ronmentally advanced development technologies and effective resource-saving dust removal technologies in open pit mining.

Methodically, the solution of these issues are based on the application of the theory of optimization of systemic and aero hydrodynamic approaches to the study of dust generation objects, equivalent circuits of specific dust removal devices, as well as the development of dust removal technologies are implemented, firstly, by the optimization of dust removal processes and secondly by their rational combination in the device.

To do this, need to solve the following tasks:

1. Substantiate the factors determining the choice of methods of dust control in mining processes.
2. Justify the optimality criterion for evaluating the recommended means of combating dust formation.
3. Assessment of the possibility of using water dust removal in conditions of varying temperatures on the basis of water-air jets, curtains, etc.
4. Consideration of the possibility of developing resource-saving technologies for the conditions of volley overloads of bulk material at varying temperatures.
5. Investigate the possibility of creating spray units for conditions of varying temperatures.
6. Investigate the possibility of creating aspiration systems based on the vortex effect.
7. To investigate the possibility of creating air and water-air curtains for dust removal systems with predetermined parameters.
8. To develop on the basis of the results obtained, resource-saving dust removal technologies in open mining works.

UDC 624.19.059.3

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INVESTIGATION OF PARAMETERS OF JET GROUTING DEVICE USING NUMERICAL MODELLING

Underground transport is a significant component of mass transportation of passengers, which is why it is built mostly in densely populated areas and central parts of large cities of Ukraine [1, 2]. Problems of efficient construction and maintenance of tunnels are relevant for Ukraine considering the scale of underground transport system and growing passenger traffic.

Soft soil improvement technologies by chemical reactions such as deep mixing and jet grouting are commonly used to improve the soft deposit to ensure safety during construction of tunnels [3, 4]. Typical applications of jet grouting are embankment foundations, water sealing bottom plug and excavation support, provisional tunnelling support and water cut-off [5]. In our investigation, the jet grouting is applied for maintenance of existing underground tunnels. Similar positive experience was described in [6].

The essence of the jet grouting method is the parallel destruction of rock and mixing of soil and stabilizing solution in mix-in-place format. It saves resources by performing two technological operations at the same time.

The drilling tool for the jet grouting is designed differently from the standard tool due to the presence of a channel for the supply of stabilizing fluid. Upon reaching the end of the screw, the cement slurry is fed into the inside of the monitor. The monitor is equipped with nozzles that convert a high-pressure energy into kinetic energy of the flow, which, in turn, destroys and mixes the soil. To cut the soil, the flow rate must be at least half the sound velocity [7]. It affects the diameter of the column [8-10], its composition and properties [11], etc.

Described above drilling tool for the jet grouting has sophisticated design. Therefore, it is hard to calculate mixture flow parameters using theoretical approach. Experimental or simulation data are usually used.

In this investigation, 3D-model of jet grouting device was developed to calculate the pressure that needs to be created in device to achieve mentioned above velocity of the grouting mixture. The material of jet grouting device (drilling tool and hydraulic monitor at the same time) was structural steel, diameter of the device – 100 mm. The inlet diameter of the hydraulic monitor's nozzle was 19 mm and the outlet diameter was 2 mm. Feed channel diameter of the device was 12 mm.

Further numerical simulations were aimed on calculating the pressure p and fluid velocity v inside the jet grouting monitor depending on position x. The results are shown in Table 1.

Table 1

The results of the calculation

x, mm	0	5	8	12	23	27	30	39
p, bar	-	166.7	169.3	172.8	174.7	174.9	174.9	175.0
v, m/s	132.4	50.2	37.9	24.4	5.9	2.4	2.4	0.8
x, mm	44	63	67	71	77	91	97	105
p, bar	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
v, m/s	0.3	0.1	0.1	0.1	0.1	0.7	0.1	1.9

The developed model and calculations show that to create a flow rate at the output close to half of the sound speed, namely 130 m/s, it is necessary to create a pressure of 175 bars. It is in line with other investigations [3, 5] and close to carried out theoretical calculations. Therefore, all the devices in hydraulic system should be designed for the high pressure.

Conclusions

1. Numerical modelling of jet grouting device simplify the task of calculation of its hydraulic parameters like resistance, velocity, pressure etc. In addition, it assists in strength calculations to ensure the safety and durability of the device.

2. In order to obtain the speed of grouting mixture that close to half of the sound speed, it is needed to feed the mixture with a pressure at list 175 bars.

3. Further investigations should consider the whole hydraulic system with a pump capable to create the flow with pressure and productivity to reach the speed of grouting mixture in the monitor's outlet nozzle required for proper soil cutting and column formation.

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UDC 624.155.152

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ENERGY-EFFECTIVE METHOD OF INSTALLATION OF FOUNDATIONS UNDER OBJECTS OF MINE SURFACES

Technological complexes of mines and metallurgical enterprises in various combinations include: buildings of air heaters, fans, electrical substations, crushing and screening complex, compressor plants, repair and electromechanical workshops, etc.

Among them, we can conditionally distinguish: