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ИЗВЕСТИЯ

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OF THE REPUBLIC OF KAZAKHSTAN

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♦

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CONDENSATION MINE WATERS

Abstract. Executed review of information on condensation miner waters over the past 65 years. It was noted that the creation of a new concept for the formation of condensate mines is a major scientific contribution to the theory of condensation of atmospheric moisture in mines and mines, analyzed research methods and techniques condensation of atmospheric moisture to the hygroscopic properties mine of rocks, it was noted that implementation in practice of the equipment and machinery created on the basis of a new concept, made it possible to significantly improve microclimate of mines and mines, where they approved, it is rational to use inexhaustible reserves of cold accumulated in the rocks and heat of condensation.

Keywords: a new concept formation of condensation mine waters, condensation of atmospheric humidity in mine air, heat power mass exchange, hygroscopicity and hygroscopic point, physical phenomena, determining the interaction of coexisting phases in the condensation of moisture and the opening of the frequency of the condensation process, Microclimate of mines and prospects of its management.

Introduction. Another type of condensation formations of nature are mine waters, which appear as a result of condensation in the mine air.

What do we understand by the term "condensation mine waters"?

Literally - this waters appearing in mines at the presence conditions promoting condensation of atmospheric moisture. It is known that when mining minerals miners often have to deal with various forms of water flows. This includes: ground and artesian waters, infiltration waters and etc. At the same time in mines and mines a special place, occupy condensation mine waters, brought to life by the direct intervention human in natural processes.

According to the definition, condensation mine waters - waters, periodically arising in mountain salt mine workings and karst caves from drops ("drops"), wet and moist spots and streams on the walls of the mines and the cameras. Such periodic mine water miners known as "ventilation brines."

Topicality raised problem is undeniable.

It is well known that further development of natural resources, fuel and energy will continue to be carried out by increasing the extraction of minerals.

Currently active develop extraction of non-metallic raw materials by underground method. Design and construction of new mines Upper Kama deposit of potassium ores, Satimol mine fields in Kazakhstan, Dekhanabad potash fertilizer plant in Uzbekistan. Mastering Gremyachin deposit - it the first in recent years implemented project development of a new potash mine in the CIS and Europe.

High rates of development of extraction of non-metallic raw materials by underground method make special demands to ensure efficient and safe mining production, most important condition for the realization of which are consideration of condensation processes, gas factors and climatic parameters of mine air.

In the conditions of transition to the market economy and especially in the context of real market relations, veracity forecast safety of mining works on gas and condensation factor acquires a specific economic meaning.

Neglect safety of mining operations on these indicators lead to major accidents, which cause damage owners of pit and mines. On the other hand, a systematic approach to this problem can reduce the like-

lihood of accidents, but reliable forecast development of condensation processes and gas evolution can significantly reduce the estimated amount of air for ventilation of treatment and preparatory sites, that reduces the operating costs of the mine ventilation while maintaining a high level of safety of mining operations.

If among soil scientists and hydrogeologists still continue the endless debates and discussions about the importance of atmospheric moisture condensing in the various natural processes, in mines and mining mine waters for a long time causing significant damage, often accompanied by the death of people.

The appearance of mine (mine) waters is explained by the condensation of water vapor in places of intensive revenue ventilation air: in salt mines due hygroscopicity of salt and difference temperature of moisture ventilation air it goes into solution and forms brines. Condensation brines usually formed in the summer, when the moisture-laden warm air enters the colder underground workings.

Water created not only a problem in work, but also a real threat to life for miners, that even in the past centuries have moved inventors to create systems for pumping out and eliminating water danger.

At the same time the best scientific forces Russian Academy of Sciences were involved in combating this scourge. Passage chemisorption and condensation processes in caves and mines, embedded in increased hygroscopicity rocks (rock salt, potassium salt, soda, etc.), noted in the middle of the last century E.A. Maksimovich, E.V. Korotkevich, Yu. P. Eremenko, E.V. Beltukov and several other researchers [1-4].

The high rate of development potash industry in the second half of the 20th century, began to make special demands for the provision efficient and safe mining, the most important factor is the climatic parameters of mine air. Solubility of potassium salts and associated risk of penetration water and brines in underground workings require a thorough justification of the thermal and humidity regime of mine workings. In the warm season in the mining networks of potash mines water vapor condenses on the walls of the rock mass. Moisture, falling out in large quantities, forms an aggressive environment, which deteriorates working conditions, adversely affects the mining equipment, trucks, road surface, condensation mine waters cause flooding of excavations. Intensive corrosion and destruction of metal structures, slipping and ignition of raw conveyor belts on drive drums create a dangerous situation in the production.

In the 70s of the last century plight of the microclimate of mines the young scientist Boris Kazakov became interested for a long time and seriously then, later became lead researcher of the Perm National Research Polytechnic Institute.

Starting in 1971 with the study of the interaction of mine potassium salt and moisture, he thoroughly understood in a very complex mechanism interphase transformations atmospheric moisture of air into whole underground lakes of mine brines. Starting with a small, he developed a theory of microclimate formation of mines. After thirty years of searching, jewelry experiments, laboratory research brilliantly defended his doctoral thesis, he established a scientific school and with an aid of his disciples and associates, implemented his own designs at a number of mines [5].

What is the novelty of his theory? Having analyzed an extensive initial scientific and production information B.P. Kazakov established that amount of moisture, falling out of the ventilation air when moving it along the workings, traversed in rocks with hygroscopic properties is determined not by the distribution of the moisture conductivity potential in the massif, as described under mass transfer for evaporation from the walls of excavations in coal mines and low value of the partial pressures water vapors at the surface excavation, which is caused by high hygroscopicity and water solubility sawmills potash mines.

This discovery was the starting point in the study of the possibility of controlling condensation processes and microclimates of mines with a huge economic effect. B. P. Kazakov was based on the fact that the current enterprises have powerful thermal engineering systems for heating of atmospheric air, construction which constitute a significant cash costs and energy costs for heating and moving - up to 10–20 MW per year, which is almost 30% of the total costs of the mineral extraction [5-10].

In the warm period of the year, change in the microclimate results to significant increase in costs the maintenance of transport developments in operation and maintenance conditions of safe operation transport and equipment. The solution of these problems is possible with a wide use of practically inexhaustible natural reserves of cold atmosphere, energy of rocks and creation of economical, reliable and

highly effective resource-saving technologies for preparation of atmospheric and processing mine air for complex spatial ventilation networks.

Today, all these issues are scientifically developed not deep enough, far removed from use in practice, and therefore their decision acquires a special urgency and has great theoretical, economic and social significance.

Based on these fundamental provisions, B. P. Kazakov and his associates have developed means of normalization and climate control in the workings of potash mines with a decrease in energy costs for ventilation of mines, material and labor resources in the operation of workings and equipment mines based on development theory of heat and mass transfer and creation of resource-saving technologies for the preparation atmospheric and processing of mine air in the nodes of spatial ventilation networks [5-10].

And also realized an idea about complex use of traditional and non-traditional sources energy to create energy-saving step control systems and climate control mines taking into account the peculiarities of the interaction processes ventilation flows during their movement along mountain mine with an energetically active medium of hygroscopic rocks.

On the basis of the above created a mathematical model of the original conjugated heat exchange between the flow of mine air and mountain massif for non-stationary cylindrical tasks, allowing to exclude when calculating the microclimate parameters of unsteady heat transfer coefficients, And use only the fundamental coefficients (thermal conductivity, thermal diffusivity, heat capacity).

Mathematical model proves the necessity of applying the new concept a step distribution of air treatment systems, with a spatial arrangement of heat and mass exchange modules in the nodes ventilation system taking into account characteristics of heat and mass transfer and migration of condensation on production of mines.

Also B. P. Kazakov had developed a unified mathematical model of the processes motion and mixing jets with different thermodynamic parameters and arbitrary arrangement their on relation transporting flow on the basis of turbulent heat and mass transfer taking into account their dynamic expansion and mutual influence during the motion combined flow in the air supplying trunks.

Details discussed processes moistening surfaces by condensation of moisture migration by output of mines with hygroscopic surfaces, taking into account daily and seasonal variations the partial pressure of water vapor in a binary mixture and the variable sorption activity of the surrounding rocks and principles of creating conditions for the accumulation of energy in stratified salt solutions and methods of artificial "pumping" of cold with allowance for turbulent convection based on the solution system of equations for a single-component fluid for weak convection in the framework of a second-order model [5-10].

Since the beginning active study of the causes formation condensation mines passed a little more than 65 years.

A large number of scientists and production workers (Isachenko V.N., Terekhov V.V., Sharov K.A.) paid great attention to directly study the mechanism of transformation of atmospheric moisture in mine condensation water, connecting in a single process heat and condensation [11, 12].

In the future, russian scientists (Kazakov B.P., Medvedev I.I., Shcherban, Dudar E.S., Vlasov D.V., Levin L.Yu. and many others) were developed scientific foundations of filtration diffusion methods for the prediction of gas evolution and condensation gas situations in mine workings, based on use fundamental laws of thermodynamics and physical chemistry, which significantly increased reliability forecast of occurring phenomena.

Now, when developing deposits of non-metallic minerals (especially potash and salt) an important place is given to studies of the interaction atmospheric moisture from injected air and mine rocks.

A detailed study influence the hygroscopicity rocks on the process of condensation moisture in mine ventilation system was made an assistant professor of Perm State University Elena Dudar [13-17].

Submitted to it by the results of numerical experiments and field observations allow fairly accurately assess the influence of the hygroscopicity rocks on activity of condensation processes, estimate the amount precipitating in the mine moisture and size of the condensation zone and also to find out some regularities of its formation.

Field observations at specific sites confirmed that during the warm season occurs cooling of outside air, entering in the ventilation network mine. In this case, water vapor contained in the air condenses, falling out in the form of moisture on the walls of the rock massif.

According to the survey noted that for small values of hygroscopic point falls a greater amount of moisture, up to 12000 tons, with a constant condensation zone size equal to 5 km [17].

Condensation can take place in any ventilated underground structures, wells, voids, but to the greatest extent it is characteristic of shallow potash mines, in which the process is intensified due to the high hygroscopicity of the rocks. Moisture and salt form an aggressive environment that adversely affects mine equipment, it reduces the load-bearing capacity of pillars, leading to flooding of mine workings. In conditions of increased hygroscopicity of rocks, air treatment is necessary, to reduce or completely eliminate the loss of moisture from the air [14-16].

It was found that on this problem in related sciences have certain developments [18, 19]. The point of view of these scientists is based on the fact that physico-chemical properties of thin liquid layers are substantially different from its properties in the bulk phase.

It is believed that in the case of the system "solid - water" impact surface phase section on the structure of a liquid can be transferred from layer to layer by a certain chain mechanism so that forms a continuous series of transition states from the crystal lattice to the saturated solution [19].

Thus, on hygroscopic surface will form a saturated solution salts with variable concentration. And if the law of Raul partial vapor pressure above the solution always less than over the pure solvent, over the adsorbed layer, it will be even less, which leads to the intensification of the process of moisture absorption from the air [18].

The model of "adsorbed layer" is more complicated, since in it, along with dilution saturated solution (condensation) takes into account simultaneously occurring dissolution of the solid phase. In this case, sorbed water is considered as a saturated salt solution with a constant at this temperature water vapor pressure above it.

Thus, humidification salts occurs when partial pressure water vapor in the surrounding atmosphere more vapor pressure over a saturated solution same salt at the same temperature [18].

Taking into account quantitatively hygroscopicity through the critical relative humidity (hygroscopic point), that is the humidity at which moisture begins to fall out from the air.

To assess this effect hygroscopicity rocks on the process of condensation, a model problem was considered in which mine network was modeled by system of parallel excavations.

The observed phenomenon of multiple condensation of atmospheric moisture when the corresponding conditions arise universal nature.

Studies E. Dudar showed that hygroscopicity of the rocks has a significant effect on the process of condensation.

In his studies in the Red Cave near Simferopol, V.N. Dublyanskii repeatedly observed inside daily recurrence of condensation an average of 15 times per day and N.F. Lukin discovered this phenomenon when studying condensation in soil, where this process was repeated more than twenty times a day.

In the seven-year experiment hydrogeologists of the Yalta expedition with scrap material of 22 cubic meters they received 12 liters per day of condensate water, and the process was resumed only on the third day. Studies of this process were, unfortunately, interrupted in connection with the restructuring of the termination of funding.

For consideration problems of mine waters are of great interest for implementation in practice of the field development plan for scientific research and recommendations L.Yu. Levin [20, 21].

His proposals are as follows. During the summer period, air-heater systems existing with each air-discharge barrel can be used for cooling and dehumidifying air. The principle operation of such plants is supply of a cooled coolant to the tubes of air heaters, where moist air, in contact with the cold walls of the tubes, is subjected to drying and cooling. Cold brine or another coolant from the pickle of refrigerant through the filter is fed to the heat exchanger. In air heater pump unit is fed into this circulating chilled water ring. Dehumidified air after coolers for air heater channel enters into the barrel where it is mixed with the untreated part of the air. The advantages of this method are a minimum reconstruction of the air heater and its use throughout the year.

A special feature of the calculation heat exchangers working on air cooling is the generation of heat during the condensation of water vapor, which goes for additional heating water.

The mathematical description of air dehumidification in air-conditioning units was used to create a program for calorimeter setting in the summer, which allows to predict the basic operation of plants, that

is an air temperature and refrigerant at the outlet from the heat exchangers apparatus, critical air temperature and amount of moisture released at the same time.

It should be borne in mind that the heating systems of the air supply shafts using gas heat generators, developed on the basis of three-dimensional numerical modeling of air flows, taking into account the individual aerodynamic features of the surface complex and providing the operation of heat exchanging equipment under conditions of condensation mode of heat exchange at the maximum coefficient use of fuel.

As a rule, in existing air conditioning systems, atmospheric air is heated in air-conditioning units, the heat carrier in which is superheated water from heat networks. Heat losses during transport of coolant and the heated air moving air heater in such installations is 30-50%. Therefore, recently, during the reconstruction of heating systems of shafts, a great interest is caused by technological schemes for heating atmospheric air with using gas heaters, which is due to relatively low operating costs, minimal losses of thermal energy and high efficiency use of fuel [20, 21].

Summarizing, it is worth noting that the deterioration of the ecological situation in many deposits of potassium salts and safe working conditions requires more vigorous efforts to eliminate negative phenomena and their consequences, as well as rapid adoption of measures to create reliable means of protecting the environment from man-made impacts.

In many respects, deterioration of the ecological situation is facilitated by the formation of condensate mine waters, which are the destroyers of the pillars, walls and roof, etc. Consequently, solution of the problem ensuring environmental safety and prevention necessitates a special approach for solution.

These problems, as a rule, require practical actions and are not solved using only mathematical analysis. The urgency of the same problem, is caused both by extreme vulnerability from man-caused factors of one of the most important natural resources and the large-scale consequences of such especially hard-to-eradicate groundwaters.

Developed on the basis of new scientific concept of the formation of condensation mine waters recommendations have social and environmental benefits, can give great savings. They should be introduced at mines and mines in the CIS, in particular in Kazakhstan, for example, in fields of the type Satimola.

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КОНДЕНСАЦИЯЛЫҚ КЕНІШ СУЫ

Аннотация. Мақалада соңғы 65 жылда конденсациялық кеніш сулары бойынша ақпараттық шолу жасалған. Конденсациялық кеніш суларын қалыптастырудың жаңа тұжырымдамасын құру кеніштер мен шахталарда атмосфералық ылғалдылық конденсациясы теориясына жасалған үлкен ғылыми үлес болып табылады, ылғал тартқыштық жыныстарын ескере отырып, атмосфералық ылғалдылықтың конденсациясын зерттеу әдістері мен тәсілдері талданған, жаңа тұжырымдаманың негізінде құрылған құралдар мен механизмдердің тәжірибесіне енгізу кеніштер мен шахталардың микроклиматын айтарлықтай жақсартуға мүмкіндік берді деп көрсетілген, онда олар тау жыныстарында және конденсация жылуында шоғырланған суықтың таусылмас қорлары тиімді пайдаланылған, мақұлданған.

Түйін сөздер: конденсациялық кеніш суын қалыптастырудың жаңа тұжырымдамасы, кеніш ауасындағы атмосфералық ылғалдылықтың конденсациясы, жылу энергиялық массалық алмасу, ылғал тартқыштық және ылғал жұтқыш нүкте, ылғалдың конденсациясы кезінде қолданыстағы кезеңдердің өзара әрекеттесуін және конденсациялық үдерістің қайталанушылығын ашуын анықтайтын физикалық құбылыс, кеніштердің микроклиматы және оны басқару келешегі.

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ТОО "ОБИС", Алматы, Казахстан

КОНДЕНСАЦИОННЫЕ РУДНИЧНЫЕ ВОДЫ

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Ключевые слова: новая концепция формирования конденсационных рудничных вод, конденсация атмосферной влаги в рудничном воздухе, теплоэнергомассообмен, гигроскопичность и гигроскопическая точка, физические явления, определяющих взаимодействие сосуществующих фаз при конденсации влаги и открытие повторяемости конденсационного процесса, микроклимат рудников и перспективы его управлением.

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