhstan) on the constructive, technological and technical and economic characteristics of fixing workings to increase the pace of their implementation and sustainability;

- means of active fastening of mine workings and progressive technological solutions for their layout have been developed;

- an effective multi-level technology of anchor fastening of preparatory workings for various mining and technological operating conditions with a combined scheme of two-level fastening for complex mining conditions of development with full filling of the well with a fixing compound has been created;

- results have been achieved to reduce the defectiveness of maintaining the workings supported behind the lava.

Practical value the work consists of:

- the development of advanced technological solutions for the implementation of the technology of anchoring workings and tarification of the disturbed mountain massif to ensure efficient and safe operation of preparatory workings;

- determining the technical and economic efficiency of technological solutions,

- production of pilot-industrial batches of systems and means of fastening with their testing in production conditions.

Implementation of the work Recommendations have been developed on the use of anchor fastening technology during preparatory workings in areas of high and reference rock pressure and the use of resins to stabilize the disturbed rock mass at the interfaces of the treatment faces of coal mines.

The technology of fixing workings with deep anchors is included in the Abayskaya mine development project, carried out by the institute of Karagandagiproshakht LLP and implemented at the mine. According to the results of the implementation of scientific and applied works on grant financing from the KN of the Ministry of Education and Science of the Republic of Kazakhstan,: The act of introduction of technological developments at the Abayskaya mine, the act of introduction into the educational process of KarSTU in the disciplines of the

specialty «Mining» (bachelor's, master's, doctoral studies) and the Protocol of intentions of introduction into the production of the Abayskaya mine of the ArcelorMittal Temirtau JSC.

Personal contribution of the dissertation It consists in the development of technology and means of multi-level fastening of a contiguous mountain massif on the basis of scientific and applied research to establish parameters and implement technology with anchoring behind the lava on the border with the developed space.

The validity and reliability of scientific statements, conclusions and recommendations are confirmed by: similar results of theoretical studies and experimental tests.

The structure of the work: the dissertation consists of an introduction, 6 sections, a conclusion and contains 150 pages of text, 102 figures, 8 tables, a list of references from 79 titles.

Implementation and approbation of the dissertation. The research results have been published and implemented in 17 scientific papers: 3 articles based on Scopus, 3 articles based COMMITTEE FOR QUALITY ASSURANCE OF EDUCATION AND SCIENCE OF MES RK, 3 abstracts of scientific conferences, 6 patents of the Republic of Kazakhstan, 2 SIS and the act of introduction into the educational process, intentions of implementation into production, acts on the implementation of research results.

The doctoral student thanks the scientific consultants for their recommendations and assistance in conducting experiments and completing the stages of the dissertation, as well as the teaching staff of the RMPI Department of the Abylkas Saginov Karaganda Technical University NPJSC and the engineering and technical staff of the ArcelorMittal Temirtau JSC for assistance in carrying out experimental and research work.