MECHANIZATION AND AUTOMATION OF MINING
NEW TECHNOLOGY FOR THE TREATMENT OF CLAY SOIL
WITH POOR HYDROTRANSPORTATION PROPERTIES

E. G. Chaikovskii and Yu. G. Gorbachev

One method of removing debris in the open-pit coal mines of Kuzbass is hydromechanization. The cost of a cube of debris in a hydromechanical approach is 2.0-2.5 times less than in an excavator approach using wheeled vehicles. Hydromechanical extraction is environmentally benign. With a closed water cycle, no waste water is released to the groundwater, and no noxious gas or dust is produced. Further increase in the capacity of the hydromechanical approach of associated with the development and introduction of more energy-efficient technologies that affect smaller land areas and permit more rapid recovery of the land, with minimal water consumption. Among much else, research and design work to improve hydromechanical debris removal must include: cost-benefit analyses taking account of an increase in extraction volume by 60-70 million m³ by the year 2000; and the development of technologies with minimum energy consumption [1]. In the Kuzbass mines, technologies for the removal of material with poor hydrotransportation properties are essential.

A promising approach here is the development of a new technology to prepare the rock for hydrotransportation.

Research at the Institute of Mining, Siberian Branch, Russian Academy of Sciences, supports a fundamentally new technology for the treatment of rock with poor hydrotransportation properties. In this approach, the material to be removed is cut into horizontal layers of height 2-4 m. The layers are broken down by a screw-cutting machine and fall to the foot of the face. At this point, the material is in individual pieces that are suitable for hydrotransportation. A new machine, the hydrocombine, is developed to cut the rock into layers. Its distinguishing feature is a screw-cutting unit capable of cutting the rock 40 times more rapidly than the hydromonitor jets. The hydrocombine and the cutting technology are illustrated in Fig. 1. An experimental prototype is undergoing tests at the Kemerovugol' Chernogorsky Production Combine.

The method used to calculate the basic parameters of the prototype hydrocombine is as follows.

Linear Dimensions of the Hydrocombine

The initial parameter is the maximum possible height of the rock face $H_{\text{max}}$, which determines the linear dimensions of the hydrocombine. On the basis of the technological requirements (a positive slope of the slope of the face, a safe distance from the face to the hydromonitors, effective removal of the debris by the hydromonitors, etc.), the length of the arm with the cutting unit is taken to be

$$L = 1.4H_{\text{max}}.$$  \hspace{1cm} (1)

On the basis of previous discussions, the height at which the arm is hinged to the A frame is chosen as

$$h = 0.6H_{\text{max}}.$$  \hspace{1cm} (2)

The minimum depth of the cutting channel also depends on the physicomechanical properties of the soil [2]

$$t_{\text{min}} = \frac{2C}{\gamma},$$  \hspace{1cm} (3)

where $C$ is the soil adhesion and $\gamma$ is its density.
The width of the working cut by the hydrocombine is (Fig. 1)

\[ B = 2R_{\text{max}} \cdot \cos \left( 90^\circ - \frac{\alpha}{2} \right), \]  

(4)

where \( R_{\text{max}} \) and \( \alpha \) are the maximum radius and angle of arm rotation in the horizontal plane, respectively.

The following basic factors influence the productivity of the hydrocombine in debris removal:

- the ratio of the volume of disrupted soil to the volume subjected to the action of the cutting unit;
- the physicomechanical properties of the soil;
- the constructional and kinematic properties of the machine as a whole, the cutting unit, and the transportational equipment;
- the mining technology, including the organization of working processes at the face, the length of a shift, and the order in which the open-pit area is developed.

The parameters of the hydrocombine and the cutting unit are constant in any particular case; the other factors are variable and depend on the technological setup and the hydrocombine operating conditions.

The degree to which these factors are taken into account influences the theoretical, engineering, and operational productivity of the hydrocombine, which consists of the productivity of the cutting unit itself and the productivity resulting from the breakdown of the cut soil.