Dismantling of the powered complex using a dismantling shield in the conditions of Southern Kuzbass mines

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Abstract. The experience of works on dismantling powered coal face systems at the mines of Kuzbass and the USA is discussed. The factors influencing the duration of dismantling of powered complexes are determined. Based on the experience of dismantling works, a scheme with a polymer mesh canopies and pilot sections of powered mining complexes with the formation of a chamber by a face has become widespread. To reduce the time for dismantling works, a technology with the use of dismantling shield (two “pilot” sections connected by an E-frame), which allows the minimum possible time for reassembly of the coal face system equipment to be achieved.

1. Introduction
The reassembly of a powered mining complex during intensive mining of working areas in Kuzbass is a crucial and stressful period, especially for longwall mines, when the downtime of the powered complex means the shutdown of the entire enterprise. When dismantling a powered complex, with an increase in the depth of development, due to the more active manifestation of rock pressure, the risk of injury to workers increases [1-4]. An unforeseen increase in the time of dismantling works, which, accordingly, entails a decrease in the economic efficiency of the mine operation, is associated with the elimination of negative manifestations of rock pressure. At the mines of JSC SUEK-Kuzbass for the last 8 years, the total number of days spent in excess of the standard for dismantling work has been more than 900 days [3].

2. Practical experience
The results of research on the problems of dismantling equipment are presented in works [1-5]. As practice shows, the method of preparing the working face for dismantling [5] is of decisive importance for reducing the time for reassembling the powered complexes of the face equipment [5]: the formation of a dismantling chamber in a previously driven mine and the formation of a dismantling chamber in the working face as the powered complex moves. Above the previously passed dismantling chamber, as a result of the bearing pressure, when the working face approaches, stratification occurs in the rocks of the immediate and main seam roof. Based on the experience of dismantling works, a scheme with the use of a polymer mesh canopy and pilot sections of powered support with the formation of a chamber by a longwall has become widespread [3].

For the extraction of powered roof support sections for many decades, a standard set of equipment and mechanisms has been used in the mines of Kuzbass: winches LPK-10B, LMT-150.01, LShM,
pumping station SNT-32. This dismantling technology is distinguished by a high number of energy consumption units and starting equipment, rather low performance indicators, a level of safety, and high costs for the acquisition and maintenance of a dismantling equipment fleet. In case of insufficient tractive effort, reeving systems are used using several mounting blocks.

For example, reassembly of powered complexes (KM-142, KM-130, FAZOS) at the Alardinskaya mine is carried out with the following equipment: winch LPK-10B, LMT-150.01, LShM, pumping station SNT-32. At the moment, the mine is using the Glinik 22/47Poz coal face system, the weight of the support section of which is 32 tonnes. When using the above equipment for installation and dismantling works, a number of problems arise:

- equipment failure due to overload;
- labor-intensive and time-consuming preparatory and final operations due to the use of a chain hoist system;
- daily relocation of equipment, switching of starting equipment;
- delivery of sections from the dismantling chamber (by dragging) takes a lot of time;
- maintenance and repair of starting equipment and mechanisms;
- high injury rate.

Dismantling and turning the support section takes 90 minutes of working time. This is due to a large number of preparatory and terminal operations (stretching the rope, hitching blocks) which are repeated 4-5 times per cycle, disconnecting the dismantled support section from the general hydraulic system of the powered complex. Moving the pilot sections also consists of multiple rope and pulley manipulations. This leads not only to a great loss of time, but this process is also very time consuming. Also, workers who dismantle the support sections are in close proximity to the dangerous zones of the rope.

When the support section is pulled out of the row, part of the roof rocks enters the working space of the dismantling chamber, which subsequently interferes with the sliding of the pilot support sections. At Alardinskaya mine, the rocks of the seam roof are represented by sandstones with a large caving step. As a result, the rock falls are rather large blocks of sandstone. The cleaning of the workplace is carried out manually with the use of small mechanization (jackhammer) and the loading of the rock mass into the transport container, which also leads to great time losses.

Based on the experience of dismantling works, in order to reduce the time for the main dismantling operations of the powered complex, dismantling of sections at many mines in the south of Kuzbass began to be carried out by Petitto Mule machine [1]. The calculation of the period for dismantling the sections using a winch and Petitto Mule is shown in table 1.

| Parameter                                      | Units amend. | Index |
|------------------------------------------------|--------------|-------|
| Number of sections                             | PC           | 130   |
| Time for dismantling of the 1st section         | minutes      | 125   | 70   |
| Removable capacity of the technological scheme | sec / cm     | 2.4   | 4.9  |
| The daily productivity of the technological scheme | sec / day   | 9.6   | 19.7 |
| Duration of dismantling of sections (1 shoulder) | day          | 13.5  | 6.6  |
| Duration of dismantling of sections (2 arms)    | day          | 6.8   | 3.3  |

However, Petitto Mule cannot be used in all dismantling chambers due to its size. In addition, Petitto Mule has a rather low speed of movement 0.5-0.9 m/s. Also, according to the results of operational tests, the need for high-quality preparation of mine workings was identified for the
successful adaptation of self-propelled equipment to the conditions of coal mines in the south of Kuzbass (figure 1).

![Figure 1. Transporting the roof support sections through the mounting chamber using Petitto Mule 3056, stuck in a bayonet.](image)

The increased labor intensity of dismantling works and irreparable losses in coal mining due to the downtime of the powered mining complex predetermined the relevance of studies to reduce the time required for reassembling longwall complexes.

When solving this problem, organization of works on dismantling JOY mining complex at the Enlow Fork mine (USA) is of great interest. Mining and technical characteristics of the mine are shown in table 2.

| No. | Name                                         | Parameter                                    |
|-----|----------------------------------------------|----------------------------------------------|
| 1   | Formation angle (by dip)                     | 0-7°                                         |
| 2   | Formation angle (along strike)               | 0-3°                                         |
| 3   | Formation structure                          | Aged (with a small proportion of disjunctive disorders) |
| 4   | Formation power (within the mining allotment of the Enlow Fork mine) | 2.7-2.9 m                                   |
| 5   | Development system                           | DSO                                          |
| 6   | Face length                                  | 400-500 m                                    |
| 7   | Excavation length                            | 3000-4600                                    |
| 8   | The number of excavation sites in simultaneous operation | 2                                           |
| 9   | Average monthly load on the working face     | 900 thousand tonnes                          |

At this mine, the reassembly of the powered complex (the length of the working face is 500 m) is carried out within 14 days.

Dismantling of the sections is carried out using two “pilot” sections connected by an E-frame (dismantling shield, manufactured by Shumar Manufacturing) and a dismantling machine Petitto Mule 2555. With the help of an E-frame (figure 2), the dismantled section is pulled out of the row, then the dismantling machine PM2555 transports the dismantled section through the dismantling chamber to the auxiliary (dismantling) walkway, where the section is loaded onto a pneumatic wheeled tractor and transported to the place of reloading onto a rail electric locomotive [3].

However, in the conditions of US mines, PM2555 dismantling machine is capable of pulling out a section from a row independently. The use of the E-frame is rational in the absence of a machine at the
time of issuing the previous section through the dismantling chamber. The main purpose of the E-
frame (dismantling shield) is to ensure the possibility of independent movement of the pilot sections 
(without the need for additional equipment).

![Figure 2. E-frame (dismantling shield).]

The scheme of moving the “pilot” sections using the E-frame is shown in figure 3.

![Figure 3. The scheme of movement of the “pilot” sections using the E-frame.]

Dismantling of the sections at “Enlow Fork” mine is carried out in the following sequence:

- two pilot sections are installed on the ventilation drift, to which the E-frame is attached;
- the work of the E-frame moves the section out of the row;
- dismantling machine PM 2555 drives up and transports the dismantled section through the dismantling chamber through an auxiliary walker to the place of reloading to the accumulator pneumatic self-propelled machine, which transports the section to the place of loading on the accumulator rail locomotive. Further, the accumulator rail locomotive transports 2-3 sections along the route to the assembly chamber;
- during transportation of the dismantled section, the workers employed in the position of dismantling the sections fix the dismantled space using Strata sand prop (“sand prop”) (figure 4), the next dismantled section is reduced, the “clasp” is laid on its canopy, the section is spaced, then, with the help of the E-frame, the pilot sections are moved, while the installed “clasp” is pressed with the help of the canopies of the pilot sections, which will prevent the “clasp” from falling out when the section is dismantled;
- then the cycle is repeated.

![Figure 4. Racks Strata sand prop (“sand support”).](image)

3. **Recommendations for the use of a dismantling shield**

In order to optimize dismantling works in the conditions of mines in the south of Kuzbass, using foreign experience in dismantling works and production indicators, it is proposed to use a dismantling shield.

The dismantling shield is in the initial position, the pilot sections are pushed to the shield. The extreme linear section from the row is hooked by the tie rod to the chain from the pulley block of the shield and moves under its own power to the bottom line (figure 5). Further, the connector on the shield boom is interlocked directly with the section link connector and the shield boom moves forward at full speed, turning the section. After that, the section hooked to the extended boom is pulled as close as possible to the boom under its own power. Then the pilot sections move to the sections in the row and move the dismantling shield. The section to be dismantled, hooked on the extended boom of the shield, moves to it as close as possible under its own power (figure 6, a).
Figure 5. Dismantling complex with pulley block and retracted sections.

The shield boom folds down, approaches the section to be dismantled, engages in the rear eye on the base and moves at a full speed, turning and moving the section. After that, the section is hooked simultaneously by the rear eye of the base to the eye of the chain hoist, and by the front eye of the base to the boom and move to the monorail due to the deflection of the boom to the bottom line.

The folded boom approaches the section to be dismantled as much as possible, engages in the rear eye of the base and deviates slightly towards the bottom line, then extends full stroke, moving the section in front of it. Then the folded boom behind the base of the section tilts forward, interlocks in the left rear eye of the base. Further, due to the deflection of the boom, the section under the monorail turns over (figure 6, b).

Figure 6. Section dismantling scheme: a) hooked on extended shield boom; b) an additional section for a monorail.
Delivery of the section through the dismantling chamber is carried out by diesel locomotive DLZ-110 FERRIT. The average time for issuing a powered support section through a dismantling chamber is about 30 minutes.

4. Conclusions
1. Dismantling with the help of a shield allows the minimum possible time for reassembling the treatment equipment to be achieved.
2. Studies showed that for the conditions of coal mines in the Kuznetsk Basin, mining flat and inclined seams, from the point of view of minimum time consumption and safety of work, there is a method of dismantling in the dismantling chamber formed by a powered complex with the installation of powered support sections for a high-strength polymer mesh canopy.
3. The expected social effect when using this technology is to improve the safety of miners.
4. These measures will increase the number of cycles per day, shorten the reassembly time by 25 days, which in turn will save up to 170 million rubles.

References
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