IMPROVED MECHANISED EXTRACTION TECHNOLOGIES IN UNDERGROUND HARDCOAL MINES FROM JIUL VALLEY-ROMANIA

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1. ABSTRACT

The paper deals with the analysis of the technical, economical and geological-mining issues of the top coal technology, widely used in Jiul Valley coal mines, in order to justify the mechanization of this technology. Because the difficult and highly variable and diverse geological-mining conditions in the Jiul Valley coalfield, various mechanization schemes could be applied, which are presented and discussed in the paper.

The Top coal caving method has been used since 20 years in the Jiul Valley hard coal basin. Due to difficult tectonics and geology, the classical- drill blast and individual support variant has been used. This experience allowed identifying features of technology and equipment to be used in different seam thickness and slope combinations, in order to obtain better output rates, productivity and work safety.

From these findings, it was concluded that they are blocks where only the classical method can be used, other ones where a light partial mechanization is appropriate, and many others suitable for full mechanization. For each of these three technologies, the existing equipment has been improved, or devised, or even prototyped. The accurate design process is presented in the paper connected to the final shape of the equipment and face arrangements.

The paper is a good source of technical learning for practitioners and equipment suppliers, the further experiments will indicate the correctness of the assumptions. The aim towards a flexible technology, which could be applied in a mining basin with local variability of geologic conditions, is a key step towards sustainable coal mining.

2. INTRODUCTION

The top caving coal mining method is a technology, which insures high output rates, with a continuously growing applicability in the Jiu-Valley coal field.

The thick coal seams within the basin represents in present about 95.6 % from total industrial reserve (from which the coal seam no. 3 represents about 70 %) and provides more than 90 % of total output of the company, the development of new mining methods was oriented towards the thick seams, being aware of all difficult problems that their mining involves in general.

Despite its high productivity, this method implies a high level of risk induced both by the phenomena lied to strata pressure and the hazard of endogenous fires.
The advantages of the method for the conditions of top coal caving are the following:

- it can be implemented under actual technological endowment in quasitotality of existing coal mines of the area without major investments;
- requires no special training of workforce;
- lead to improved technical economic indicators compared with the classical mining methods.

The disadvantages of the method are:

- geotechnical phenomena occurs more frequently that in case of classic methods;
- loss of coal (low recovery index), increasing with the increase of caved height;
- self-ignition hazard of coal reminded in the goaf.

The main characteristic of top coal caving is the extraction of coal in two stages: the first stage the extraction is performed at the face support height and is a classic winning method, the second is the removal of coal between the roof (natural or artificial) and the canopy of the face support, the so called top coal.

The method is alternatively named in the literature also roof caving, sublevel caving a.s.o.

In the Figure 1 the conceptual scheme of the top coal caving method is presented, a special attention being accorded to the different zones of the area of influence of the face, i.e.:

In vertical plane the face cutting zone, (F) with height $H_f$ and the caved zone, (S) with height $H_s$.

In the horizontal plane, the virgin coal zone (I), the cut slice zone (II in F and III A in S), the supported caved block zone (II in S), the fractured coal harvesting zone (III B in S) and the goaf zone (IV). The face empty zone (F) is the space occupied with equipment and man. The horizontal dimensions of the mentioned horizontal zones are $p_1$, the slice width, $p_2$ the overall face width and $p_3$ the caving zone width.

The seam (or slice I ) of height $H_e$ is mined in the following manner. The zone II, of height $H_f$ and thickness $p_1$ is mined by conventional methods (shearer-loader or drilling-blasting method.

After a few steps of conventional mining cycles, a caved block III of height $H_s$ and thickness $p_2$ results, which consists of the hanging compact block IIIA and the fractured block IIIB.

The fractured coal from the zone IIIB, of height $H_s$ and thickness $p_3$ is removed into the space of the face F, supported with individual props or powered supports, and handled toward, the face end and rather towards the surface by the means of the face conveyor or an additional conveyor.
Regarding the position of the fractured caving block, relative to the support and the plan of harvesting the caved coal we can have one of the following situations (Figures 2, a, b, c, d, e).

If classic roof support is used, i.e. bars and props, the top coal can be recovered in the longwall (Figure 2.a) or in rear (Figure 2.b) of the bars.

If mechanized roof support is used, the top coal can be recovered using doors in caving shield of the support (Figure 2.c), or in a chink between the edge of the special construction shield called banana and the floor (Figure 2.d). The last possible method of recovering the top coal is using doors in the canopy of the support (Figure 2.e).

3. METHODS ACTUALLY USED

In the Jiul Valley Coalfield, actually, a classic top coal caving method is used, with individual hydraulic props and articulated caps.

The scheme of this method with the relevant working stages is presented in Figure 3.

Stage 1 – face coal cutting, using explosives and/or pick hammers, with a web of 1.25 m;

Stage 2- supporting the mined slice roof, with hanging bars and steel props;

Stage 3- removal of rear props and caps gradually on the length of face;

Stage 4 – harvesting of top coal by windows opened in the wire grid in many points at 15 m distance interval.

For the condition of Jiul Valley coalfield there were delivered two versions of the method, one for seams with slope less than 22 degrees and other for seams with slope over 45 degrees. The first version has two subversions, respectively for natural or artificial roof.

After dismantling and moving the scraper conveyor to the new front line, a new cycle can begin.

4. IMPROVED METHOD

The proposed new method uses specially designed and developed mechanized roof support SMA-S (Figure 4).

The following 3 variants of the mining method based on top coal caving and mechanized support for the coal seam no.3 have been developed:

- By longwall faces onto slope up to $30^0$, by advancing onto the coal seam direction below the natural roof and in slices;
- By longwall faces onto slope between $30^0$ - $45^0$, by advancing onto the coal direction below the natural roof and in slices;
- By longwall faces in horizontal slices for slopes of the coal seam higher than $45^0$ and horizontal thickness higher than 25 m.

The most frequently occurs the last case, for which the scheme of technology is presented in Figure 5. The meaning of notations are the following: 1 and 2 are respectively base and head gates in the floor; 3 and 4 respectively head and base
crosscuts; 5 and 6 raises, 7 attack gallery, 8 and 9 respectively tail and main gates of the faces.

Figure 2. Different situations of removing the coal from caved block: individual props and bars support, coal harvesting at a) front, b) bar, powered support, coal harvesting at c) shield, d) canopy e) under shield

Figure 3. The method actually used in Jiul Valley coalfield
Figure 4. The SMA-S mechanized roof support.

Figure 5. The schematic of the mining technology.
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The top coal caving method has been an emergency technical solution in order to maintain the output level imposed by the market’s requirement in conditions of decreasing work force.

Because the classical version of this method despite the productivity raise exposed a high level of safety and health risk, the equipment and technology of mechanized top coal caving was developed.

Taking into consideration all these facts the further development of high productivity mining methods and technologies should consist in the development of mechanized longwall faces for top coal caving in the thick coal seams mining.

The paper deals with the presentation and explanation of this technology tailored for the conditions of the difficult hard coal basin of Jiul Valley.

The application of the mechanized top coal caving method will enhance the global advantages of the method and will overcome a part of its disadvantages.

References


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