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ABOUT CERTAIN PROPERTIES OF SEDIMENTARY MINE ROCKS

As a result of the investigations fulfilled dependences of change of the structure of the pore space of the sedimentary rocks samples determining their liability to water and gas recovery were ascertained.

Key words: mine rocks, mining depth, coal seam, natural humidity, capillaries.

The development of the coal seams in the Ukraine is carried out at the great depths at present. The increase of the depth of the mining from 500 up to 1100 m gave rise to growth of displacements of the rocks enclosing a mine working 3.1 – 3.8 times. With the increase of the depth of the development the mining and geological conditions determining worsening the conditions of the mine workings maintenance are changed. The process of the underground pressure in such mine workings depends on the aggregate influence of many factors which the stressed state of the rocks and their physical and mechanical properties should be related primarily to. Under conditions of the increasing stressed state of the massif the rheological properties of the mine rocks are changed, too. The mine rocks that form the sedimentary massif and looked solid and stable at the moment of construction of the mine workings deteriorate completely on the expiry of the some time, therefore.

It is considered [1] that the properties of the sedimentary mine rocks are similar to some extent to the properties of the materials being products of the modern technology. These rocks were formed as a result of the process that was analogous to some degree to the metal ceramics technology. And so, the modern creep theory of the aging materials based on the fundamental conceptions of Boltzmann and Voltaire and on the theory of viscoelastic models going back to D. Maxwell, W. Voigt and D. Thompson became the enormous development during the last century thanks to its wide applications in the various spheres of the engineering [2].

As a result of the multiple investigations of the peculiarities of deformation of the sedimentary rocks massif it was ascertained that the property of heredity, i.e. the dependence of the observable deformations on the whole preceding stress history, is inherent in it. The original evidence of rightness of this conception is the experience of discrimination of cores in disks by drilling the deep holes [3,4]. It is the evidence of reality of destruction of the rocks test samples that were previously in the triaxial compression state.

To the problem of the core being retrieved from the hole which properties are considerably changed in time the consequence phenomenon that is inherent in the sedimentary rocks, too, should be attributed [5,6]. It should be noted that the criterion of discrimination of the cores in the disks was used to work out the method of prognosis of the stroke hazard that is normative for the pits mining the stroke hazardous deposits at present.

To study the properties of the sedimentary rocks the long-continued experiments were carried out in the Donetsk National Technical University with the use of the sandy

shale test samples (A.I. Gayevoy mine, depth 975 m) and of the clay shale test samples ("Uglegorskaya" mine, depth 820 m, and K. Marx mine, depth 1000 m). The test samples were sampled in the mine outside the limits of the unloading influence of the mining. By means of the core drilling the holes of 5 m length and of 59 mm diameter were bored in the A.I. Gayevoy mine, the holes of 9 m depth and of 42 mm diameter were bored in the "Uglegorskaya" mine, and the holes of 5.2 m depth and of 46 mm diameter were bored in the K. Marx mine. As a basis of the investigations the phenomenon arising by the motion of the wetting liquid along the capillaries of the various dimensions (diameters) was assumed [7]. The experiments were carried out according to the following methods. The considerable number of test samples were sampled in the mine. The test samples were divided in groups in the laboratory (7-8 test samples in each group) and kept there during 900 days at the normal pressure and room temperature. The decrease of their mass up to stabilization was measured in each group of the test samples. Then according to the standard methods (ГОСТ 11014-81) the test samples were placed into the drying cabinet and dried at a temperature t = 105-110 °C during one hour. After the weighting of the test samples dried their physically bound (natural) humidity Wф.с. was ascertained. The total or maximum moisture capacity Wп was determined after satiation of the experimental samples with water (during 10 days). The tests were repeated in another groups of the test samples in 40, 150, 225, 260, 300, 350, 400, 420, 500, 560, 600, 700, 800, 820, 840, 900 days.

The principal sense of the experiments consisted in estimation of the dynamics of decrease of the natural humidity, increase of humidity of the test samples after drying and of influence on the unloading processes named, as well of the interconnection of the lasts with the change of the humidity. All the weightings were executed with the special electronic balance (type ВЛР-200г, ГОСТ 24104-80) accurate within the third after unity digit. By the study of the mine rocks properties the change of their humidity was considered not only as the physical characteristic, but also as the criterion of the increase of the pore space volume and of redistribution of the pore volume ratio with dimensions $>10^{-7}$ m, and with dimensions $<10^{-7}$ m possessing in the main different properties. The dependence of the total moisture capacity Wп and of the physically bound humidity Wф.с. on the time T for the experimental samples of the sedimentary rocks is shown in Fig. 1.

It is obvious from the results received that the unloading of the sedimentary mine rocks results in the change of the pore space structure being characterized by the increase in time of the pore volumes represented with the capillaries of more than 10^{-7} m diameter and by the simultaneous decrease of the pore volumes represented with the capillaries of less than 10^{-7} m diameter. The analysis of the experiment results allowed ascertaining the decrease of the mass of the samples at the first temporal stage, too. This process was accompanied by the evaporation of water solutions from the pores with the dimensions of more than 10^{-7} m and was fixed during 4–10 days. The unloading of the rock samples was added further to the evaporation process, what contributed to the change of the dimensions and structure of the pore space. One can suppose that the unloading was the cause of the evaporation of the water solutions from the pores of those dimensions ($<10^{-7}$ m) which the evaporation was impossible before from. It was ascertained that the double electrical layer arises at the border of division of the rock capillary walls and water which importance decreases by the increase of the pore dimensions. Taking into account the physical originality of the process ascertained one can suppose that the evaporation is conditioned by its nature by the decrease of the capillary water pressure because of the development of the process of unloading, i.e. the increase of the pore radii r. The capillary pressure Pк in the pores of the sedimentary

rocks is calculated on the capillary tension of water and the limiting wetting angle Θ=65° in accordance with the Laplace's equation [8].

$$P_к = \frac{\cos\theta}{r}.$$

It is obvious from the formula adduced that the capillary pressure will decrease by the increase of the pore diameter from 10^{-8} up to 10^{-7}, too. Just its decrease will characterize the motion of the water solutions from the unloaded massif to the mine working.

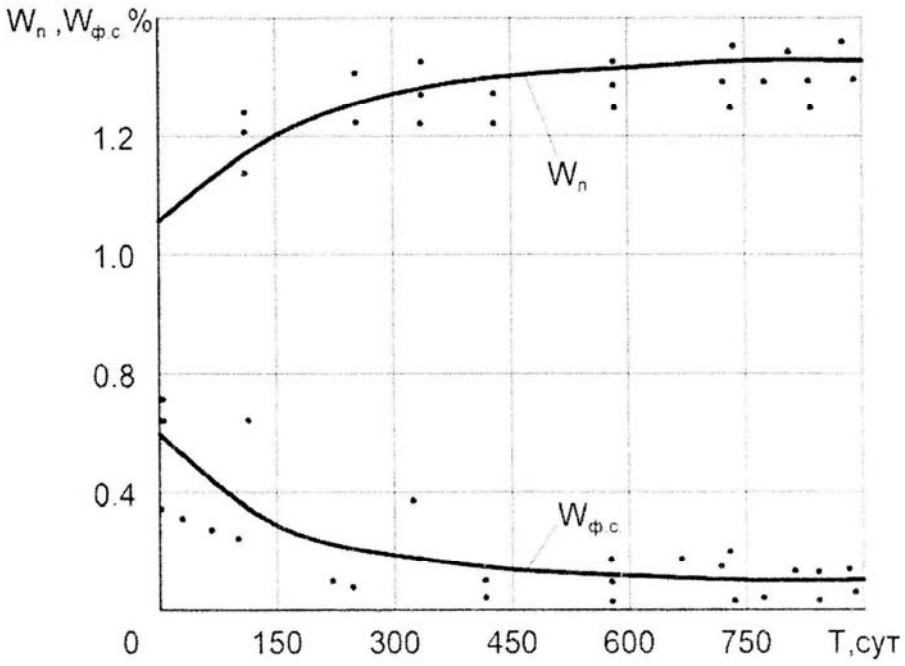

Fig.1. Dependence of the total moisture capacity Wп and the physically bound humidity Wф.c. on the time T of the sedimentary rocks samples

Thus, as a result of the investigations fulfilled it was ascertained that the destruction of the rock massif is real not only following the increase of the potential stress, but also by the unloading of the mine rocks. The necessity of the more drastic experimental study of the nature and peculiarities of the destruction of the sedimentary rocks by the unloading including the time factor and the change of the rocks moisture is absolutely obvious.

Conclusion. The dependences ascertained confirm the change of the structure of the pore space and redistribution of the pore volume with dimensions $>10^{-7}$ m $<10^{-7}$ m in the investigated samples and prove the reality of the unloading process in time, as well the practical importance, i.e. the liability of the coal-rock massif to water and gas recovery ipso facto.

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ПРО ДЕЯКІ ВЛАСТИВОСТІ ОСАДОВИХ ГІРСЬКИХ ПОРІД

В результаті виконаних досліджень встановлено залежності зміни структури порового простору зразків осадових гірських порід, що визначають їх схильність до водо- і газовіддання.

Ключові слова: гірські породи, глибина розробки, вугільний пласт, природна вологість, капіляри

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ABOUT SOME PROPERTIES OF SEDIMENTARY ROCKS

As a result of the carried out researches we established the dependences of change of structure of porous spaces of samples of the sedimentary rocks defining their liability to water and gas recovery.

Keywords: rocks, depth of working out, coal layer, natural humidity, capillaries