ENGINEERING SCIENCES

FORMATION OF A MODERN APPROACH TO THE SYNTHESIS OF TECHNOLOGIES WHEN MINING GAS-COAL DEPOSITS

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The coal industry occupies one of the key positions in forming the nationwide energy balance of Ukraine. About 35% of all electricity is generated from mined hard coal by burning it in thermal power plants [1, p. 28]. Every year, coal production becomes more difficult, which is caused by the priority of mining the better, economically attractive reserves and gradual transition to reserves of poorer quality. Coal is mined using mechanized complexes. Nevertheless, hard-to-reach coal reserves remain in the mine fields, the loss of which is contrary to the principles of rational nature management.

Natural coal mine gas-methane is a complicating factor that limits the volumes and rhythm of coal production at mines, and at the same time is a useful energy resource. Coal mine gas-methane, millions of cubic meters of which are annually emitted into the atmosphere, is an alternative energy source that can be used to replace natural gas. This aspect is fixed in the Law of Ukraine "On Alternative Fuels", and its exploration, extraction and use is regulated by the Law of Ukraine "On Gas (Methane) from Coal Deposits" [2, p. 1; 3, p. 1]. The energy value of coal mine gas-methane has been proven by many examples of its associated production and use in many countries around the world [4, p. 2; 5, p. 1].

Considering also the energy value of coal mine gas-methane and the huge volumes of its occurrence in a coal deposit in addition to coal, it is more expedient to call such a deposit "gas-coal". This is coal mine gas-methane in the coal-bearing stratum of the coal enterprise mine field, which is contained in coal seams, their associated interlayers and host rocks. Various types of degassing are used to extract coal mine gas-methane from the coal-rock stratum at large, modern and promising mines [6, p. 3]. With the underground degassing method, the concentration of CH_4 in the gas-air mixture ranges from 25-60%,

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and with the surface method, the gas-air mixture contains up to 90-97% of methane.

In order to improve mining efficiency and environmental protection, a number of mines, such as Stepova Mine, Mine Administration Pokrovske and Krasnolymanska Mine, have applied innovative projects for the utilization of coal mine gas-methane for the production of electricity and thermal energy. As an example, about 17000 Gcal of heat was produced at the Krasnolymanska Mine from 19.8 million m^3 of coal mine gas-methane captured by the degassing process, and about 6 million kW of electricity was obtained at the Stepova Mine (DTEK Pavlohradvuhillia) from 1.3 million m^3 of extracted coal mine gas-methane [7, p. 1]. At 6 mines, where the CH_4 concentration in the gas-air mixture is more than 25%, gas-methane is utilized along with degassing, and the level of its utilization for the economic purposes of surface complexes ranges from 10 to 40%. Therefore, it can be stated that the energy potential of coal mine gas-methane during mining operations is extracted from the bowels and is not fully utilized for the needs of industry and the population.

In the traditional mining of coal deposits (mechanized mining), as a result of the diversity of mining-geological conditions for coal seam mining (hypsometry, geological disturbances, fluctuations in the seam thickness), there are cases when it is not economically feasible or impossible to extract certain volumes of coal reserves. In such cases, the technology of borehole underground coal gasification (BUCG) is applicable, since the experience of its implementation has been confirmed in a number of leading countries of the world [8, p. 39; 9, p. 2]. Underground gasification has a strong advantage over traditional mechanized mining of hard-to-reach reserves, because their opening and preparation by production wells from the daylight surface can be conducted anywhere along the mine field area.

Underground gasification is a physical-chemical process of converting coal into combustible gases with sufficient caloric content for energy and technological use. The final underground gasification product is generator synthesis gas, which contains a wide range of valuable combustible gases. The technology for implementing underground gasification provides for a wide range of physical-chemical studies on coal conversion, as well as the development of efficient schemes for conducting mining operations. The generator gas also contains methane in the range of 5-25%, depending on the type of injected blast, coal composition, etc. It is also expedient to consider the specified gas as an associated energy resource and develop technological solutions for its further use.

Therefore, in the complex mining of a gas-coal deposit using the synthesis of technologies for traditional mechanized mining of the main balance reserves and underground gasification for mining hard-to-reach reserves, productive

gas-methane flows are formed: with the traditional method – from underground and surface degassing systems, in underground gasification – as part of the resulting generator synthesis gas.

The gas-methane produced by these technologies, in addition to generating electricity and heat in a coal mine, can also be used for a wide range of industries, including heating settlements in close proximity (with a methane content of 90-97%) using gas hydrate technology [10, p. 398]. The gas hydrate technology provides for the conversion of gas-methane extracted by the degassing system from gaseous to a crystalline solid gas-hydrate state, in 1 m^3 of which 160 m^3 of methane can be placed in a compressed state. This technology for producing ice-like blocks will make it possible to transport compressed gas by special refrigeration units to consumers in a more economical way than pipeline transport [11, p. 171].

As a result of using the gas hydrate technology, the total level of methane utilization (for energy production and use in other industries) in the synthesis of technologies can be increased to 80-90%. However, the scientific idea needs to conduct a complex of studies on rational thermobaric parameters of the hydrate formation process based on coal mine gas-methane of different concentrations.

Given the aspects of extracting the energy resources of a gas-coal deposit in a complex, the formation of a modern approach to the implementation of technologies can be schematically represented in Figure 1. Thus, an increase in the production of energy resources from gas-coal deposits is possible through the synthesis of technologies based on a synergistic approach, which provides for the creation of new principles of forming a complex technological innovative mining system from simpler elements using their best peculiarities and advantages.

A complex innovative mining system is transformed by combining technological elements for different conditions: for operating coal mines – “Mechanized mining – Gas hydrate technology – BUCG technology”, and for mothballed and closed mines having off-balance reserves – “BUCG technology – Gas hydrate technology”.

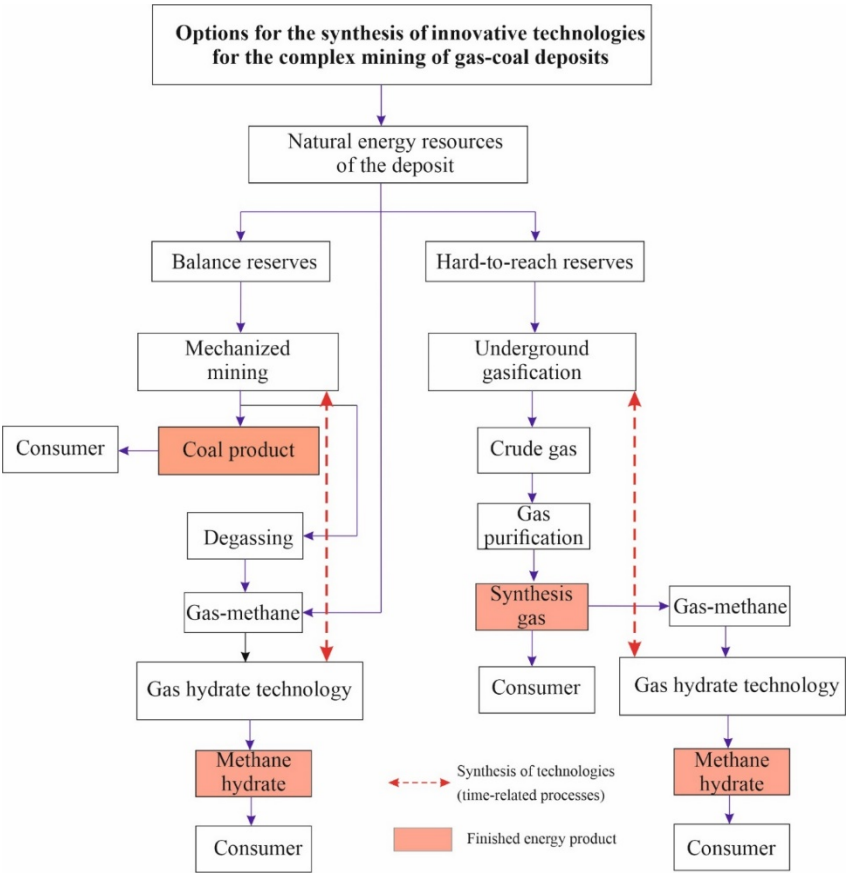

Figure 1. Options for the synthesis of technologies for the full-fledged production of energy resources in the complex mining of gas-coal deposits

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