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FORMATION OF THERMAL FIELDS BY THE ENERGY-CHEMICAL COMPLEX OF COAL GASIFICATION

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ФОРМУВАННЯ ТЕПЛОВИХ ПОЛІВ ЕНЕРГОХІМІЧНИМ КОМПЛЕКСОМ З ГАЗИФІКАЦІЇ ВУГІЛЛЯ

Purpose. The objective is to generate thermal energy from basic segments of the energy-chemical complex formed on the basis of borehole underground coal gasification with determination of its operation modes.

Methodology. The set engineering tasks were performed using, analytical studies, bench studies and field studies represented in research projects, patents, and feasibility studies concerning construction and scientific support while equipment operating of a pilot mine gasifier under the conditions of solid fuel seam gasification in the context of excessive fissuring of rock mass enclosing the gasifier. Studies of thermal and power indices of the station for coal gasification were carried out with the help of Information Program “MTB BUCG” (“Material and Thermal Balance of Borehole Underground Coal Gasification”) developed by the researchers of the Department of Underground Mining and the Department of Chemistry (State Higher Educational Institution “National Mining University”). Besides, the Program was piloted using industrial gasifier at experimental mine “Barbara” (Katowice, Poland).

Findings. Basic indices of coal gasification station depending upon a type of forced-draft mixture for an underground gasifier were determined. Studies concerning the efficiency of thermal energy generation were carried out using rocks enclosing the underground gasifier and generator gases being the basic heat generating segments of the energy-chemical complex for coal gasification being formed on the territories of operating coal mines or mines at the stage of their closure. Prospects of gasification and thermal energy generation using rock disposals of coal mines have been estimated. Modes of internal heat provision of heat-generating segments of the energy-chemical complex have been determined.

Originality. Dependencies of heat-exchange distribution within roof rocks in the process of coal seam gasification depending upon the length of a reaction channel, zones of thermochemical reactions in it and methods of heat exchange have been obtained. Dependence of payback period of cogeneration plant in terms of underground coal gasification on electrical energy and gasification product (generator gas) has been determined. Graph of thermal energy generation in terms of different operation modes of basic segments of energy-chemical complex has been constructed.

Practical value. Technological scheme of a thermal utilizer has been developed. The plant provides possibility of thermal energy utilization in the process of coal gasification within the seam occurrence. Basic modes of thermal energy generation at the coal gasification station being a heat-generating segment of the energy-chemical complex have been determined.

Keywords: *underground gasification, thermal field, heat energy, energy-chemical complex, coal seam, generator gas*

Introduction. Currently, increase in electrical energy consumption takes place in Ukraine as a result of tech boom. This factors into increase in coal production and energy feedstock turnover [1]. Lack of rational planning and control over electrical energy consumption as well as power resources production results in unreasonable technogenic load on the environment [2]. In terms of nonreciprocal effect of mining enterprises and energy providers engaged in mining and processing of power resources on the environment it is quite critical to implement technological processes with minimum emissions and complex use of sources of both natural energy and technogenic one.

Closure of coal mines causes a number of problems connected with socio-economic and ecological factors [3]. The mines contain non-commercial reserves of solid fuel seams developed partially by mine workings [4]. The analysis of the world practices shows that in the field of fuel and energy complex it is efficient to mine and process such reserves within their occurrence obtaining chemicals and energy products according to the method of borehole underground coal gasification (BUCG) [5]. Open coal reserves are prepared by mine gasifiers. Mine field reserves which have not been undermined yet, are developed with the help of underground gasifiers prepared from the Earth's surface. Underground gasification of extraction pillars of gasifiers is performed downward, upward, or along the strike. While implementing the BUCG method, the mine facilities are restructured for a surface complex to purify and process gasification products [6]. This helps make considerable reduce in costs for industrial construction of the complex infrastructure.

Analysis of the recent research and publications. Formation of an energy-chemical complex in the context of underground coal gasification within mine facilities makes it possible to develop mobile and module plant providing optimum indices of power energy and thermal energy generation. Components which should be involved in the process of coal gasification within its occurrence are as follows: changes in technological parameters of underground gasifiers [7], mining and technical [8] and mining and geological situations [9] of an area for degassing.

Gasification of coal formations in the context of Ukraine should involve information concerning thickness of solid fuel seams. Basically, according to geological data, it is no more than a meter. In compliance with the proper criteria taking into consideration the current state of engineering science, in terms of enclosing roof and floor undermining and overmining, such solid fuel seams are suitable for the BUCG [10].

Both world and national practices concerning the development of methods for underground gasification of solid fuel types show that to implement gasification methods using a BUCG station under the conditions of Ukrainian coal basins it is required to engage maximum quantity of gasifiers to provide the efficiency [11]. Hence, capacity of surface complex for gasification products purifying and processing should be sufficient to maintain 3 to 5 stations. The analysis of a number of conducted studies verifies the gasification method efficiency as it provides fuel gases [12] as well as thermal energy [13]. Potential of the energy type may be applied to heat the gasification station and to cover the requirements of housing and utilities infrastructure.

Currently, mining and geological conditions as well as mining and technical conditions of coal seams occurrence in Ukraine force to improve the gasification method which will provide the efficiency of heat and material balance and economic expediency of the process. Not only changes in leaktightness of the gasifier along with reaction channel movement but also increase in degassed area should be taken into consideration.

Unsolved aspects of the problem. Studies on coal gasification process have paid much attention to a formation of thermal field around underground gasifier with a possibility of the heat recuperation using rock mass [13]. However, the studies have not taken into account the fact that the underground gasifier is a component of the energy-chemical complex located on the territory of an operating mine or a mine being at the stage of its closure. In this context, the formed complex can obtain thermal energy not only from rock mass enclosing the underground gasifier but also from the combustible gases and available mine dumps.

Objective of the paper is to analyze possibilities of thermal energy generation in the process of energy-chemical complex operation on the basis of underground coal gasification with the determination of its basic operation modes.

Explanation of scientific results. Power gas providing the generation of electricity, technical gas and condensate for the production of chemical raw material (Fig. 1) as well as the heat of gasification products and rocks enclosing the gasifier are basic products of a BUCG station. The formed energy and chemical complex gives the most expedient possibility for the complete use of thermal energy.

Table 1 demonstrates basic indices of a BUCG station in terms of gasification of a coal seam with m = 0.82 m thickness (Solenivka coal area of Krasnoarmeisk district, Donetsk region).

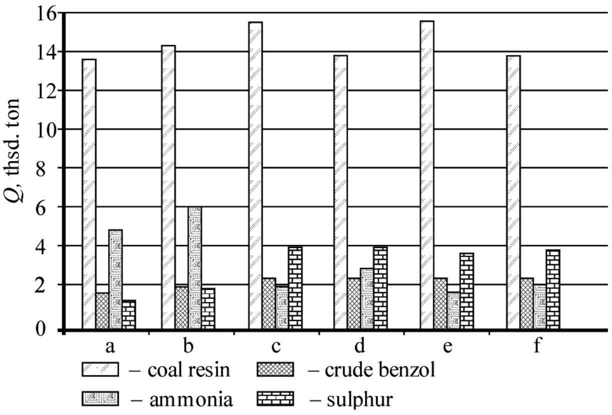

Fig. 1. Output of chemical products in terms of gasification of coal seam with thickness of m = 0.82 m (Solenivka coal area of Krasnoarmeisk district, Donetsk region):
a – air forced draft; b – water and vapour forced draft; c – oxygenic (O_2 = 65 %); d – vapour and oxygenic; e – carbon and oxygenic (O_2+CO_2); f – vapour, carbon and oxygenic; (H_2O (vapour)+O_2+CO_2

Table 1

Basic indices of a BUCG station in terms of gasification of thin coal seam with different compositions of forced-draft mixture supply

Indices of gasification with 5 gasifiers	Composition of forced draft					
	air	oxygen	O_2+CO_2+ vapour	O_2+CO_2	vapour and air	O_2+vapour
Thermal capacity, Gcal	79.85	118.00	108.70	120.60	90.50	122.10
Power capacity, mW	92.60	136.90	126.10	139.90	105.00	141.64
Combustion gases generation (CH_4, CO, H_2), mln m^3/year	233.80	468.30	395.00	503.50	297.60	529.40

Rational use of heat produced by the underground gasifier in the period of active thermochemical process helps provide heating of forced-draft mixtures, conversion processes within a surface complex as well as domestic needs of BUCG stations. In the course of productive process attenuation, the utilized thermal energy by the gasifier is supplied to vapour turbine plant to generate electricity; and the residual heat is supplied to production processes of active systems of BUCG stations. Average power of the attenuating underground gasifier is 15–24.4 Gcal or 17.4–28.3 mW; operational period of the vapour generator after coal seam gasification in a vapour mode (t > 100 °C) is 1.2–1.9 years, in the context of thermal mode, it is 1.7–3.0 years if t = 98.5–67.8 °C.

Both complex and rational uses of secondary resources being a result of gasification makes it possible to provide the efficiency, safety, and low-waste gasification process of thin seams of solid fuel. As it has already been mentioned, the efficiency of a gasification station is in its complete use of thermal energy. Functionality of the station is provided at the expense of the formed energy-chemical complex in the neighbourhood of a mining enterprise, a mine in particular. That is why, to analyse the efficiency of thermal energy generation in the process of energy and chemical process operation on the basis of underground coal gasification, the authors have studied the formation of thermal fields around fire face, generator gases, and waste dumps. Waste dumps are one of the components of the energy-chemical complex located on the territory of a mining enterprise.

Thermal field formation within the rocks around fire face. Gasification product and rocks enclosing the gasifier are those heat carriers and energy accumulators in the process of BUCG method use. Heat is extracted from the heat carriers and accumulators during gasification period and in the course of attenuation process.

Dynamics of temperature field formation within rocks and gasifier is connected with the availability of both convection and conduction heat exchanges among gaseous BUCG products, fire face, and rock mass depending upon mining and geological as well as mining and technical conditions of solid fuel seams occurrence. The analysis of industrial, bench, laboratory, and analytical research of a thin seam gasification process [14] has helped to construct a graph of average field of temperature distribution according to the length of fire face of the underground gasifier (Fig. 2).

Formation of transition zone and reduction zone as well as their functionality depends upon controllability and direction of oxidation reactions within oxidation zone forming a temperature capsule through time and space around the reaction channel taking into consideration the advance of the fire face, leaktightness of the gasifier as well as heat-capacity indices and thermal-conductivity indices of rocks. In terms of a reduction zone, thermochemical reactions proceed with the consumption of heat generated within the oxidation zone if the zones are balanced at the expense of compensation of endothermic effect of carbon-CO_2 and carbon-H_2O reactions. Physical and chemical factors are formed within the transition zone. The factors have an effect on kinetics of reduction zone reactions while generating combustible components of generator gas (CO, CH_4, H_2, etc.).

Thermal field formation around the produced generator gas and its recuperation. Generator gas, getting to the surface through a gas-outlet well, is a vapour-gas mixture of solid fuel gasification products; when the mixture cools down, liquid phase (condensate) and gaseous phase are formed. While cooling down, the condensate is divided into resin water solution of various chemical compounds and resin. BUCG gas contains 0.3–0.7 g/m^3 of coal dust and rock dust, chimney soot and other inclusions.

The temperature of residual BUCG gases heat is rather high (300–600 °C). Taking into consideration features of the BUCG method, the authors of the paper have designed a heat utilizer providing a possibility to use power by generator gas in the process of an underground gasifier operation (Fig. 3). Compared with standard heat utilizers it is far more advantageous both in terms of its design and economic expediency.

The heat utilizer is mounted in a pipeline network of the surface complex to purify and process products of underground gasification. The design took into consideration the necessity to distribute aggressive vapour-gas raw material involving long period of the resource operation of the plant.

The heat exchanger-utilizer is a case-like steel or ceramic heat recuperator with steel or ceramic pipes inside. Parting wall divides it into two parts – a vapour part and condensate one. Generator gas is supplied into

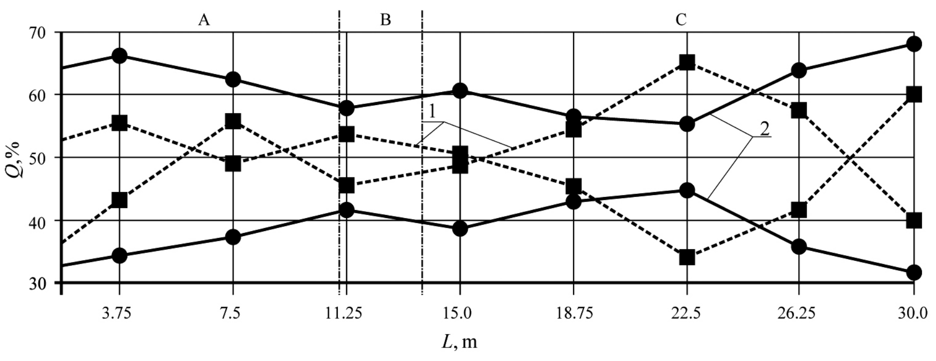

Fig. 2. Heat-exchange distribution (Q) within roof rocks in the process of thin coal seam gasification taking into account the length of fire face (L) and zones of reaction channel of the gasifier:
A – oxidation zone; B – transition zone; C – reduction zone; 1 – conductive heat exchange; 2 – convection heat exchange

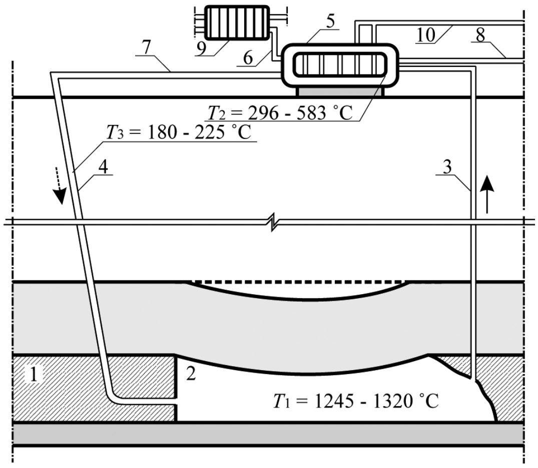

Fig. 3. Technological scheme of the heat utilizer:
1 – coal seam; 2 – reaction channel of underground gasifier; 3 – gas-outlet well; 4 – forced-draft well; 5 – heat exchanger-utilizer on heat pipes; 6 – pipe-line with generator gas; 7 – pipe-line for the supply of vapour-air mixture; 8 – pipe-line to remove BUCG products; 9 – heat exchanger; 10 – pipe-line for water supply

the vapour part. Then the heat is supplied into the condensate part through heat pipes. Simultaneously, air forced draft required for gasification is supplied to the same part. The generated vapour-air mixture heated up to 180–225 °C is supplied to a forced-draft well with its forwarding to a fire face of the underground gasifier. Operation principle of the heat exchanger on heat pipes is to transfer heat flow from one gas medium to another one: gas – air – water – vapour. Alkaline metals (potassium, nitrogen, lithium, etc.) with high thermal capacity are used within the pipes as a heat carrier.

The heat exchangers on pipes are compact, reliable, ergonomic, and mobile. Highly efficient heat exchange and deep utilization of the heat by vapour-gas BUCG product with its fractionation is one of the most promising trends for thermal energy generation.

Taking into consideration current tendencies of cogeneration technologies development, the Department of Underground Mining of State HEI "NMU" has developed technological schemes with free-piston units (FPUs), accumulators of heat energy, gas-vapour turbine, and combined system of power resources generation using unified energy carrier – artificial gas generated on the basis of borehole underground coal gasification. Generator gas is used to generate electricity and thermal energy in a group of vapour gas turbines, FPUs. In this context, combustion products from turbines and units are supplied to a waste-heat boiler to generate vapour applied to generate heat or electricity. Residual heat of outcoming gases from the waste-heat boiler is reused within two thermal accumulators: autonomous peak circuit to generate electricity and within underground accumulator to utilize heat for heat-supplying needs. Vapour generators mounted in the wells of underground gasifier utilize the heat of generator gases, and vapour being formed in the generator is supplied for vapour-water electricity generation and partially for underground accumulator. Accumulators collect, store, and generate thermal energy. The system of thermal energy accumulation makes it possible for a combined electric power station to operate 3–5 hours in a peak mode.

Use of heat as an intermediate energy carrier of heat-intensive liquid (technical oil, brine solution, glycol, etc.) in the process of accumulation makes it possible to improve the efficiency of cogeneration station by 60 % in terms of peak mode. Implementation of such principle of energy cogeneration in terms of BUCG provides fuel saving up to 35 %, and the process efficiency is 44–52 %.

Cogeneration, combined technology of energy generation is applied both in the process of solid fuel seams gasification and after the process termination using the heat accumulated within the rock strata enclosing the gasifier. Payback period of such a cogeneration plant on the basis of gas-turbine engines taking into account the prices for electricity is 1.4–2.5 years (Fig. 4).

Prospects of gasification and thermal energy gasification using mine dump rocks. Formation of energy-chemical complexes takes place at the territories of mine facilities; that is why mine dumps gasification and generation of thermal energy from them is one of the alternatives to generate extra combustible gases and thermal energy.

Averaged composition of coal mine dumps is: 1.5–4.6 % of carbon and sulphur, 4–16 % of moisture with sufficient volume of air penetration and heat conductivity. Preparation of a mine dump for the gasification requires its saturation with combustible waste of oil-chemical industry (masut, worked-out oils, resin, bitumen, etc.) as well as adequate leaktightness and stability while covering mine dump surface with liquid glass.

Saturation of rock dumps with combustible waste makes gasification process more controllable and efficient. Intensity and directional effect of the process are provided with the varying and heating of forced-draft mixtures and pressure within the reaction channel of a waste dump; in this context, temperature mode within a fire face is 800–1300 °C.

While using overheated vapour in forced-draft mixtures, hydrogen H_2 makes up most part of the combustible gases (46–69 %). Indices of the dump saturation with liquid carbohydrates have an effect on the composition of

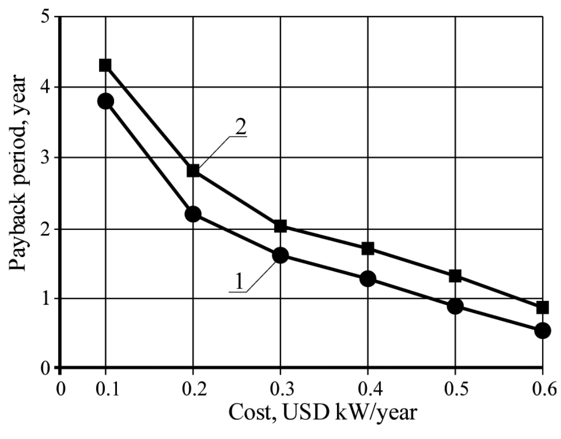

Fig. 4. Dependence of payback period of cogeneration power system on the cost of electricity and artificial gas: 1 – USD 109 /1000 m³; 2 – USD 183 /1000 m³

gasification products; however, heated forced-draft mixtures (105–160 °C) and pressure are the basic index of the effect on both intensity and efficiency of the process.

Force-draft losses are 3.8–7.4 m^3/kg of the mine dump organics depending upon the forced-draft mixture composition. Increased interference of a mine dump mass allows obtaining the pressure in the reaction channel within 0.14–0.2 MPa depending on oxidation zone geometry. Basic filler of generator gas in the process of mine dumps gasification are: combustible gases (CH_4, H_2, CO) and ballast gases (CO_2, N_2, H_2S). Thermal value of the generated gas is 3.5–8 mJ/m^3.

Thermochemical processing of coal mine dumps is characterized by the alternation of gasification process and combustion process. The combustion process is characterized by the availability of oxidation zone and zero pressure within it. Such an alternation of the processes provides stability while forming reduction zone of the gasifier characterizing by endothermic reactions with heat consumption.

After mine dump gasification, the bunt-out rocks become valuable material being used in chemical industry as fillers for various mastics; fillers for concrete mixtures and production of building materials (clay pellets, bricks, ceiling panels, etc.) in construction industry, and for the construction of pavements and highways.

Carcinogenic products of mine dump gasification are subjected to thermal processing within the underground (mine) gasifier. Such gasification products of mine dumps as generator gas, chemical raw material, and heat are used by energy-chemical complex to generate energy and obtain chemical products.

Thermal energy is generated in the gasification process and after its termination. Rock mass of a mine dump has high coefficient of thermal capacity, and residual heat may be used to generate electricity and heat for a long time.

Table 2 represents the indices of mine dump gasification, if it contains 2.0 of carbon and sulphur and 9 % of moisture. The indices have been determined involving the Information Program "MTB WUCG" developed by the researchers of the Department of Underground Mining and the Department of Chemistry (State Higher Educational Institution "National Mining University"). Besides, the Program was piloted using industrial gasifier under the conditions of experimental mine "Barbara" (Katowice, Poland). Analysis of its input data makes it possible to estimate basic power indices of underground gasifier operation in comparison with the surface one.

When organic compounds of a mine dump are degassed, chemical elements and rare metal are extracted by means of desalinisation [15]. Valuable chemical component are extracted with the help of sorption plants of the energy-chemical complex. Use of thermochemical methods to eliminate mine dumps makes it possible to generate electricity and thermal energy; to extract chemical elements and rare metals with the provision of the processes efficiency; to provide environmental safety and logistic tendencies for the development and functioning of low-waste technologies of technological segments of mining energy-chemical complex.

Studies of thermal generating segments of energy-chemical complex as for the mode of internal heat supply. The studies carried out by the authors have helped to point out basic stages of the operation modes of the underground gasifier being a component of the energy-chemical complex. Fig. 5 shows the generation modes.

When underground gasifiers operate at stage one in the mode of gasifier firing and reaction-channel forming (a mode of coal seam burning), products of coal seam thermochemical processing are purified to remove dust and directed to heat utilization. The stage also involves constant monitoring of the composition of both generator gas and condensate. The vapour generated in the process is partially supplied to the vapour generator for the production of electricity. Another share of vapour is used for technological needs of a compressor station (heat of forced draft). Such a mode lasts for 0.3–0.4 years.

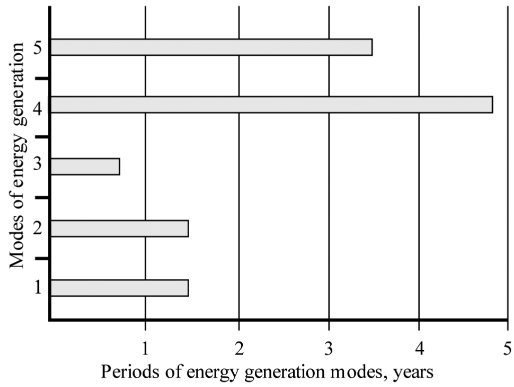

Fig. 5. Graph of thermal energy generation by the underground gasifier in terms of various operation modes:
1 – firing and forming the reaction channel of the underground gasifier; 2 – process of solid fuel seam gasification; 3 – washing of the underground gasifier; 4 – extraction of gasification products and utilization of heat from rock deformed mass and degassed area of the gasifier; 5 – artificial tightening of deformed rock layers above the gasifier and gasification of industrial and domestic waste

Table 2

Indices of a mine dump gasification with various compositions of forced draft

Indices of mine dump gasification station	Composition of forced draft					
	air	oxygen	O_2+CO_2+vapour	O_2+CO_2	vapour and air	O_2+vapour
Thermal capacity, Gcal	4.6	9.1	9.4	8.6	5.9	9.8
Power capacity, mW	5.3	10.4	10.7	9.8	6.7	11.2
Combustion gases generation (CH_4, CO, H_2), mln m^3/year	6.3	8.7	9.8	8.2	7.1	10.8

Stage two. A mode of coal seam gasification starts when the share of combustible gases (CH_4, H_2, CO) as a part of generator gas is over 18 %. Certain gas share is supplied to a cascade area of FPUs to generate electricity and to utilize heat. At the stage of gasifier operation, recuperators of heat of the rocks enclosing the gasifier as well as combined power system with heat accumulation supplement actively the heating network of the energy-chemical complex. Such a heat generating mode is preserved for a period of solid fuel seam gasification lasting for 0.9–1.3 years.

Stage three involves a mode of gasifier washing. The stage also involves generation of gasification products and thermal energy. The period lasts for 0.38–0.66 years. The longest one is a mode of gasification products extraction and utilization of heat from rock deformed mass and degassed area of the gasifier (2.9–4.86 years).

After the finishing of the underground gasifier operation period, it is possible to prolong its service life. To do this, it is required to perform artificial tightening of the deformed rock layers over the gasifier. The above-mentioned makes it possible to use worked-out area of the underground gasifier for municipal waste utilization. The utilization period varies from 2 to 3.4 years.

Conclusions. The heat generated by the segments of the BUCG-based energy-chemical complex meets the technological and domestic requirements of both surface and underground complexes as for the electricity and thermal energy.

Cogeneration technological systems on free-piston units being a component of the BUCG station provide accumulation and generation of thermal energy and electricity with 26–35 % fuel saving. Efficiency of the cogeneration process varies within 44–52 %. Taking into consideration the current situation in the energy industry of our country, payback period is 1.4–2.5 years.

Analysis of the gasification potential of rock dumps of coal mines makes it possible to get additional source of combustible and technical gases, thermal energy, and chemical substances. The segment of the energy-chemical complex helps to generate thermal energy at the level of 4.6–9.8 Gcal or electricity at the level of 5.3–11.2 mW. The amount of combustible gases (CH_4, H_2, CO) is 6.3–10.8 mln m^3/year.

It is planned to devote further studies to the consideration of the possibility of utilizing industrial and domestic waste, greenhouse gases, and carcinogenic substances within the formed underground gasifiers. This will make it possible to reduce technogenic load on the environment, to develop the area of applying thermochemical technologies for mining and processing of organic fuels and raw material as well as to develop low-waste enterprises on the basis of coal gasification.

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Мета. Отримання теплової енергії на основних сегментах енергохімічного комплексу, сформованого на базі свердловинної підземної газифікації вугілля, зі встановленням режимів його роботи.

Методика. Поставлені інженерні завдання виконувались із застосуванням аналітичних, стендових і натурних методів досліджень. Дослідження теплових і енергетичних показників станції з газифікації вугілля проводилося за допомогою інформаційної програми „МТБ СПГВ“, розробленої в Державному ВНЗ „НГУ" співробітниками кафедр підземної розробки родовищ та хімії, що пройшла апробацію на промисловому газогенераторі в умовах експериментальної шахти „Барбара" (м. Катовіце, Польща).

Результати. Визначені основні показники роботи станції з газифікації вугілля залежно від типу подачі дуттьової суміші до підземного газогенератора. Оцінена ефективність отримання теплової енергії від гірських порід, в яких розташований підземний газогенератор, та отриманих генераторних газів. Ці джерела є основними теплогенеруючими сегментами енергохімічного комплексу з газифікації вугілля, що формується на території діючих вугільних шахт чи тих підприємств, які знаходяться на стадії закриття. Оцінена перспективність газифікації вугілля генерації теплової енергії з породних відвалів вугільних шахт. Визначені режими внутрішнього теплозабезпечення теплогенеруючих сегментів енергохімічного комплексу.

Наукова новизна. Отримані залежності розподілення теплообміну в породах покрівлі пласта при газифікації вугілля залежно від довжини реакційного каналу, зон термохімічних реакцій у ньому й способів теплообміну. Встановлена залежність терміну окупності когенераційної установки при підземній газифікації вугілля від ціни на електроенергію та продуктів газифікації (генераторний газ). Отримано графік генерації теплової енергії за різних режимів експлуатації основних сегментів енергохімічного комплексу.

Практична значимість. Розроблена технологічна схема теплоутилізатора, що забезпечує можливість утилізації теплової енергії у процесі газифікації вугілля на місці залягання пласта. Визначені основні режими генерації теплової енергії на станції з газифікації вугілля, що є теплогенеруючим сегментом енергохімічного комплексу.

Ключові слова: *підземна газифікація, теплове поле, теплова енергія, енергохімічний комплекс, вугільний пласт, генераторний газ*

Цель. Получение тепловой энергии на основных сегментах энергохимического комплекса, сформированного на базе скважинной подземной газификации углей, с установлением режимов его работы.

Методика. Поставленные инженерные задачи выполнялись с применением аналитических, стендовых и натурных методов исследования. Исследование тепловых и энергетических показателей станции по газификации углей проводилось с помощью информационной программы „МТБ СПГВ", разработанной в Государственном ВУЗе „НГУ" сотрудниками кафедр подземной разработки месторождений и химии, которая прошла апробацию на промышленном газогенераторе в условиях экспериментальной шахты „Барбара" (г. Катовице, Польша).

Результаты. Определены основные показатели работы станции по газификации углей в зависимости от типа подачи дутьевой смеси в подземный газогенератор. Оценена эффективность получения тепловой энергии от горных пород, в которых размещен подземный газогенератор, и полученных генераторных газов. Эти источники являются основными теплогенерирующими сегментами энергохимического комплекса по газификации углей, который формируется на территории действующих угольных шахт, или тех предприятий, что находятся на стадии закрытия. Оценена перспективность газификации углей и генерации тепловой энергии из породных отвалов угольных шахт. Определены режимы внутреннего теплообеспечения теплогенерирующих сегментов энергохимического комплекса.

Научная новизна. Получены зависимости распределения теплообмена в породах кровли пласта при газификации углей в зависимости от длины реакционного канала, зон термохимических реакций в нем и способов теплообмена. Установлена зависимость срока окупаемости когенерационной установки при подземной газификации углей от цены на электроэнергию и продуктов газификации (генераторный газ). Получен график генерации тепловой энергии при различных режимах эксплуатации основных сегментов энергохимического комплекса.

Практическая значимость. Разработана технологическая схема теплоутилизатора, что обеспечивает возможность утилизации тепловой энергии в процессе газификации угля на месте залегания пласта. Определены основные режимы генерации тепловой энергии на станции по газификации угля, которая является теплогенерирующим сегментом энергохимического комплекса.

Ключевые слова: *подземная газификация, тепловое поле, тепловая энергия, энергохимический комплекс, угольный пласт, генераторный газ*

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