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Complex Dehydration of the Rock Mass

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***Abstract**: The article presents the results of a complex dehydration of the rock mass. Complex influence on the wet rock mass consists of three mechanisms of dehydration processes: vibration, vacuum and electroosmotic. The novelty of the dehydration device is that it concentrates the mechanisms for implementing all three methods of dehydration. Experimentally are established dependences of the residual moisture in the material of the oscillation frequency of the working body, its length and the inclination angle, the magnitude of the perturbing force of the vibration generator, the electric field voltage, as well as the influence of each individual mechanism set up efficiency of the device and is noted that the electroosmotic method is effective for reducing the capillary moisture and vibration and vacuum methods are effective in the selection of external moisture from large pores of bulk layer of the rock mass.*

***Keywords:** dehydration, vacuumization, electroosmosis, vibrotransportation, integrated approach.*

I. Introduction

Improvement of mining equipments and mining technologies, ore dressing and enrichment of the rock mass leads to an increase in amount of small class size in the final product and necessity of dehydration. This is primarily dehydration of flotation concentrates on coal preparation plants, secondary enrichment of technogenic waste in the form of sludge and tailing ponds extraction of minerals while hydro mining and hydro support and so on. Necessity of perfection of the dehydration processes associated with their energy intensity, duration and multistage operations. The most effective kind of dehydration is thermal. However, it requires significant energy consumption. Dehydration on vacuum filters of different constructions is carried out in a continuous mode of their operation, which is an advantage, but the main Disadvantages – is it's pretty high humidity of dewatered sludge (20-25%), a significant carryover of useful solid product to the filtrate during dehydration fine rock mass with a particle size of less than 0,5 mm and a high resistance of the precipitate by vacuum filtration. [1]

Vibratory dehydration on the vibrating screens for classification of small and fine fractions is an efficient and economically feasible, but it is used only for preliminary dehydration, since it does not provide sufficient dehydration (15-20% residual moisture) [2, 3].

In recent years, began to be used a centrifuge for dehydration of coal sludge after flotation and fine coal - after small jigging. This method allows to reduce the moisture content to 6.0%, but its realization requires expensive equipment.

Aim of the work of the authors is to find a technical solution for a sufficiently deep dehydration (4,0 ÷ 6,0% residual moisture) of the rock mass, the study of regularities of mass transfer, the proof of its effectiveness and efficiency, resulting in the proposed method of complex dehydration of wet rock mass, which combines three dehydration mechanism (vibration, electrokinetic and vacuum), concentrated in a single device [5], which is designed in the Institute of Geotechnical Mechanics. NS Polyakov NAS of Ukraine.

II. Methodology And Materials

Application of the electrokinetic method based on electroosmosis showed positive results during dehydration of coal flotation concentrates [6, 7]. Its attractiveness consists in the opportunity in the process of usage to intensify deeper dehydration of easily filterable and difficult filterable concentrates by extraction of moisture from the pores and capillaries of the solid residue. It is related to a change in the surface tension forces of the liquid or decomposition of the liquid molecules under the action of galvanic current when the portions of the water molecules decomposed into this field are transferred from one pole to another through dehydrating layer of porous rock mass. This well-known process in the physics called electroosmosis.

General view of the vibration device for the complex dehydration of wet rock mass is shown in Fig. 1. The device represents vibrating working body installed on the frame 1 by means of two rubber buffers. The housing working body 3 is isolated by rubber bumpers 4 from the loading bunker 5, which is connected to the positive pole 6, of the regulated constant-current source. In the upper sections of the working body is installed insulating spacer 7and in the lower part (bottom) 8 is installed fine mesh for the passage of the free liquid during dehydration of the rock mass. To the mesh is connected negative pole 9 constant current source under the mesh is located collecting chamber 10 for small dropout of the rock mass and drainage humidity, which are removed through the pressure seal 11. In the collecting chamber 10 through the channel 12 is carried out vacuumization by a vacuum pump 13. The continuity of the movement of material for the working body 14 is provided by vibroexciter with an adjustable frequency and perturbing force [5].

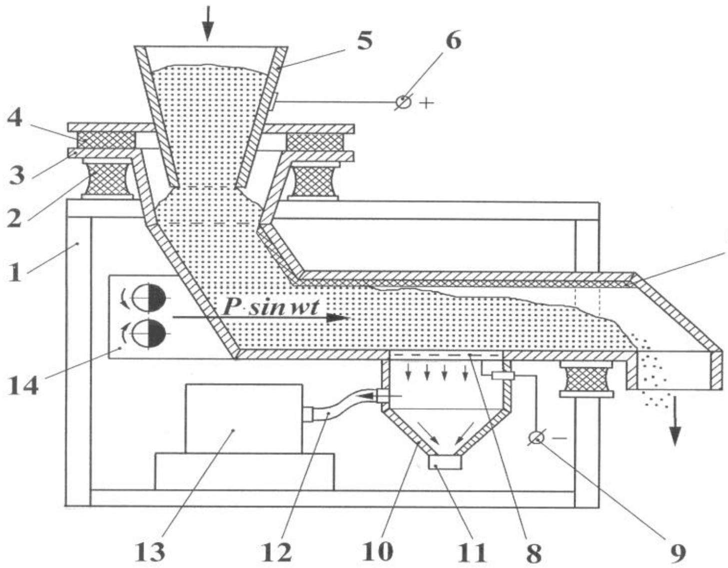

Fig. 1. The general view of the vibratory device for the complex dehydration of the rock mass

In determining the serviceability of the device establishes a number of dependencies percentage of residual moisture of variable parameters: the length of vibrotransportation, the voltage of the electric field, which provides a osmotic mechanism of dehydration share participation of each mechanism in the process of dehydration, the magnitude of the disturbing force of the vibration generator and the angle of the working body.

In Fig. 2 is shown dependence of the residual humidity on the inclination angle of the working body in the conditions of the conducting the previous experiment. With increasing the residence time the slope angle of the rock mass on the working body is reduced, therefore the degree of dehydration is significantly decreased.

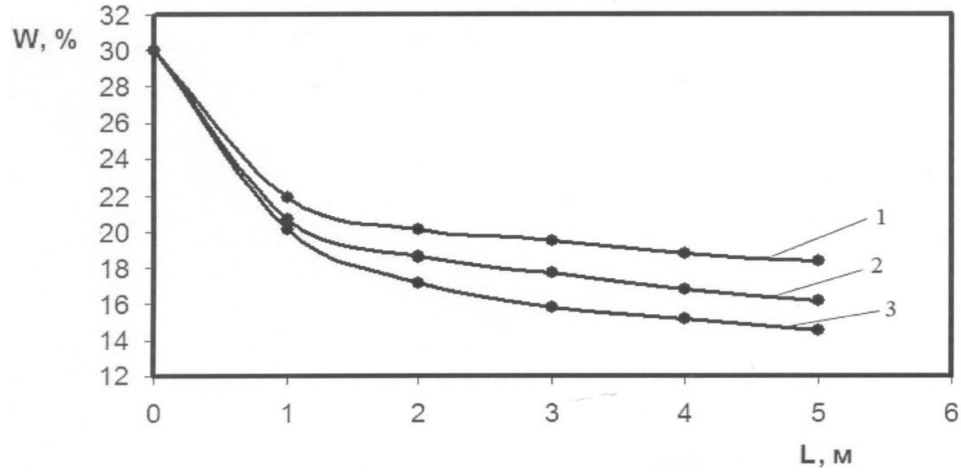

Fig. 2. Dependence of changes of the residual moisture of rock mass on the inclination angle of the device of the working body: 1 - at a inclination angle of 15º; 2 - at an inclination angel of 10º; 3 - at an inclination angel of 5º

Determination of the dependence the dehydration degree from the oscillation frequency of the operating body is shown in Fig. 3

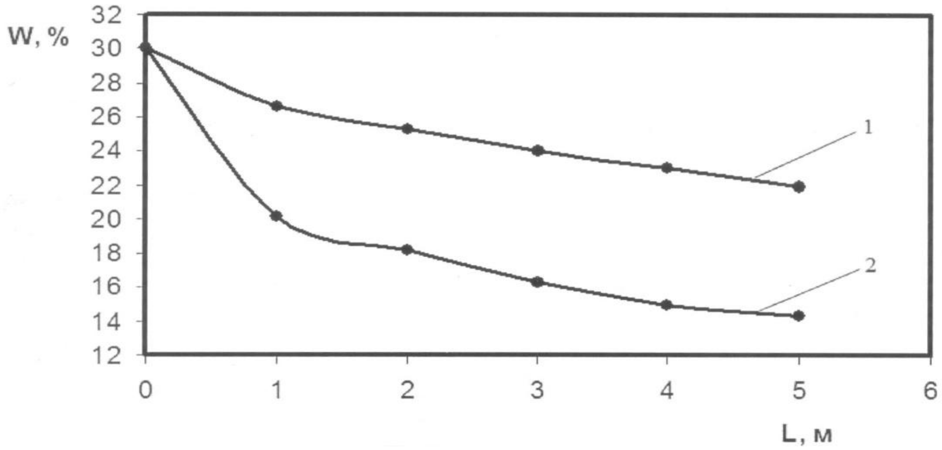

Fig. 3. The Dependence of change of the residual moisture from the oscillation frequency of the working body: 1 - at a frequency of 1500 rev / min; 2 - at a frequency of 3000 rev / min

With increasing the frequency, observes a significant dehydration of the rock mass. The intensification of the process occurs in connection with enhanced segregation of the material and cleavage of the binding liquid (so-called constrictions) between the individual particles.

The increase the time of the material on the working body during the operation of the device and change in the value of the perturbing force F vibration exciter leads to a significant reduction in external moisture in a layer of the rock mass. Depending on the nature of its changes upon variation these factors are shown in Fig. 4. Yet this insufficient deep dehydration is explained by the fact that the capillary moisture, due to large surface tension, requires greater effort for removal. The increase of perturbing force leads to heightened tension of metal constructions of the device and an increase in material's speed of movement on the operating body at the same time does not promote improvement of dehydration. There is a necessary to use the mechanism of residual dehydration of the rock mass, with which you can extract the capillary moisture.

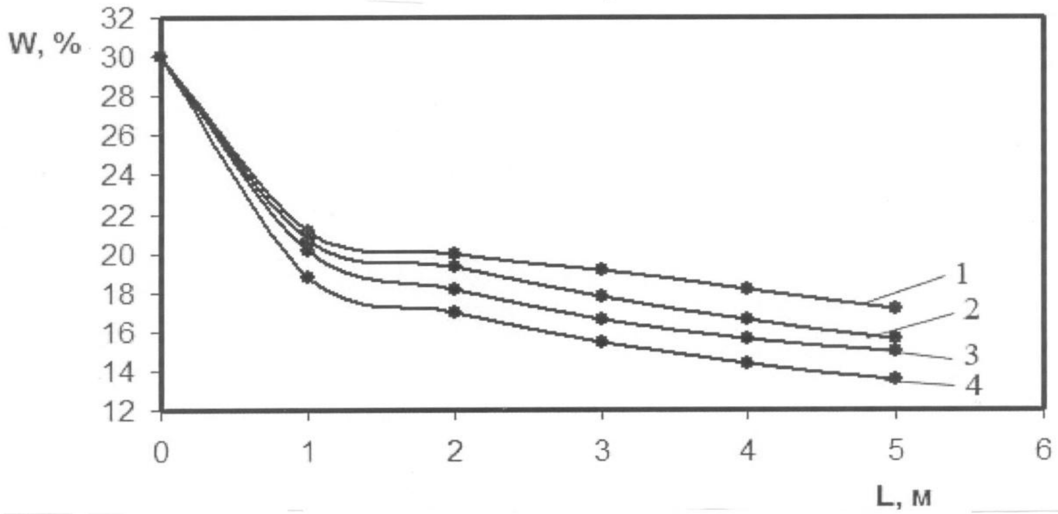

Fig. 4. The Dependence of change of the residual moisture on the magnitude of the perturbing force at a frequency of 2650 oscillations / min: 1 - at F = 0,8 kN; 2 - at F = 0,7 kN; 3 - if F = 0,5 kN; 4 - at F = 0,6 kN

Taking into consideration the positive experience of electrokinetic method of dehydration [6-8] is used in the device also this method based on the leading the constant electric field to the moist layer of the dehydrated mass. In this case, the electroosmotic effect is realized, based on the transfer of moisture from the positive to the negative pole. As the experience of its use is not enough, there was a need to study the regularities of the electroosmotic mass transfer in an electric field, and to intensify the process this method is used by the authors in combination with vibration and vacuum. The research results are shown in Fig. 6 where is shown the effect of a combination of methods on the process of dehydration. It is found that a relatively high percentage of residual moisture (14%) is obtained mainly due to the vibration and vacuum (external moisture extraction), as shown in Fig. 2. This should be considered when creating portion of dehydration as an additional capillary extracting residual moisture.

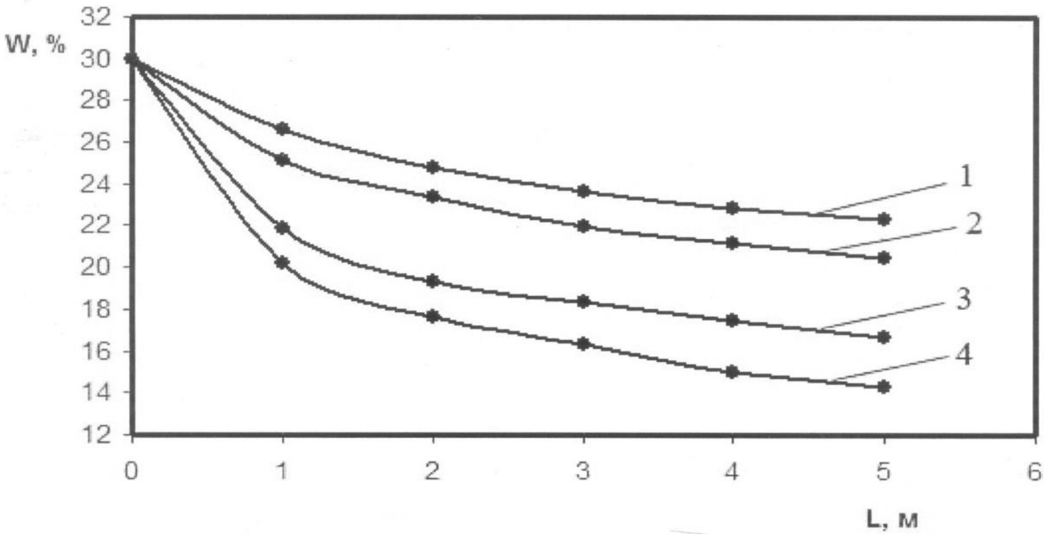

Fig. 5. Dependence of change of residual moisture from a combination of mechanisms of influence on rock mass: 1 - vibrating influence; 2 - the impact of vibration and electroosmosis; 3 - the impact of vibration and vacuum; 4 - the impact of vibration by vacuum and electroosmosis.

III. Conclusions

Thus, the results showed the operability of the vibration device the complex dehydration of the rock mass, determined a degree of influence of each of the three methods of dehydration and the ability final dehydration via of the electrokinetic method using electroosmosis.

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