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PROSPECTS OF UTILIZATION MINING METHANE ON THE BASIS OF GAS HYDRATE TECHNOLOGIES

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Abstract: the peculiarities of the innovative approach to the utilization of coal mine methane, which is extracted by significant volumes due to the technological process of underground development of coal-gas fields, are revealed. An innovative energy-saving technology for producing gas hydrates with the maximum possible accumulation of alternative gas volume on the basis of methane degassing systems of coal mines in the Western Donbass and transporting them to the infrastructure of the region to reduce the share of imported gas and pollution.

Keywords: gas hydrate, mine methane, coal mine, energy, degassing system

Western Donbass is a strategically important region for ensuring the energy independence of our country, where coal (over 60%) is extracted for the generation of energy in thermal power plants [1, p. 29; 2, p. 5]. The intensive development of Western Donbass reserves is accompanied by the release of an integral component of coal seams – coal-methane gas, which complicates mining and leads to the creation of ways to combat it – the construction of underground or surface degassing systems [3, p. 137].

In most high-gas mining companies, coal mine gas is almost completely emitted into the atmosphere through data from ventilation and degassing systems, except for

the share of enterprises using it to generate electricity and heat their own infrastructure
8 – 10% [4, p. 300]. This leads to irrational annual loss of valuable energy and environmental pollution [5, p. 4983].

All coal mines that are part of PJSC "DTEK Pavlohradvuhillia" and operate the Western Donbass coal reserves are gaseous – from the second category to the over-category. The projected reserves of methane for 10 coal mines reach 10 billion m^3, and annually 100 – 120 million m^3 of methane gas is released by the systems of mine degassing and ventilation, which damages the atmospheric air and the environment [6, p. 21].

The degassing systems are used at the high-gaseous mines of "Zakhidno-Donbaska", "Stepova", "Yuvileina", "Ternivska", and "Heroiv Kosmosu". It should be noted that the concentration of methane in the methane-air mixture varies widely – from 3.2 to 60.0%, averaging 30.0 – 40.0% [7, p. 42]. Therefore, to increase the methane content of the mixture, it is necessary to provide a set of technical solutions for the modernization of degassing systems.

The use of mine methane as a substitute for natural gas to provide the public and industrial facilities is constrained by significant capital investment for the construction of pipelines and measures to increase methane concentration in the methane air mixture to the level of natural gas.

Based on current global trends in the use of mine methane as an energy carrier [8, p. 137; 9, p. 155] promising and innovative direction for mine methane utilization may be the use of gas hydrate technologies to convert it from a gas state to a crystalline state. In this case, 1 m^3 of gas hydrate contains up to 200 m^3 of gas, suitable for transportation in special cooling mobile units. However, this technological solution requires carrying out a complex of new scientific researches, namely rationally selected thermobaric conditions of hydration and features of decomposition of gas hydrates [10, p. 397; 11, p. 12]. Based on these ideas, work has been done on the use of generator gas methane in underground coal gasification to create artificial gas hydrates [12, p. 289; 13, p. 174]. That is, for the most complete

and effective development of energy resources of coal-gas fields, a scientific and methodological approach to the development and introduction of new technologies needs to be innovative, comprehensive and synergistic [14, p. 290; 15, p. 31], and their impact on the environment is minimal [16, p. 46; 17, p. 77].

The solution of the problems of rational use of methane resources of coal mines and the reduction of its emissions into the atmosphere through the use of gas hydrate technologies for the coal mining region of Western Donbass is very relevant.

Projects for the utilization and rational development of coal bed methane are mainly implemented through the use of coal boilers for the use of underground gas degassing grids, surface degassing systems (stationary installations), construction of cogeneration stations to generate electricity and heat. To reduce methane emissions into the atmosphere, flares are installed. All these innovations make it possible to recycle up to 20% of the methane recovered, but a significant part of them is released into the atmosphere.

Western Donbass infrastructure is characterized by the presence of a number of industrial sites and small settlements with an average density of location. Accordingly, the main consumers of potentially extracted methane can be both industrial enterprises and the population of cities and surrounding settlements.

To date, projects to maximize the use of methane resources extracted from coal mines by ventilation and degassing systems are not being implemented. In the first approximation, the prospecting enterprises for the implementation of gas methane technologies for the rational use of mine methane are the West Donbass mines, which are located in the outskirts of the town of Ternivka and where the system of underground degassing is used. The enlarged algorithm of execution of technological processes for providing settlements with alternative gas is shown in Fig. 1.

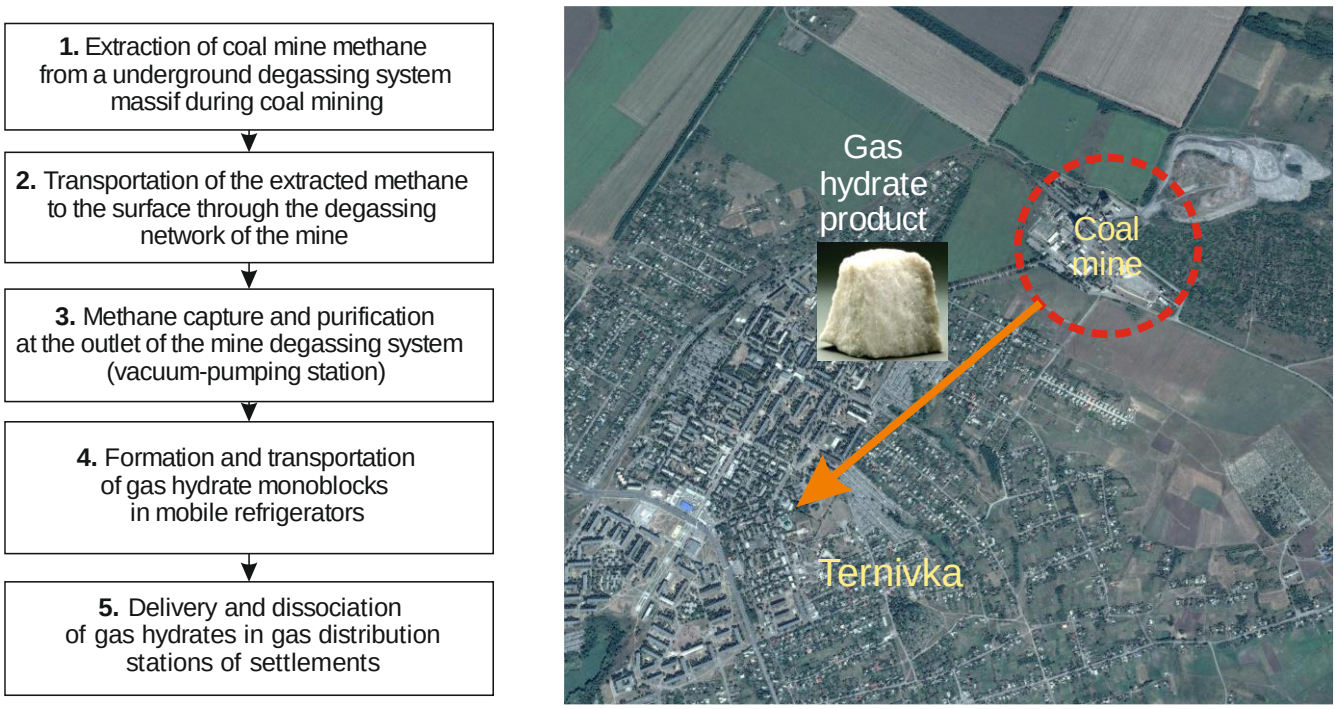

Fig. 1. Algorithm of execution of technological processes for providing settlements with alternative gas

The operation of the proposed technological system for the production of artificial gas hydrates is as follows. The methane-air mixture is extracted in the process of coal mining through degassing wells drilled through the rock behind the treatment site. Then, from all the clearing holes, the methane is transported via the degassing well network to the bottom surface, and if it is not designed to use methane to heat the surface of the buildings, the methane is released into the air after the vacuum pumping station. After the vacuum pumping station, it is proposed to install an additional methane-air mixture purification unit, after which the purified gas enters the capacity of the mobile refrigeration mobile unit equipped with the hydration reactor. Under certain thermobaric conditions, the formation of a gas hydrate in the reactor is possible with the addition of intensifiers and process water. As the tank is filled, the mobile unit transports monolithic gas hydrate units from the mine to the distribution stations of the settlements where the gas hydrate unit is subject to dissociation.

In the presence at the mine of technological units for gas treatment a day, it is possible to get 10 – 15 thousand m^3 of purified methane from the degassing system. The daily supply of alternative gas by civil and industrial buildings will depend on

the speed of formation of gas hydrates and the number of mobile refrigeration units operating production routes in the mine settlement system.

Thus, the implementation of gas hydrate technologies in operating coal mines will allow for a number of significant improvements, namely:

– to provide the population of settlements close to coal mines with alternative gas for heating of civil or industrial buildings;

– to provide alternative gas with small or non-gasified settlements close to coal mines;

– it is rational to use mine methane and to obtain alternative gas with a projected and expected cost of 100 – 120 $/1000 m^3 of gas, which is 50 – 60% lower than traditional natural gas;

– increase the level of utilization of methane in coal mines by 85 – 90% and reduce its emissions into the atmosphere;

– create additional jobs for coal mines to service the hydration complex.

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