6th INTERNATIONAL MULTIDISCIPLINARY CONFERENCE

METHODS AND EQUIPMENT FOR THE EXTRACTION OF JIU VALLEY COAL SEAMS WITH SHORTWALL FACES

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Abstract: Starting from the analysis of the existing technologies and equipment to mine out the coal seams using shortwall faces, of the specific geologic-mining conditions, existing in the Jiu Valley coalfield, a series of equipment and related technologies are presented which can improve the performances of coal mining in these conditions.

The analysis the application area and particularities of shortwall mining methods points out that they can be applied in a wide range of geological-mining conditions, from very good to difficult ones. Considering the parameters and particularities of shortwalls, machines and machinery were developed, which in correlation with various technological schemes, can lead to special technical-economical performances.

Technologies with various degrees of mechanization are currently applied in shortwalls. For the improvement of mining technologies in shortwalls, the concerns of the specialists were directed towards the development of cutting machines, conveyers, and load-haul machines, powered and individual supports. Part of this machinery are common to other mine working types as well (galleries being drifted, longwalls), and another part are especially intended to shortwalls.

An essential particularity of shortwalls is the large ratio of active length to total length of the face. This is an important advantage of shortwalls compared to longwalls. From this point of view only, shortwalls have a minimum required opening to run work, while longwalls keep a large portion of the face inactive, determining a series of disadvantages. The small openings of shortwalls allow a simpler technical furnishing, with lighter and suppler machinery.

Shorter faces, simpler and suppler machinery in the shortwalls result in lower technical and human accident rates in these faces. Shorter faces allow more production resources to be placed in a more restricted seam range, allowing higher production and productivity.

The proposals of our research team aim at improvements of coal extraction technologies in seam sections with difficult geological and mining conditions. Depending on the multitude of factors influencing working technologies, these can have a lower degree of mechanization or can be fully powered.

For shortwalls, the selected machinery should have the following characteristics:

- Cutting machines should be shorter and cutting parts more flexible, to go easily over the conveyer stations;
- Conveyers should be curved, with driving station in the pre-face;
- Face equipment for individual or powered support should be supple and easily assembled and disassembled.

To develop a coal extraction technology in shortwalls, a large number of machinery specific to these types of faces have been analyzed and original technical solutions have been designed. In faces where coal is dislocated by drilling-blasting, we recommend the use of the loader-conveyer in Fig. 1, designed by the authors.

The active branch of the loader-conveyer is horizontally placed and the inactive one vertically.

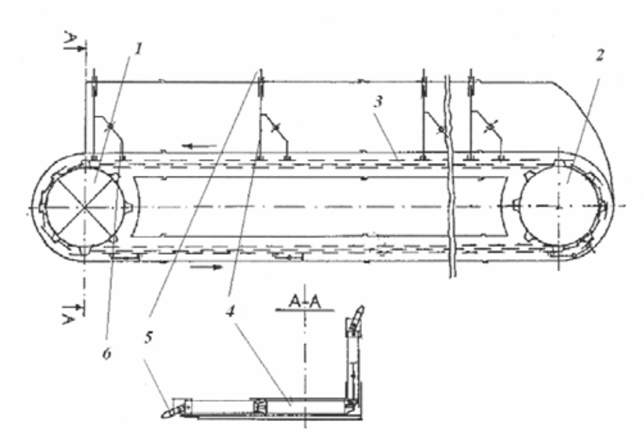

Fig.1. Loader-conveyer.

The scraper is kept perpendicular to the direction of movement with a support, which is linked to the chain by an eye hook. The scraper-support unit has a certain mobility, so that its movement follows a helical surface at the extremities of the conveyer.

The conveyer chain moves in guide paths which control the position of the scrapers during their movement (along plane and helical surfaces, respectively).

Since the working part of the loader-conveyer both cuts and loads the coal, the resistant forces corresponding to the two operations were performed. The following starting data were used for the calculations: length of the scraper – wedge grip – bit unit - 560 mm; chain speed - 0,5 m/s; scraper pitch - 960 mm. The equation of dependence of traction force (F_{tr}) on the length of the conveyer (L) was obtained:

$$F_{tr} = 552 + 963\,L \quad [N] \tag{1}$$

To level the floor of the face, to increase coal loading efficiency and to diminish the resistance to conveyer movement toward the face, CMR-2 type bits are fixed to the scrapers. Wedge grips are used to fix bits to the scrapers and bits are fixed to the wedge grips with elastic bolts. Scrapers are fastened in cantilever and are entailed by a calibrated C-19x64 mm type chain. They are attached to the chain by eye hooks. The scraper joins the eye hook by a cylindrical articulation, letting it rotate vertically.

Considering that the working part of the conveyer acts as a cutting chain, an equation of the dependence of total cutting force (F_1) on the conveyer length(L) was determined.

$$F_1 = 273\,L \quad [N] \tag{2}$$

Thus, the total force required to drive the conveyer is:

$$F = 552 + 1236\,L \quad [N] \tag{3}$$

And the power required to drive it:

$$P = 0{,}56 + 1{,}25\,L \quad [kW] \tag{4}$$

To drive an up to 17 m long loader-conveyer a 22 kW motor was found to be sufficient; a 45 kW motor can drive an of up to 35 m long loader-conveyer. Considering that faces have different lengths, or lengths vary in the range of the same face field, the heading speed (v_a) towards the face of the loader-conveyer will be correlated to the length of the face (L), in accordance with the power of the driving motor.

The following interdependence has been established between these values:

:

$$P = 0{,}56 + L\,(1{,}23 + 0{,}18\,v_a) \quad [kW] \tag{5}$$

Asynchronous electric motors can be used with short-circuit rotor to drive the loader-conveyer, with the power of: 20; 22; 25; 32; 35; 40; and 45 kW, explicating v_a , v_a diagrams

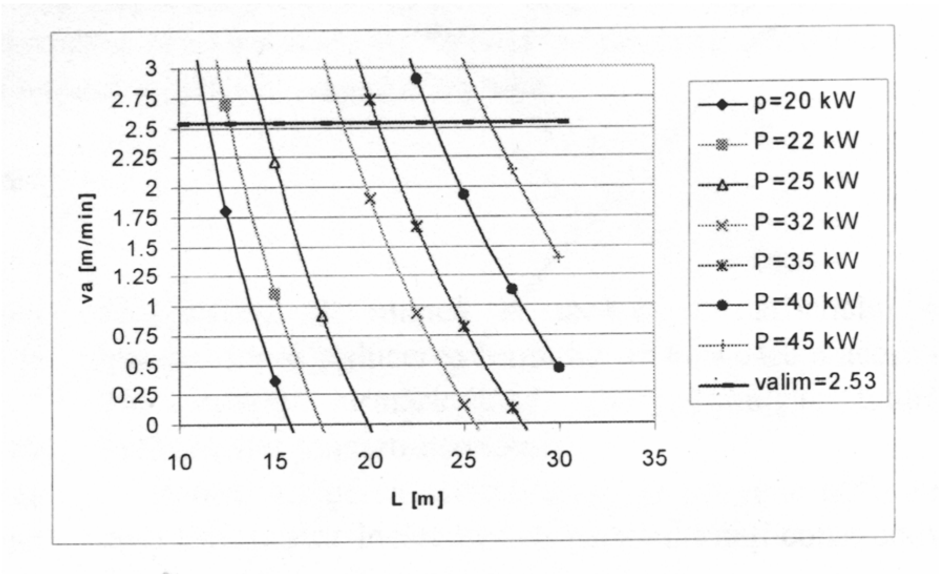

Fig.2. Dependence of conveyer length on its heading speed

are obtained, function of L with parameter P, illustrated in Fig. 2.

Basically, heading speed is recommended not to higher than 2,53 mm/min, speed for which the cutting width is equal to the active length of the CMR-2 bit. At present, coal is removed from a 30 m long, 3 m high and 1,25 web width face, by five men in 8 – 10 hours. The proposed loader-cutter removes the same amount of coal in no more than an hour. Since its estimated flow rate is 180 t/h,. it is obvious that the use of the loader-conveyer cuts down the removal time of the coal and, implicitly, the duration of the cycle by 7-8 hours, and the required work amount is reduced accordingly.

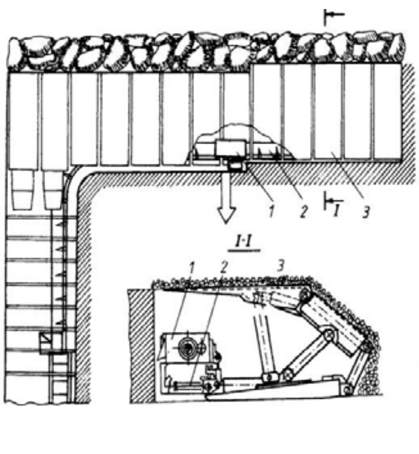

Fig. 3 Shortwall equipped with power complex: 1 – cutting machine ESA – 60L;

2 – Halbach-Braun conveyer; 3 – SMA power support

In the intention of cutting down design and manufacturing stage duration and costs, for the manufacture of this machinery, it is recommended some of the parts of TR-3 type scraper conveyer to be used. For complex powered shortwalls, we suggest ESA-60L machine, Halbach&Braun curved conveyer and SMA-2 support to be used. Correlating the analyzed machinery with the conditions specific to Jiu Valley shortwalls, various technological alternatives could be developed, with a corresponding degree of mechanization, to suit the requirements of the beneficiaries.

Figures 4, 5, and 6 show examples of technical – economical indicators that can be obtained in complex powered shortwalls with the following characteristics:

- face length: l = 10 ÷50 m;
- face height: h = 3 m;
- duration of the shift: t = 6 ore;
- team: 6 workers;
- theoretical cutting machine productivity: 2t/min.

For the estimation of the indicators, reference values were given to the cutting machine's operation coefficients (K_e = 0,3; K_e = 0,4; K_e = 0,5).

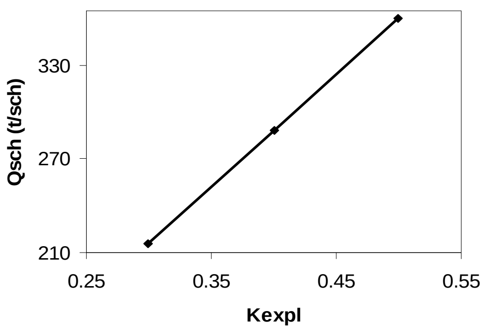

Fig.4. Dependence of production on cutting machine's operation coefficient.

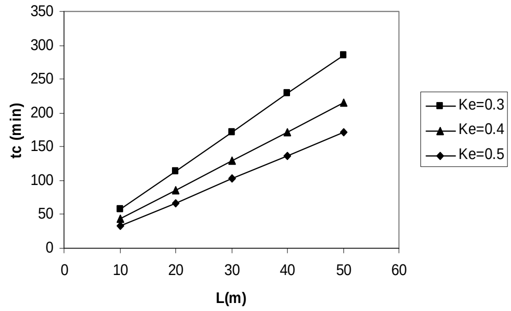

Fig.5. Dependence of cycle duration on the length of the shortwall

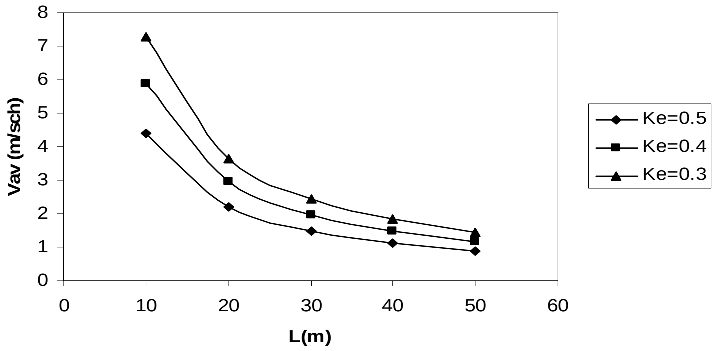

Fig.7. 9 Dependence of face advance, its length and operation coefficient of the cutting machines in shortwalls

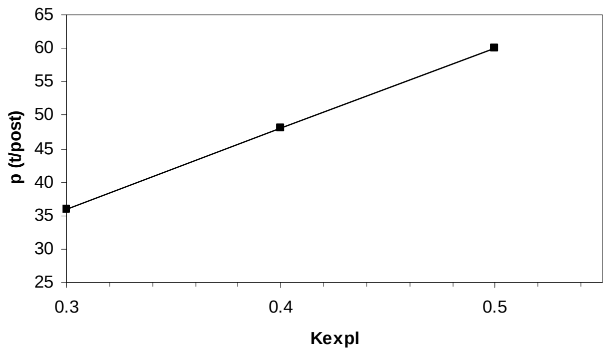

Fig.6. Dependence of work productivity on operation coefficient of the cutting machine in shortwalls and chamber

In conclusion, mining out coal in shortwalls has the following advantages:

– The face field is prepared by drifting only one gallery;

–simple, low installed power machines are used at the face;

–only a small staff is required to service the machinery;

–when mechanization of the technological process is complex, and power supports are used in the crossings, their positive effect is obvious.