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INVESTIGATION OF COAL DUST FORMATION UNDER CYCLIC CRYOGENIC INFLUENCES

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Abstract. Analysis of the need to consider the fractional composition of coal dust in the calculation of the dust load is carried out. The impact of cycles of freezing and thawing on the fractional composition of the dust generated during mechanical destruction of coal marks D are found. To achieve this goal, in vitro experiments were carried out with coal mark D of the Tugnuisky deposit. The collected sample was split into smaller samples and, with the help of mechanical crushing followed by classifying, the following fractions were obtained: 1 mm, 1 + 0.63 mm, 0.4 mm -0.63, -0.4 +0 25 mm, -0.25 mm + 0.2, 0.2 + 0.14 mm, -0.14 mm. For determining the fractional composition of the coal, depending on the degree of hydration was used Camsizer XT installation, which allows obtaining a density distribution of particles in a sample. Altogether were conducted 80 trials, of which 40 - in the natural moisture and 40 - with artificial moisture (full saturation).

The experimental results showed that there is a relationship between the fractional composition of the sample, its moisture content and the number of cycles of freezing and thawing. It is shown that the level of dust, depending on the number of cycles at increasing humidity is substantially reduced: by the degree of destruction of 7-fold effect of the dry coal is 1-fold to humidified coal.

Also was found the effect size fractions on the degree of destruction. In particular, the processing of the experimental data showed that the initial fraction of less than 0.14 mm output of fine dust does not change, and further research may be excluded from the analysis. The maximum degree of destruction observed dust sample fractions 1 + 0.63 mm, which should be used in determining the impact of man-made laws of moisture on the fractional composition of the dust in the cyclic cryogenic effects. The established regularities will continue to develop the best plan of experimental work to achieve this goal for different marks of coal.

Keywords: dust concentration, fractional composition, coal, pneumoconiosis, cycles of freezing and thawing, dusting, respirable fraction.

Introduction. Currently, there is no unified system for measuring the dust content in the working area. Each country adheres to its own way of normalizing the dust content in the air of the working area and, accordingly, its dust suppression measures. The only thing that is similar in all countries is the rationing of coal dust depending on the content of silicon dioxide in it, because this compound has a negative impact on the early appearance of pneumoconiosis in workers. Table 1 shows the maximum permissible concentrations of coal dust in different countries. The table shows that Russia is the most" loyal " to dust: the content of silicon dioxide can reach up to 70%, which is unacceptable in most developed countries [1, 19].

Table 1

Indicative data on the measurement and assessment of dust concentration in the coal industry in Germany, France, the UK, the USA and Russia.

Indicator	Germany	France	The UK	The USA	Russia
Maximum permissible dust concentration, mg/m^3	10	13,5	7	2	10
Assessment of quartz content	q>5% with a coefficient K=1; 0,7 и 0,3	Fixed q>7%	At the testing stage	Fixed q>7%	q>10%, 2 mg/m^3, q<10% - 10 mg/m^3

Over the past 10 years, it has been revealed that the incidence of workers is affected not only by the content of free silicon dioxide, but also by the fractional composition of dust (the most dangerous is the dust fraction from 2 to 5 microns, since it is retained in the alveoli of the lungs and remains there in 50-90% of

cases). A number of countries have already implemented a transition to the regulation of dust content in the air depending on the fractional composition. Some countries draw such a border up to 2.5 microns, others - up to 10 microns. In Russia, this rationing is not carried out, which negatively affects the whole situation: if in the world there is a tendency to reduce the level of pneumoconiosis, in Russia – on the contrary, lung diseases in workers are among the three most frequent occupational diseases. All this indicates the urgency of the problem of dust control at coal enterprises in Russia [2, 62].

In the work of Kudryashov V.V. [3, 112], the fact of increasing the dust yield during the destruction of rocks subjected to a cyclic process of freezing-thawing was established and experimentally confirmed. At the same time, the author did not consider the influence of freezing-thawing cycles on the fractional composition of dust and also the number of cycles.

Similar studies using modern analytical base were given by Romanchenko S.B. and Rudenko Yu.F. in [4, 30], where it was found that with a decrease in air temperature (the range was studied to -25ºC), the intensity of dust formation in the development of rocks increases. The fractional composition of dust was also studied, but the influence of humidity and cyclicality on the amount and fractional composition of dust was not considered.

Methods. The aim of the work was to establish the dependence of the yield of fine dust fraction on the freezing-thawing cycles. At the Scientific center of Geomechanics were conducted laboratory studies of dust-producing capacity of the Tugnuisky open-pit, with a coal mark D. Method of measurement was as follows: was initially selected a representative sample of coal that represents the pieces with a mass of 1 kg. Single piece was pre-moistened during the day. By preliminary crushing, grinding and subsequent sieve analysis, the following size classes were distinguished: +1, -1 + 0.63 mm, -0.63+0.4 mm, etc.

Each sample was divided into equal parts and was frozen once and seven times, before and after freezing, control measurements were carried out. Figure 1 presents the results of studies of the effect of freezing-thawing cycles on the dust formation of coal samples with a size of +1 mm, from which it can be seen that the main effect of one freeze on the dust formation of coal occurs at a fraction of 100 microns. 7 cycles of freezing-thawing affect the formation of a smaller fraction in the entire sample under consideration. Evaluation of the results of dust formation was assessed by the presence of a fraction of up to 25 microns.

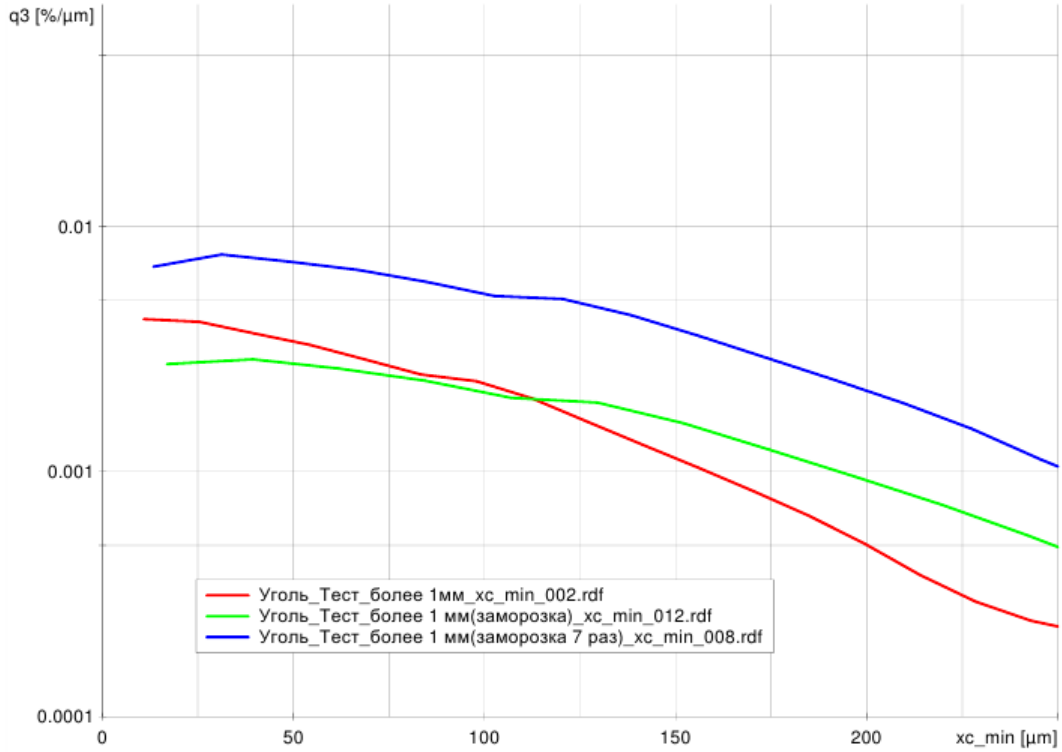

Figure 1. Results of measurements of dust formation of coal samples more than 1 mm

For a pre-moistened coal sample, there is a different situation (Fig. 2): at the interval from 15 to 25 microns, the number of small particles prevails in the coal, not subject to single and 7-fold freezing. This effect is explained by the ability of coal particles to stick together, forming larger particles. However, with a fraction of 75 microns, the percentage of fine particles begins to prevail samples without freezing and with one freeze to 250 microns.

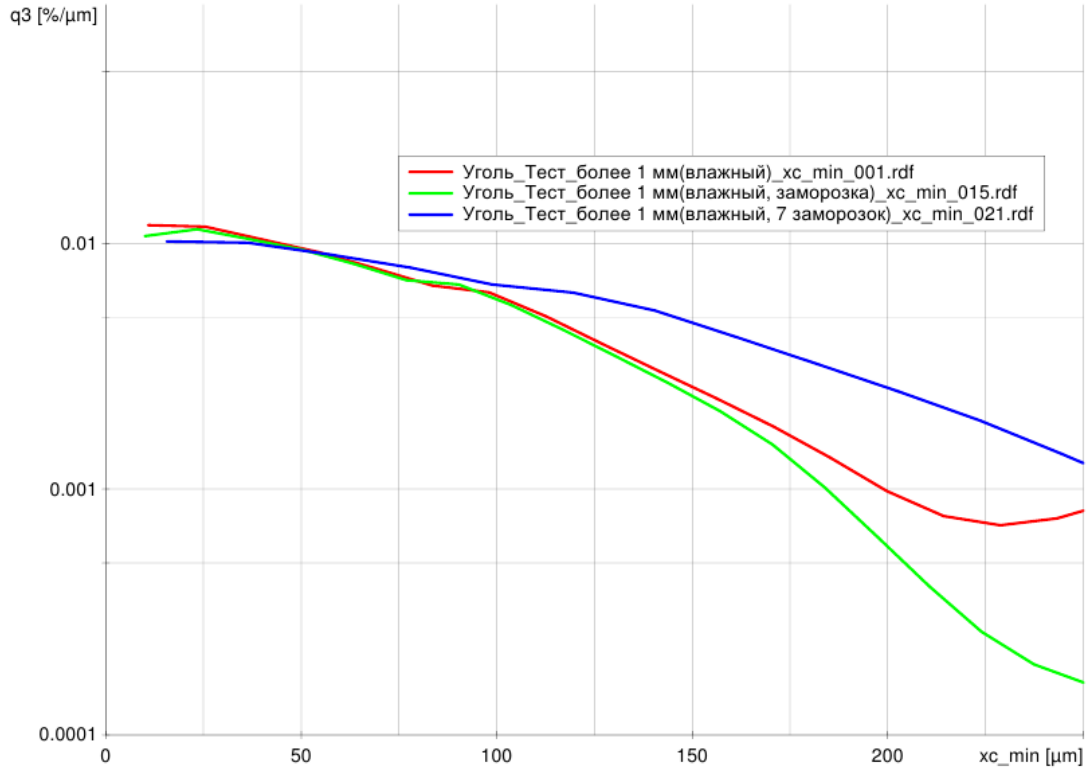

Figure 2. Results of measurements of dust formation of coal samples more than 1 mm saturated with water

For coal sample fractions: -1+0,63; -0,63+0,4; -0,4+0,25 mm occur the same changes, that and under fraction +1 mm. Although, under fractional the composition of the -0,14 mm cycles freezing-thawing affect dusting marginally, i.e. in further experiments cannot be viewed. This may be due to the difficulty of trapping particles by the Camsizer XT unit on which the studies were conducted.

Conclusion. There is a dependence of the state of the coal on the cycles of freezing-thawing. Whether it is dry or saturated with water, its fractional composition increases in the direction of fine particles that adversely affect workers. This effect is significant and should be taken into account when choosing methods and means of dust suppression of coals subjected to cryogenic effects.

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