

STUDYING THE METHOD OF MINING OF HIGHWALL MINING SYSTEMS (HMS)

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ABSTRACT

The so-called "Highwall Mining Systems" have been effectively applied for the last 10-15 years in coal mining practice in USA, Australia and the RSA. In general, those are systems of underground coal mining with mine entries directly communicating to the surface. However, they are almost unfamiliar under the above-mentioned name to a wide range of mining professionals and they have not been described in Bulgarian mining references yet. A comprehensive study of those methods of mining, technical and technological analysis allowed the presentation of the mining method and technology, technical and technological feasibility and requirements for effective application.

INTRODUCTION

Methods of mining with mine entries, directly communicating to the surface were applied in the early stages of development of mining. Later, with the improve of technologies in mining, an extension of the field of application of opencast mining took place, mining operations went into the depth and those methods were forgotten.

Those methods were rediscovered 10–15 years ago. That was based on the extension of the application of opencast mining operations in wide areas and in depth, of modern devices for mechanization and automation, including means for positioning and control. One of the important preconditions for rediscovery of that method of mining was the coal mining practice in USA and Australia.

Mining operations are re-considered, when effective economic boundaries of the opencast mine are achieved and coal or other soft minerals are still available out of them. As a result opencast mining may be ceased, extended to new effective boundaries or transferred to underground mining.

The so-called "contour mining system" is applied in the mining practice of USA, Australia and the RSA. That means opencast development to certain final contours of the mine), and when the final contour is achieved, mining operations are ceased. Sometimes, systems and technologies for limited underground mining are applied. The underground mining is performed through mine entries directly communicating to the surface, and the main equipment is based on benches on the surface. That mining method is familiar in the mining science and practice of the USA, Australia and the RSA with the collective name of Highwall Mining. The system is based on an integrated mechanized technology, which is realized by a completed set of mining machines and devices.

Mutual interrelation and dependency of the system decisions (parameters of the mining method), parameters and feasibility of the integrated mining equipment, technology and

organization of work in the recent practice is so strong that the common title of system and technology – Highwall Mining System (HMS) is quite popular.

MOST IMPORTANT FEATURES OF THE METHOD OF MINING

In general, the HMS is based on a working area (bench), where the coal seam opens, above the lower edge of the site (bench) and the stable bord, and the height is great (highwall). That site may be bench or ditch with a certain width and length.

The most important feature of the system consists in driving of a grid of mine entries with a direct connection to the bench, to the surface. The mine entries are blind, with different shape and dimensions of the cross-section. They are different orientation to the spread and dip of the seam. They are driven in a certain specific order and consecution, without any support during the driving and during the leaving. Technological stability of mine entry and roof control in the mined-out room are guaranteed by narrow bench ribs between entries. Main parameters of the mining method are: type and direction of mine entry; type and dimensions of cross-section, length of the entry; width of the narrow rib and dimensions of the operating area in length and width. Without reading the opportunities for creating different variants of the system, with respect its parameters, the qualitative variants of that method of mining are based on the type and direction of the blind entry. For example – adits along the line of spreading at different levels, adits at one and the same level, mining inclined shafts along the dip, along the rise or in a diagonal. In those variants, some of the parameters of the method of mining are determined by the specific natural conditions (thickness, inclination), others on the opportunities of mining equipment and a third one on the condition of opencast mining works during the final period.

MINING TECHNOLOGY

The mining technology of that method of mining consists of a mechanized mining complex. The complex equipment provides the drive of entries without the constant presence of people at the stope.

In general, the mining equipment consists of self-advancing controlled platform, cutter head, push-beam transfer system and a number of service devices, which generally form the mining complex.

The technological scheme of operation of the complex is as follows: the main platform is positioned on the operating site and is directed against the spot of the entrance of future mine entry; advance of the cutter head starts, which inserts into the massif and forms the initial cross-section of the entry; further driving of the entry is performed by pushing or dragging of the cyclically elongated pusher by the push-beam mechanism. When final length of the entry is achieved, the operation of the cutter head is ceased and it is pushed backward by shortening of the push-beam transfer mechanism. After getting out of the cutter head, the controlled platform, on its own drive, moves to a new position.

Parameters of the mining system, technology of work are based on specific mining conditions and final technical-economical results of mining are achieved for a specific scheme of organization.

A INVESTGATION ON HMS SYSTEMS AND TECHNOLOGIES

An investigation on web sites and publications related to HMS reveals that almost all of the information aims an advertisement. There are very few publications (Fiscor, St., Coal Age, 2002) showing the history, analysis, assessment and results of a specific practical application.

An investigation aiming a study of the opportunities for practical application of HMS in Bulgarian coal mines was carried out. (Dermendjiev, K., A, Slavov, 2003). It comprised the variants: Superior Highwall Miner (SHM); Nex Gen HMS (NHMS); Addcar HMS (AHMS); Racho HMS (RHMS) and Racho variants Racho Narrow Bench Mining System (RNBMS); Racho Skip Car System (RSCS) and Racho Conveyor System (RCS).

Results of the investigation showed that HMS have been known in the USA for long and that many variants and performances are familiar. Variants of HMS differ, depending on the completed set and dimensions of the controlled platform, type and the principle of operation of the cutter head, the push-beam transfer system, the auxiliary equipment of the powered support and control, loading and discharge mechanisms. Those differences bring to differences in the type, configuration and parameters of the entries, the order and consecution of mining, extraction and losses.

The analysis of technical and technological opportunities of the above HMS variants and mining conditions in some of

the opencast coal mines in Bulgaria showed that the system Superior Highwall Miner may be applied. The selection of that system as a basis for assessing its feasibility and requirements for effective use are to a certain extent due to the more detailed information, which is available about it (Fiscor St., 2002).

The complex mining equipment of the SHM system, fig. 1 consists of a self-moving crawler platform. The four crawlers have their own driving systems and autonomous control. The control centre, the cable idler, the hydraulic pushing-beam mechanism, the transporting system for reloading and discharge of the mining mass are mounted on the platform..

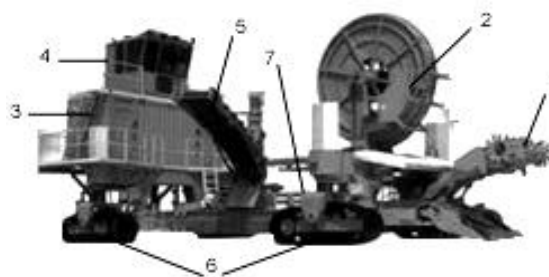


Figure 1. General view of a mining complex SHM-20
1. Cutter head; 2. Cable idler; 3. Power head; 4. Machine control centre; 5. Rear-discharge units; 6. Crawlers; 7. Push-beam transfer mechanism

The most important element of the complex is the cutter head, fig. 2. It represents a modified miner for narrow room stopes, the so-called "continuous miner" with a self-drive. It has a separate drive and individual hydraulic drive systems. The connection of the cutter head to the platform in the working move and maneuvering and transportation of mine mining mass is performed through engaging and disengaging two-auger panels of 6 m length. Two motors of 300kW each, positioned on the platform, drive the auger transportation system. That system may transport coal to a distance of 300 m.

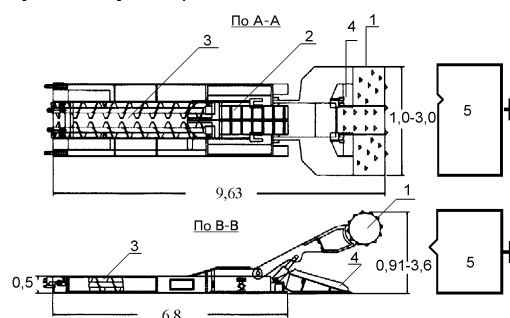


Figure 2. Cutter head: 1 – working instrument (cutter bit); 2 – short transporter; 3 – auger panel, 4 – loading device; 5 – mining room

The system is designed for mining of horizontal and slightly sloping seams of a slope not more than 12° and thickness from 0,91 to 3,6 m.

The simplified scheme of the method of mining, positioning of the mine equipment in the layout and in the cross-section is shown in fig. 3.

A detailed study and investigation is performed with the aim of assessing feasibility of the system and SHM mining technology and conditions for effective use.

The main parameters of the method of mining, parameters of main processes and final technical and economical characteristics of method of mining and mining technology are deter-

mined on the basis of variation of the values of a wide range of parameters, characterizing the geological, mining and technical conditions of operation.

The following parameters: strength of uni-axial pressure of the massif and the coal seam, shearing strength of the seam, depth of occurrence of the seam beyond the contour of the high bord, seam thickness are a subject of variation.

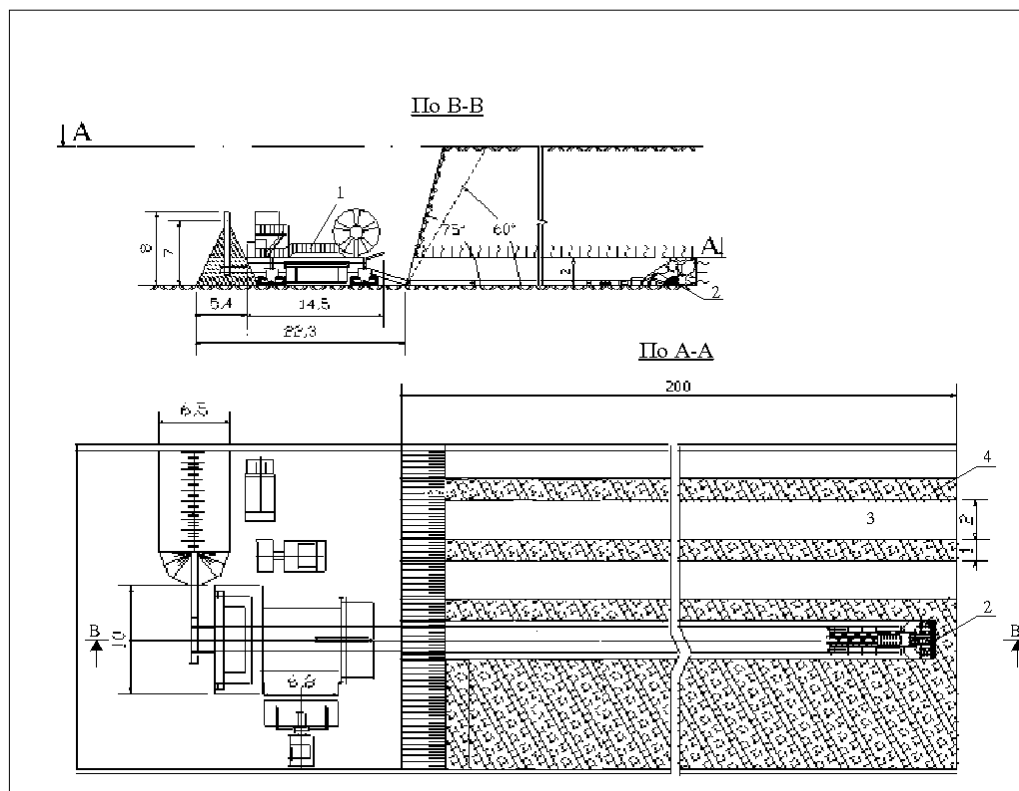


Figure 3. Scheme of system and technology Rectangular-shaped entries (rooms); 4 – narrow bench (rib)

The following are determined with the aim of analysis and synthesis of effective decisions for the method of mining and mining technology: ratio of width of the mining entry (room) and the narrow rib for different strengths of uni-axial pressure and depth of mining; working speed of advancing of the cutter head depending on the shearing strength, duration of working cycle. Those values allow the synthesis of a multitude of variants and feasibility characteristics. The rate of extraction of reserves and productivity of the complex are applied for basic parameters for evaluating and selection of decisions.

Approximate values of some of the economical parameters are determined in the final stage of the investigation. Those parameters are used for final decision-making. Various organizational schemes of operation are used to determine those values, shift and day-time loading of the mining complex, price of coal and equipment, effect of financial and conditions of work.

Results of the investigation showed that effective application of HMS and the SHM system, in particular, require a

comparatively high strength and stability of the rock mass. When reserves of depth not more than 200 m are mined and stability of entries is guaranteed and gob area has the ratio of entry (room) width – rib – 1:1, the strength of uni-axial pressure of the coal seam should not be less than 20 MPa.

The economic efficiency of the system may be achieved, when the coefficient of extraction is not less than 50%; the average shift loading of the complex is more than 1000 t/d, and quantity of mined coal is not less than 1,5 million tones, when mining by a SHM is applied.

CONCLUSION

The Highwall Mining Systems belongs to the methods of mining with entries directly communicating to the surface. In the mining practice they are applied as different variants, under the title of mining technology, performed with different machines, combined in a system (complex). HSM and "SHM", in particular, is a very effective system and technology for underground coal mining. It allows a gradual transition of

opencast toward underground mining and more complete extraction of the natural resource through extension of boundaries of extractable reserves in the area and in depth. The application of those technologies is limited by the strength and strain properties of the rock mass and due to the strata control of mine entries and gob area. For that reason effective application of those systems and technologies in some of the opencast mines in Bulgaria will not be possible.

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