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Substantiating applicability of Western Donbas coal seams (Ukraine) for underground coal gasification

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Abstract. The paper studies areas of coal seams in the Western Donbass (Ukraine), which can potentially be suitable for underground coal gasification (UCG) technology, which, in the conditions of the difficult energy situation in Ukraine, can significantly affect the consumer market of energy carriers. On the basis of a detailed research on the mining-geological and mining-technical conditions of ten sites according to the criteria for their suitability for UCG, the optimal site and coal seam have been chosen. The structures of coal seams, side rocks (roof, bottom), the location and size of tectonic disturbances, hydrogeological conditions, as well as the technical and elemental composition of coal have been analyzed. Based on the conducted research, it has been determined that it is recommended to place the experimental underground gas generator on the C_5 coal seam of # 4 site, located on the territory with the most developed infrastructure and optimal criteria for gasification suitability. The practical significance of the research is in the fact that the experience of mining the UCG # 4 site of the experimental gas generator allows adjusting the technology parameters for subsequent industrial replication. The proposed approach to the selection of a site and a coal seam can also be tested in other coal deposits with similar mining-geological and mining-technical conditions.

Keywords: *underground coal gasification, coal seam, gas generator, coal, deposits.*

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1. Introduction

According to the prospected resources, Ukraine ranks seventh in the world (34.2 milliard ton; total reserves are estimated as 117 milliard tons). In this context, crude oil and gas reserves are 2.4% of coal ones [1-4]. Due to the limited resources of crude oil and natural gas (currently, output is 8-9.3% of the required production) coal importance for the national industrial complex growth and economic development of Ukraine is closely connected with the progress of coal sector [5-7].

Underground coal gasification (UCG) with further extraction and use of gasification products, which basic combustible components are CO, CH_4, H_2, is one of the ways to solve the problems of clean coal technologies [8, 9]. However, no unified theory of complex underground processing of coal and mine gases is available [10]. Consequently, the development of complex environmentally friendly methods to transform coal into new energy sources, liquid motor oils, olefins, and paraffin is actual mission [11[11], 12].

School of underground coal gasification was founded within the verge of Artem Dnipropetrovsk Mining Institute (the Dnipro University of Technology today) in the 1920s. Famous scientist, Professor O.M. Terpigoriev proposed the basic principles of underground gas generator operation. Moreover, he participated actively in the industrial implementation of the first Pidzemgaz stations in Ukraine [13-15]. The suggested technology provides not only economical but also ecological benefits [16-19].

Starting from 1968, a number of scientists and researchers from the Department of Underground Mining of the Dnipro University of Technology (Artem Dnipropetrovsk Mining Institute) took active part in studies and developments of UCG methods at Pidzemgaz stations in the Russian Federation (Shatskaya and South-Abinsk stations); in Uzbekistan (Angren station); within lignite deposit of Synelnykove experimental site in Ukraine; with the Russian Federation research institutes (Skochinsky Institute of Mining; Uglegaz of MMI; Uzbekistan (Tashkent Polytechnic Institute); in Ukraine (Institute of Geology and Geochemistry of Combustible Minerals in Lviv, Donetsk Research & Development Institute, Dniprodiproshakht, Kryvyi Rih Mining Institute); in Poland (Central Mining Institute in Katowice, AGH University of Science and Technology in Krakow, Research Institute of Radical Technologies in Warsaw) etc. Design institute Dniprodiproshakht has developed four production projects of Pidzemgaz station for coal and lignite with the participation of the Dnipro University of Technology employees [13, 20-22].

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Taking into consideration the criteria of coal seam applicability for UCG, mining and geological, hydrogeological, and mining conditions of the seam occurrence are analyzed to substantiate the selection of an experimental gasification site [23-26]. Thickness of a coal seam, its ultimate composition and rank, physical and mechanical characteristics, structure, texture and ultimate composition of rocks, enclosing the coal seam, water inflow, disjunctive and plicative disturbances are the basic criteria in terms of which the coal seam is applicable/inapplicable for UCG [27-30]. The required design capacity of a site for underground coal gasification as well as its service life is calculated basing upon the coal reserves and taking into consideration the payback for the construction and operation of gas generators [31-34]. Ultimate composition (output of combustibles $V = 27\text{-}36\%$), structure and texture of coal seams, make them maximally applicable for UCG [35].

The aim of this study is to conduct an investigation of coal seams in the Western Donbass (Ukraine), which can potentially be suitable for underground coal gasification (UCG) technology.

2. Materials and methods

It should be noted that there are no unified criteria to evaluate the expediency of underground coal gasification use within the coal deposits [36, 37]. The Dnipro University of Technology has applied author's approach to determine the expediency of UCG use for the specific mining and geological conditions. The approach was tested industrially and supported as an efficient one while developing technical documentation of the underground gasification project as well as feasibility study (FS #3858) within Synelnykivske lignite deposit. Calculation of the document was supplemented by the data taking into consideration the current approaches concerning applicability of lignite and coal deposits for UCG [38, 39].

As practices have shown, the methods are rather efficient while determining UCG applicability in terms of manufacturability and in terms of economic indices. To evaluate potential gasification, a deposit is divided into patterns. Their applicability for underground gasification is identified with the help of general coefficient K which depends upon the natural parameters of gasification area occurrence relying upon the relevant coefficients [40, 41].

Carbonous content of Western Donbas is associated with Lower Carboniferous deposits of C_1 series [42-44]. The coal seams occur at 3-12° north-eastwardly. Rock occurrence is linear one with northern and north-eastern dip at a 3-4° angle. The angle increases up to 5-8° in the neighbourhood of tectonic fault zones [45, 46]. The coal field contains three geological and industrial areas: Petrykivka, Novomoskovsk, and Petropavlivka. The coal is mined by DTEK Pavlohradvuhillia established in 1974. It involves 11 mines, Pavlohrad Preparation Plant, and other enterprises [47-49].

Further thorough study of Western Donbas deposits is required since their traditional mining is neither efficient nor expedient [50-52]. Moreover, sites of coal seams (both balance and off-balance ones), left in the process of mine operation, should also be analyzed since according to their criteria they may be applicable for UCG. In the next section we will discuss the characteristics of the selected sites.

In summary, our methodology offers a comprehensive framework that synergizes innovative evaluation techniques with practical industrial insights. This approach systematically dissects the coal deposit into distinct patterns, facilitating a nuanced analysis of each zone's gasification potential based on geological and economic parameters. By employing a unique general coefficient and integrating current best practices, we enhance the feasibility and efficiency of underground coal gasification projects.

3. Results and discussion

3.1. Geological investigation of selected sites

Sites #1, 2, and 3 are located within a field of Pavlohradska mine in Pavlohrad District of Dnipropetrovsk Region. It is a north-eastern slope of Ukrainian crystalline rock mass, stretching along the south-western boundary of the Dnieper-Donets Rift. Pavlohrad Town is at 8.0 km distance south-westwardly. Donetsk-Kyiv highway and Pavlohrad-Lozova and Krasnoarmiisk railway are nearby.

Site #1 is within the eastern mine-take wing. Its dimensions are: 2000 m along the strike and 350 m down-dip. The site area is 700000 m^2. Pivdenno-Ternivskyi fault limits it in the north (H is 30-130 m). The fault has a small branch line in the central share of the site (i.e. fault #11 where H is 1.5 m) (Fig. 1).

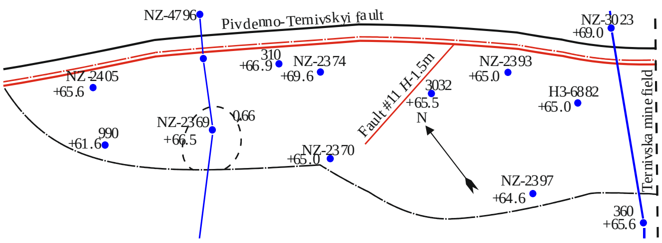

Figure 1. Site #1 plan

Site #2 is within a slope share of the western field of Pavlohradska mine. Its dimensions are: 1500 m along the strike and 1400 m down-dip. The site area is 610000 m^2. In the north, it is limited by Pivdenno-Ternivskyi fault #11 (H is 30-130 m; and 58-68°). In the west, the site borders on Blahodatna mine field (Fig. 2).

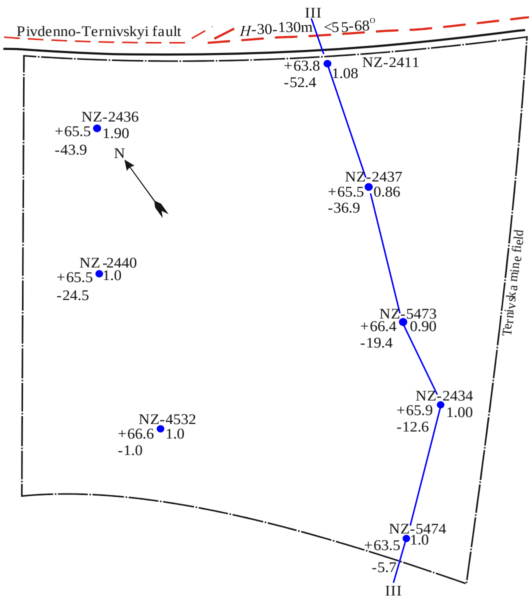

Figure 2. Site #2 plan

Site #3 is within the eastern mine-take wing. Its dimensions are: 900 m along the strike and 850 m down-dip. The site area is 765000 m^2. In the west, it is limited by fault #12 (H is 0-35 m; <55°). In the east, it borders on Ternivska mine field (Fig. 3).

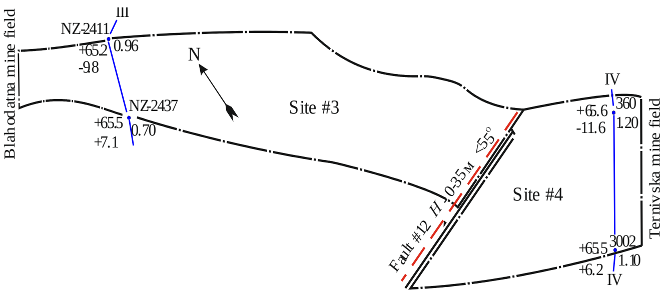

Figure 3. Site #3 plan

Up to 50 coal seams occur within the mine field. Only 9 of them are of working thickness ($m \geq 0.45$ m).

The coal belongs to gas rank. In terms of one of the basic thickness criteria, C_4 and C_5 seams are applicable for UCG. Below you can find characteristics of the seams in accordance with all the criteria to identify their suitability for underground coal gasification.

The coal seam C_4^1 is of simple structure; its occurrence is linear at 3-4° angle northerly and north-easterly increasing up to 5-8° within the zone of tectonic disturbances. Average thickness of the seam is 0.77 m; it varies from 0.54 to 1.1 m. The seam coal is low-ash and low-sulfur. Combustion heat varies from 21.4 to 23.1 MJ/kg; average value is 22.1 MJ/kg. The lowest calorific value is 17.3 kcal/kg.

The main roof of the seam and its floor is coal formation (C_1) represented by the alternation of argillite, aleurite, and sandstone strata. The immediate roof of the seam is represented mainly by tough massive argillites. The argillite may be replaced with horizontally layered mica aleurite. Aleurite roof stability is somewhat higher than the argillite one. The main roof of the seam is represented mainly by horizontally layered monolith aleurite of moderate stability.

Usually, horizontally layered tough aleurite of medium stability is both the immediate and the main floor of the seam. Its upper thickness is 0.9-1.2 m. In water, the aleurite has a tendency to slaking and disintegration. Argillite of "curly" type may occur in the immediate floor. The mineral is unstable while watering. Hence, the rocks can be characterized as weakly stable and moderately stable ones exclusive of excessive fissuring zones in the neighbourhood of tectonic disturbances. Water level is associated with coal deposits. Pressure height is 54 m and more. Specific water output is 0.0036-0.073 m/s and K_f is 0.0056-1.72 m/day.

The coal seam C_5 is of simple structure; its thickness is continuous; occurrence is linear at 3-4° angle northerly and north-easterly increasing up to 5-8° within the zone of tectonic disturbances. The coal is of medium ash and sulfur content. Combustion heat varies from 24.5 to 25.7 MJ/kg; average value is 4.9 MJ/kg. The lowest combustion heat is 19.1 MJ/kg. Coal deposits, represented by the alternation of argillite, aleurite, and sandstone layers, are the seam main roof and floor. The immediate roof is represented mainly by aleurite and argillite. The main roof is of medium caving features (A_2). The immediate roof is represented mainly by aleurites and argillites. Aleurite of an upper layer is of "curly" type of 0.6-1 m thickness. Lower, it is with sandstones interlayers. The mineral is of medium stability. Argillite of an upper layer (0.8-1.0 m) is of "curly" type. It is more compact lower along the seam. It is moderately stable. It becomes unstable if watering takes place. Figures 4-7 show geological sections in terms of the sites.

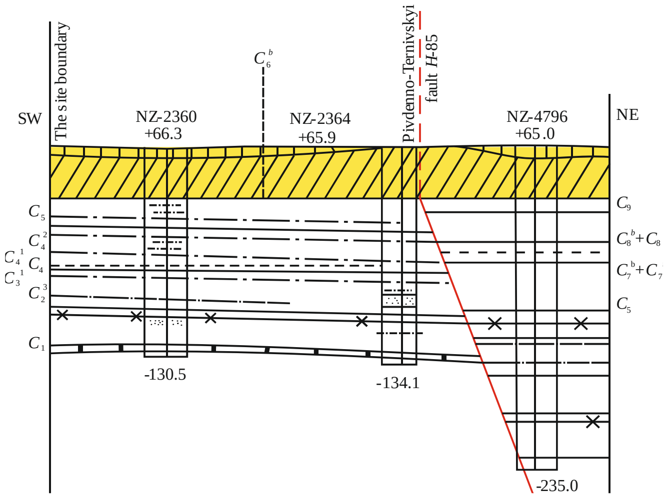

Figure 4. Geological section I-I

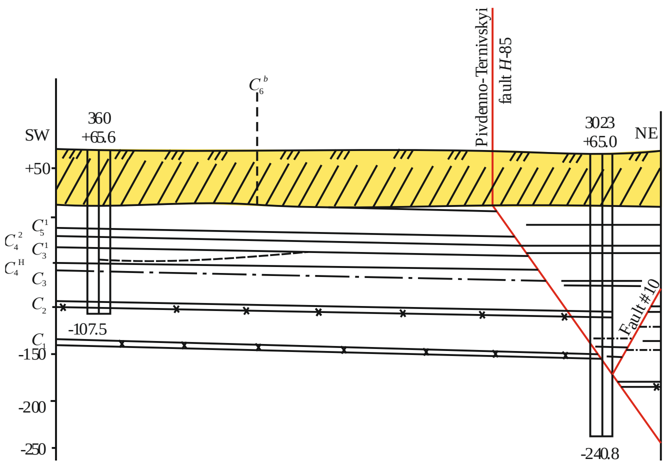

Figure 5. Geological section II-II

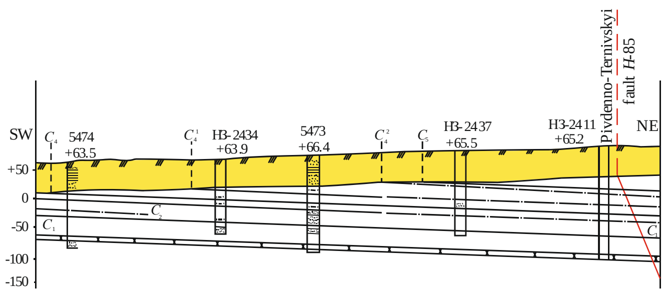

Figure 6. Geological section III-III

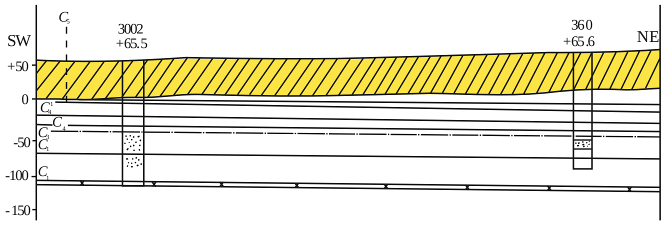

Figure 7. Geological section IV-IV

The water level is of fractured type and pressure one. Its value varies from 58 up to 165 m. Specific output varies from 0.0012 to 0.089 l/s; and K_f is 0.0037-1.36 m/day. Since there are no natural impermeable layers on the rise, potential water influx may be up to 3 m^3/h. The water will inflow from sandstones, occurring above, and from the seam itself.

Site #4 is within Stashkov mine field in the eastern part of Pavlohrad geological and industrial area being 30 km away from Pavlohrad Town and 20 km away from Pershotravensk Town. The mine field is characterized by heavy tectonic disturbance which concerns especially its west mine-take wing. A number of sites in the neighbourhood of the western technical boundary were not developed.

Geometry of site #4 is as follows: 1200 m along the strike and 350 m down-dip. The site area is 420×800 m^2. It is limited by A fault (H is 10 m) in the north; fault #3 (H is 0-20 m) in the south; Bohdanivskyi fault (H is 100 m) in the west; and fault #5 (H is 0-10 m) in the east (Fig. 8). Within the area, coal is represented predominantly by gas coal ranks.

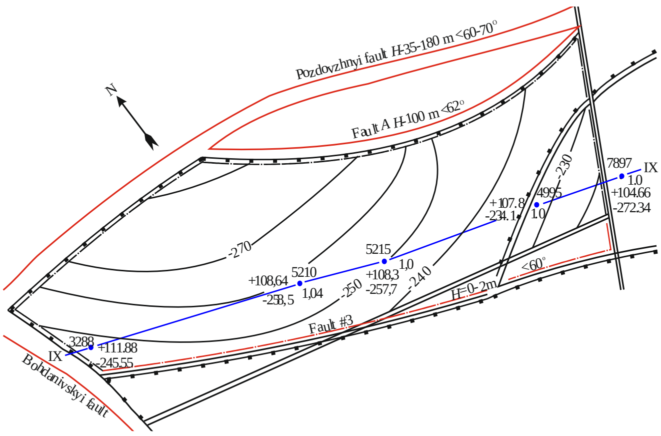

Figure 8. Site #4 plan

The carbonous formation involves two coal seams with $m \geq 0.45$ m working thickness. In terms of one of the basic criteria (i.e. thickness), C_5 seam is applicable for underground gasification. Below you can find their characteristics in accordance with all criteria to identify suitability for UCG.

Coal seam C_5 of Stashkov mine field is characterized by heavy tectonic disturbance. Especially, it concerns the western mine-take wing. A number of sites in the neighbourhood of the western technical boundary were not developed. In this connection, sites of C_5 seam, located down-dip above Pozdovzhnyi fault as well as A fault limited by faults #5 and 3 along the strike and up-dip through up to 20 m amplitude, are of great interest. Occurrence depth of C_5 seam varies from 340 down to 390 m. Its average thickness is 1.05m varying within the range of 0.9-1.14 m. The seam is of simple structure; its occurrence is linear and continuous. Slope angle is 3-5°.

Combustion heat of the coal varies from 24.7 to 26.4 MJ/kg; average value is 25.4 MJ/kg. The lowest combustion heat is 18.1-18.8 MJ/kg. Within the analyzed site, reserves of C_5 seam are evaluated as 540 thousand tons.

Coal deposits (C_1) are both the roof and floor of the seam. They are alternations of argillite, aleurite, and sandstone layers. Right in the roof, carbonous rocks are represented by argillites (4 m thickness); overlying aleurites (12.5 m thickness); and argillites above them (9 m thickness) with sandstone interlayers of 2 m thickness. Above, the geological section demonstrates alternations of sandstones and sandy siltstone. Argillite and aleurite are reliable impervious strata. They will protect the fire face against static water getting from the sandstone.

Argillite with 2 m thickness and aleurite of “curly” type with 2.5 m thickness occur right in the floor. Rocks of the immediate and main roofs are slightly fissured and horizontally layered. The fact favours significantly their caving. Rocks of the immediate rocks are from slightly stable to the moderately stable ones. In view of a minor bend between the development wells, sandstone will be rather stable. Figure 9 demonstrates the geological section.

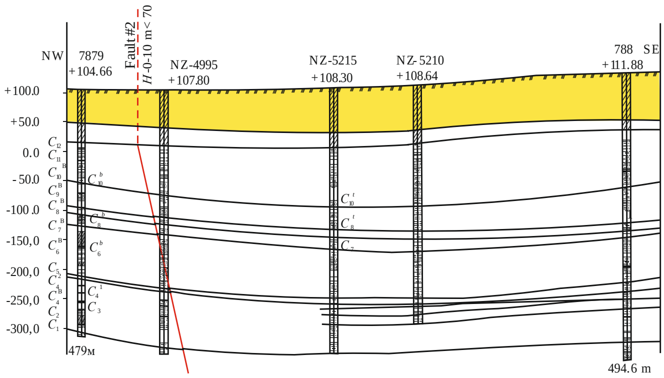

Figure 9. Geological section IX-IX

Gas permeability of the rocks is minor; sandstone is aquitard (0.1 millidarcy); aleurite and argillite are tight.

The seam coal is fissured; two systems of cleats are observed in it. The cleats stretch almost coincides with the seam strike. The coal is permeable; water conductivity coefficient of the seam is K_c = 25.61 m^2/day. Within the area of the coal seam burning, potential water inflow may be 3 m^3/hour.

Hydrogeological conditions of the site are relatively favourable. The site is isolated all around by tectonic disturbances resulting from hydraulic connection with the above-mentioned water-bearing levels. The water is associated with coal and sandstone seams. Aquifer of karst deposits is of sheet-like and fissured type with a subartesian surface. Pressure (H) varies from 49.35 up to 71.9 m. Filtration coefficient is K_f = 0.0045-0.914 m/day. Water conductivity coefficient is K_c = 5.28-13.3 m^2/day. Since the sandstone is limited by tectonic disturbances, the roof sandstone contains minor reserves of static water. The seam inundation will take place at the expense of the water reserves being available within the seam. These parameters suggest a predictable hydraulic behavior during extraction operations.

Northwardly, site #5 borders on Zakhidno-Donbaska mine field; southerly, it borders on Yuvileina mine field. Site #6 is within Zakhidno-Donbaska mine field being at the territory of Petropavlivka District of Dnipropetrovsk Region. District centre Petropavlivka is at the distance of 20 km from the mine. Moreover, Pershotravensk Town and Brahynivka railway station is nearby.

Dimensions of site #5 are as follows: 2400 m along the strike and 400 m is down-dip. The site area is 960000 m^2. Pozdovzhnyi fault #1 limits it northwardly (H is 18-8 m; <57-75°); and fault #4 limits it southwardly (H is 0-12 m; <6575°) (Fig 10).

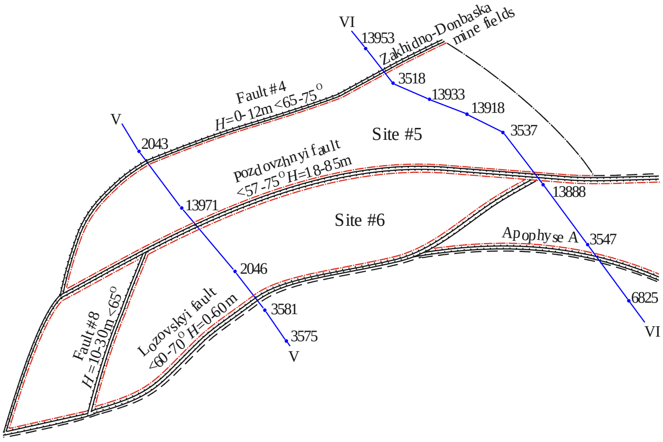

Figure 10. Plan of sites #5 and 6

Site #6 is in an incline share of the mine field. Its dimensions are as follows: 3600 m along the strike and 400 m down-dip. The site area is 1440000 m^2. On the rise, it is limited by Lozovskyi fault. (H is 0-60 m; <60-70°); Pozdovzhnyi fault #1 limits it down-dip (H is 18-85 m; <57-75°) (Fig. 10). Up to 40 coal seams and layers have been penetrated; 13 of them are of working thickness ($m \geq 0.45$ m). The coal is of gas and fat rank. In terms of a thickness criterion, being one of the basic ones, C_6+C_6^t seam is of interest from the viewpoint of gasification. Below, you can find characteristics of the seam.

In terms of site #5, average occurrence depth of C_6+C_6^t seam is 240 m; it is 285 m in terms of site #6. Its thickness varies from 1.14 to 1.18 m with average 1.15 m value in terms of site #5, and 1.00 to 1.40 m with average 1.12 m value in terms of site #6. C_6+C_6^t seam is a continuous formation with a simple structure. Its occurrence is flat with 2-5° of rock inclination angle. The coal is of ash and sulfur content. Its combustion heat varies from 23.9 up to 26.2 MJ/kg; average value is 25.1 MJ/kg. The lowest combustion value is 17.8 MJ/kg.

Argillite (60%) and aleurite (39%) are the immediate roof of the seam. Very rarely, sandstone (1%) is available. Aleurite and argillite are fissured with flora remnants. The deposited minerals are from slightly stable to unstable and very unstable ones. The main roof is unstable and easily caved. Sandstone contains minor capacity of static water. Expectable water inflow is 9 m^3/hour.

The immediate floor is represented by aleurite (65.5%), argillite (34%), and sandstone (0.5%) in some cases. The aleurite and argillite are of cloddy texture; a layer of "curly" type with up to 1-1.5 m thickness occurs over them. It contains phytoleims. Water-bearing levels are associated with the seams of coal, sandstone, and limestone. The layer is of moderate stability; it becomes unstable while moistening. Figures 11 and 12 show geological sections of the sites.

Sand of Buchak Paleogene series is the roof. The water-bearing system is of sheet-like and fissured type with a subartesian surface. Average filtration coefficient is 0.68 m/day. The upper share of the section is of higher filtration characteristics. Carbon aquifers are connected hydraulically with Neogene-Paleogene and Quaternary deposits.

In view of the fact that the sites are isolated from the hydraulic connection by means of the abovementioned water-bearing levels, the seam inundation will take place owing to the water reserves available within the coal stratum.

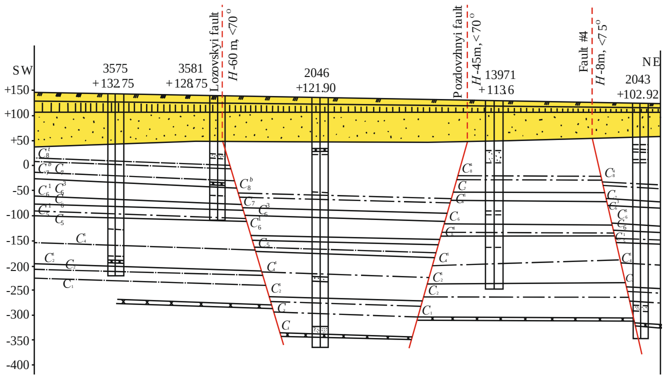

Figure 11. Geological section V-V

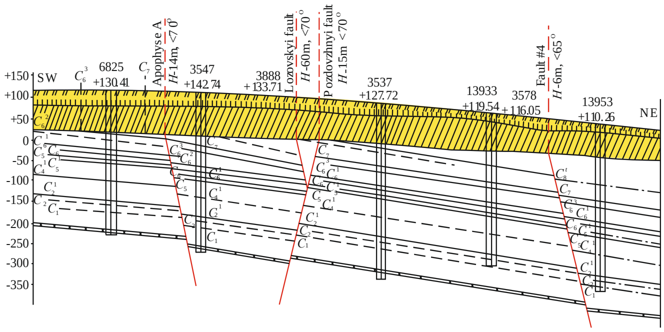

Figure 12. Geological section VI-VI

The sites #7 and 8 are within Blahodatna mine field in Pavlohrad District of Dnipropetrovsk Region. The mine field area is 32 km^2. Its northern boundary passes through Verbskyi fault; false one passes through Pavlohradskyi-Viazivskyi fault.

The settlement of Blahodatne is at the mine field territory. Pavlohrad Town is at 8.0 km distance south-westwardly. Donetsk-Kyiv highway as well as Pavlohrad-Lozova and Pavlohrad-Krasnoarmiisk railway is nearby. The major one Samara River, being a left feeder of the Dnieper River, flows in the southern part of the mine field.

The analyzed site #7 is in the incline part of the mine field. Its dimensions are: 850 m along the strike and 1350 m down-dip. The site area is 1147500 m^2. In the north, it is limited by Pivdenno-Ternivskyi fault; in the south, apophyse A-A (H is 2.5 m, <55°) limits it (Fig. 13).

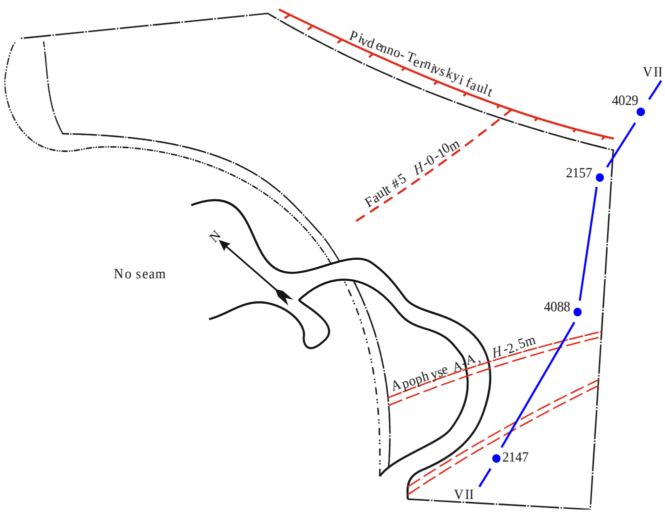

Figure 13. Site #7 plan

Tectonic disjunctive fault isolate site #7 from the upper water-bearing levels. Water will inflow from sandstone and the seam itself. Expectable water influx is up to 8 m^3/hour.

Site #8 is within the incline part of the field. Its dimensions are: 2300 m along the strike and 1000 m down-dip. The site area is 2300000 m^2. In the north, the site is limited by Pivdenno-Ternivskyi fault (H is 30-130 m, <55-65°); and in the east it borders on Pavlohradska mine field (Fig. 14).

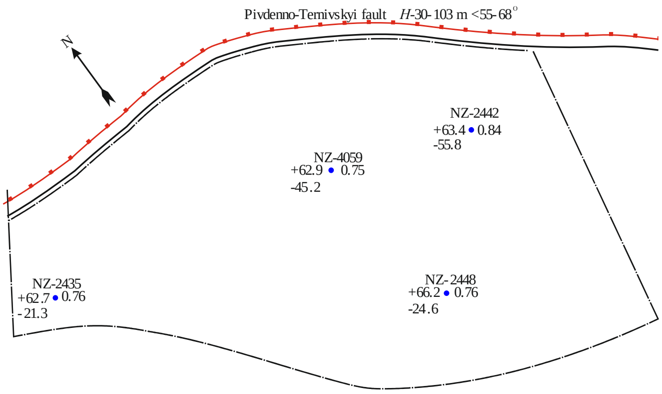

Figure 14. Site #8 plan

There are 12 seams on the mine balance. The coal is of gas ranks. In terms of thickness, being one of the basic criteria, C_5-C_5^t seams of site #7 are of interest for UCG. Site #8 is represented by C_4-C_4^b coal seams. Below you can find characteristics of the seams.

The seam is of simple structure; its thickness is stable; occurrence is continuous; rock inclination is at a 3-4° angle northwardly and north-eastwardly. The seam is separated by disjunctive disturbances. The coal is of medium ash and sulfur content. Combustion heat varies from 24.4 to 25.2 MJ/kg; average value is 24.8 MJ/kg. The lowest combustion heat is 18.9 MJ/kg.

The immediate roof of the seam is represented mainly by aleurite and argillite. Aleurite is horizontally layered; its hardness is medium, varying from low stable to unstable one. Argillite is layered with the insignificant amount of open-type fissures; it is of moderate hardness.

Argillite, aleurite, and sandstone are the seam main roof and floor. The main roof is easily caved. The immediate floor is represented mainly by aleurite and argillite. Aleurite is slightly fissured; on the top, it is of "curly" type with 0.6-1.0 m thickness. Argillite is horizontally layered; on the top, it is of "curly" type (m = 0.8-1.0 m). Figure 15 demonstrates its geological section. The seam is of simple structure; its occurrence is continuous; rock inclination is at 3-5° angle north-eastwardly.

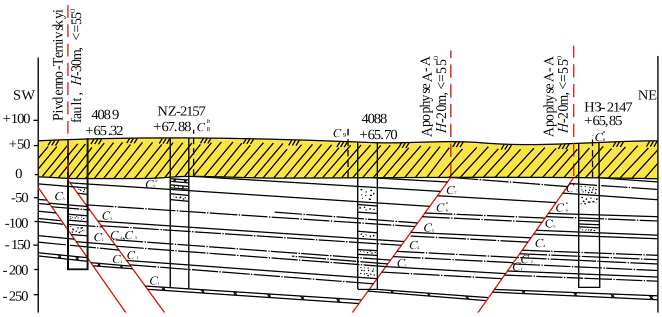

Figure 15. Geological section VII-VII

Occurrence depth varies from 84.0 to 122.0 m. Its thickness varies from 0.75 to 1.10 m. Average value is 0.85 m. The coal is of medium ash and sulfur content. Combustion heat is within the range of 24.05-26.6 MJ/kg. The lowest combustion heat is 17.4 MJ/kg. In terms of site #8, the seam reserves are 2.2 million tons. Geological conditions are similar to those within site #2.

The immediate roof of the seam is represented mainly by tight and massive argillite replaced in some cases with horizontally layered aleurite. Aleurite roof stability is somewhat higher to compare with the argillite one. Argillite, aleurite, and sandstone layers are the main roof and floor of the seam. The main roof is represented mainly by horizontally layered, monolith, and stable aleurite. The immediate floor of the seam is represented by mainly horizontally layered, dense, and medium-stable aleurolite; at the top, it is 0.6-1.4 m thick of "curly" type. In water, the aleurolite is prone to swelling and breaking. Argillite may occur within the immediate floor. In case of watering, it is not stable. The enclosing rocks of seam C_4- C_4^b belong to the unstable ones except the zones of increased fissility near the tectonic disturbances.

Aquifer is of layered-fissured type with pressure surface. Specific output is 0.0036-0.073 l/s, K_f is 0.0056-1.72 m/day. Basing on the fact that there is no structural barrier from the side of seam outcrop, one can expect water influx of up to 30 m^3/hour.

Site #9 is located within the field of Ternivska mine. The mine is located in Pavlograd District. There are such settlements as Blahodatne and Ternivka near the mine; the town of Pavlohrad is located north-westward at the distance of 13 km. Donetsk-Kyiv highway as well as the railway connecting Donetsk and Dnipro is nearby. The site is located within the eastern flank of the incline area of the mine field. The site dimensions are as follows: along the strike – 1150 m and to the dip – 1500 m. The site area is 740000 m^2 (Fig. 16).

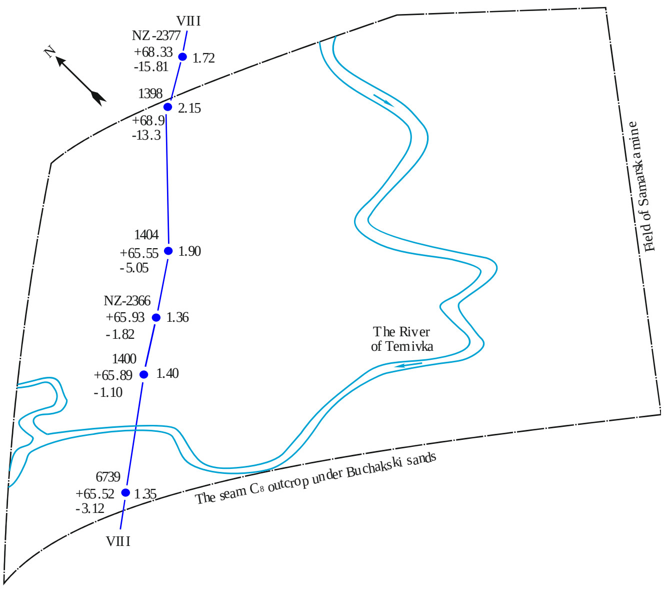

Figure 16. Plan of site #9

The coal within the area is of gas rank. Coal-bearing thickness contains 9 seams of working thickness ($m \geq 0.45$ m). Among them, seam C_8- C_8^b is suitable for gasification in terms of its thickness. The seam characteristics are given below.

Depth of the seams C_8+C_8^b occurrence varies from 65.0 to 85.0 m. Average seam thickness is 1.4 m. Rock occurrence is linear and stable. Seam structure is complex; interlayer thickness in the middle of the seam is 0.1-0.5 m. Rock inclination is northward at the angle of 3-5°. Coal is of low ash content and mid-sulfur. Combustion heat varies within the range of 22.9-25.6 kkal/kg; average value is 23.8 kkal/kg. Lower combustion heat is 18.2 kkal/kg.

The dividing rock layering, represented by massive, slightly micaceous argillite broken by rare fissures, is the immediate roof of C_8^b seam. In terms of thickness being less than 1 m, that is a "false" roof. The argillite is of lumpy texture with the vegetation remains.

It is prone to caving and sloughing. The aleurolite is slightly micaceous, horizontally layered, and unstable with the thickness of 3-15.5 m; it is broken by fissures. The main roof is represented mainly by aleurolite and sandstone. Mining conditions are complex due to the neighbouring Buchakskyi aquifer.

Homogenous and massive argillite (m = 1-17 m) prevails within the immediate floor; within the upper share (0.6-1 m) it is of lumpy texture and of "curly" type. It is unstable. The main and immediate floor rocks are characterized by low stability; they are prone to swelling while watering. Figure 17 shows the geological section.

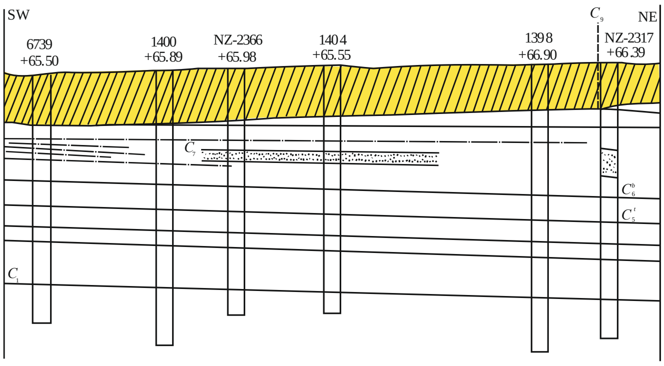

Figure 17. Geological section VIII-VIII

Permeability of the enclosing rocks is lower than the one of coal. Coal reserves in terms of the seam within the site boundaries are 3.1 million tons.

Sandstones, limestones, and coal seams are aqueous among the Carbon deposits. A weathering zone developed down to the depth of 150-200 m as well as the sites of coal seam and sandstone outcrops under the sands of Buchakska series are the most watered ones in the Carbon thickness. Aquifer is of strata and fissured type with the pressure surface. Pressure head is 54 m and higher. Specific output is 0.0036-0.073 l/s, K_f is 0.0056-1.72 m/day. Buchakski sands and the seam occurring by 25-30 m higher are involved in the seam watering. Paying attention to the shallow depth of the seam occurrence and its considerable watering, water influx is expected to be up to 20-26 m^3/hour.

Site #10 is located within the field of Yuvileina mine in Pavlohrad-Petropavlivka district of Western Donbas. Following settlements are right near the site: Pershotravensk (town), Petropavlivka (settlement) located 12 km north-eastwardly, and Pavlohrad (town) to the north-east at the distance of 45 km. Regional centre of Petropavlivka includes bast plant, flour milling plant, and butter making factory. Villages of Rosynky and Mykolayivka as well as Brahynivka railway station are located near the mine. Railway main line Yasynuvata-Pavlohrad-Dnipro passes at the distance of 5 km from the site boundary, it is connected with Yuvileina mine by the rail access through Mykolayivka station.

Site #10 is within the inclined mine field. It is limited by the following faults: Podovzhnyi #3 in the north (H – 6-10 m, <70°) and Podovzhnyi in the south (H – 40-125 m, <60-70°). The site dimensions are as follows: along the strike – 2000 m and to the dip – 300 m. The site area is 600000 m^2 (Fig. 18).

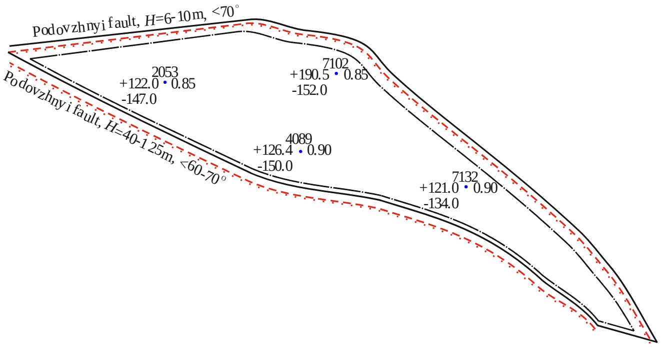

Figure 18. Plan of site #10

The coal rank within the site under analysis is gas. Coal-bearing thickness contains 10 seams of working thickness ($m \geq 0.45$ m). Among them, C_6 seam is suitable for UCG in terms of one of the main criteria. The seam characteristics are given below. Depth of the seam C_6 occurrence varies from 250 to 280 m. The thickness is within the range of 0.85-1.2 m in terms of the average value of 0.9 m. The seam is of simple structure; the rock occurrence is linear and stable. Rock dip is south-eastward at the angle of 3-5°.

Coal is with medium ash and sulfur content. Combustion heat is within the range of 22.3-25.4 MJ/kg in terms of average value of 23.1 MJ/kg. The lowest fuel combustion heat is 17.7 MJ/kg.

Argillite is the immediate roof of the seam (60%); aleurite occurs rarely (40%). The argillite is dark gray; its thickness varies from 1.2 to 1.7 m; it is of low stability. The aleurite is gray; it alternates with sandstone. Its thickness is 0.75-1.1 m. It is of low stability. In turn, it becomes unstable within the excessive fissuring zones. The immediate roof consists of aleurite (70%), argillite (29%), and sandstone (1%). The aleurite is gray and white mica-schist with plant remains; it is "curly" type in the upper share of the layer. Its thickness is 0.35-15 m. It has a tendency for slacking. Its stability is of medium value; it becomes unstable while watering.

The main roof is easily caving. It is represented by dark gray argillite with plant remains; it is of "curly" type in the upper share of the layer. Its thickness is 0.5-12 m. It has a tendency for slacking and for intensive heaving. It is unstable mineral. Sandstone, limestone, and coal seams are the watered rocks. Water content depends upon the fissuring degree. Aquifer is of sheet-like and fissured type. Well outputs penetrate the coal levels. In terms of maximum decrease, being 3.6-79.5 m, they vary from 0.052 to 1.8 l/sec; specific output varies from 0.0013 to 0.178 l/sec. In view of the fact that the faults protect the site from the upper aquifers, the expected water inflow may be 3 m^3/hour. The seam reserves are 1.2 million tons within the site.

3.2. Substantiated applicability coefficients for the selected sites

A comprehensive review of the site's geological and operational characteristics was first undertaken to ensure the selected locations meet all technical and safety requirements. Detailed field observations, combined with in-depth laboratory analyses and numerical modeling, have provided critical insights into the variability and reliability of key parameters. Relying upon the practices of Pidzemgaz stations, field experiments, bench tests, laboratory studies, and analytical research, and taking into consideration the factors, influencing gasification of DTEK Pavlohradvuhillia coal seams, applicability coefficients, shown in Tables 1-4 have been substantiated.

Table 1. Basic expediency criteria of underground gasification as for the coal seams of Western Donbas (Part 1)

Coal seams	m, m	A, %	Structure of the coal seam		Wall rocks (roof, floor); total			Sulfur content in the seam; S, %
			Ratio between the thickness of interlayers and the seam thickness; m_{pr}/m	Expansion of the interlayers over the site area; S_{pt}/S	Thickness of clays or other low-permeable rocks within the roof; h^1, m $h^1/m > H_{obv}$;	Thickness of clays or other low-permeable rocks within the floor; h, m $H \geq 2.0$ m	Distance from the seam roof to certain high-permeable layers or undrained water-bearing levels (h_2); $h_2 > h_m$, h_m – height of fractured zone, m	
C_4^1	0.77	8.2 – 23	–	–	6.2 > 4	3.2 > 2	8.0 > 6.9	1.4
C_5	1.05	10.2 – 12	–	–	8.8 > 5.3	4.0 > 2	10.2 > 8.8	1.5
C_6	1.15	9.2 – 21	–	–	8.1 > 5.9	3.5 > 2	9.5 > 9.2	1.7
C_4	0.85	11.2 – 28	–	–	7.7 > 4.3	2.5 > 2	11.3 > 7.8	2.3
C_8	1.40	8.8 – 30	0.36	0.68	9.8 > 7.3	3.6 > 2	12.0 > 11.2	2.8
C_6	0.9	10 – 26	–	–	14.5 > 4.6	2.2 > 2	10.6 > 8.5	2.2

Table 2. Basic expediency criteria of underground gasification as for the coal seams of Western Donbas (Part 2)

Coal seams	Minimum safe mining depth ($H_Б$, m) and angle of seam dip α = 0 up to 45°; $H/m \geq 15$, where n = 15, $H_b = m \cdot n$	Tectonic disturbances $L_H \geq L_Г$	Q_{air}, MJ/m³	Q_{oxygen}, MJ/m³	Q_{air}, MJ/m³	Q_{oxygen}, MJ/m³	Ratio between the gas permeability of coal and rocks
			Water influx in the channel, m³/hour		Humidity of UCG gas, g/m³		
C_4^1	29.6 m > 11.5; H_b = 11.5 m	The site boundaries; disjunctive disturbances	3.2	7.14	3.2	7,14	17 – 28
			1.3 – 2.4		421	265	
C_5	96.8 m > 15.8; H_b = 15.8 m	The site boundaries; disjunctive disturbances	3.48	7.5	3.48	7,5	16 – 24
			0.86 – 1.2		308	226	
C_6	72.5 m > 17.3; H_b = 17.3 m	The site boundaries; disjunctive disturbances	2.94	6.68	2.94	6,68	19 – 29
			1.0 – 1.45		375	254	
C_4	44.7 m > 12.8; H_b = 12.8 m	The site boundaries; disjunctive disturbances	2.4	5.42	2.4	5.42	18 – 30
			2.12 – 3.07		505	378	
C_8	25.4 m > 21; H_b = 21 m	The site boundaries; disjunctive disturbances	2.6	5.5	3.63	7.66	17 – 32
			2.2 – 3.24		493	365	
C_6	17.5 m > 9.7; H_b = 9.7 m	The site boundaries; disjunctive disturbances	2.71	5.65	3.31	7.34	19 – 28
			1.8 – 2.52		476	334	

Table 3. Coefficient of suitability of Western Donbas coal seam sites for UCG (Part 1)

Geological factor									Hydrogeological factor			
Coal seam	Coal reserves and coal rank	Thickness of coal seam	Structure and texture of seam	Ash content of coal	Mining depth	Disturbance of UCG site	Lithology of wall rocks		Watering and permeability of rocks	Water influx into the gas generator	Seam watering	Seam permeability
							roof	floor				
C_4^1	0.66	0.54	0.61	0.82	0.64	0.65	0.71	0.6	0.62	0.64	0.82	0.76
C_5	0.65	0.65	0.82	0.84	0.85	0.74	0.76	0.71	0.74	0.72	0.85	0.84
C_6	0.68	0.66	0.8	0.82	0.81	0.63	0.7	0.55	0.70	0.66	0.82	0.84
C_4	0.73	0.56	0.66	0.76	0.64	0.67	0.72	0.56	0.61	0.58	0.80	0.76
C_8	0.74	0.68	0.55	0.67	0.62	0.64	0.68	0.50	0.63	0.61	0.8	0.78
C_6	0.67	0.6	0.65	0.72	0.83	0.74	0.69	0.52	0.65	0.64	0.78	0.80

Table 4. Coefficient of suitability of Western Donbas coal seam sites for UCG (Part 2)

Mining and technical factor							Coefficient of coal seams suitability for UCG
Coal seam	Rock pressure	Coal losses in situ	Blowing and gas losses	Environmental protection	Heat losses	Available consumers of the gasification products	
C_4^1	0.82	0.78	0.80	0.77	0.52	0.83	0.64
C_5	0.80	0.88	0.90	0.87	0.62	0.85	0.70
C_6	0.80	0.86	0.88	0.85	0.63	0.80	0.71
C_4	0.83	0.78	0.80	0.78	0.54	0.84	0.67
C_8	0.85	0.74	0.77	0.74	0.64	0.80	0.68
C_6	0.80	0.84	0.86	0.82	0.57	0.85	0.66

The coefficients represent the possibility to mine coal seams of the sites using underground coal gasification method involving the implementation of operational parameters, providing success of the technique. It is recommended to place an experimental gas generator within coal seam C_5 of UCG site #4 where there is the most developed infrastructure, and criteria of applicability for gasification are optimal. Development practices of UCG site #4 will help correct the technological parameters for further industrial expansion.

Building on these coefficients, the next step is to conduct pilot-scale experiments that will help us validate and fine-tune the UCG process under controlled conditions. We believe that the insights gained during this trial will allow us to adjust our gasification methodology more accurately and enhance the simulation models we use for similar geological settings. Continuous monitoring, along with close collaboration with field experts, will be crucial to ensuring both the efficiency and safety of the operation as we advance toward industrial-scale applications.

4. Conclusions

The following was taken into consideration while determining applicability for UCG of the sites of Western Donbas coal seams at the territory of DTEK Pavlohradvuhillia:

– operation analysis of Ukrainian Pidzemgaz stations in the process of coal gasification;

– pursuance of the research using underground experimental gas generator and bench units;

– geological, hydrogeological, and structural conditions of the coal seams occurrence; and

– surface topography as well as infrastructural development.

The determined coefficient of changes in the applicability of coal seams for gasification depends upon the availability of natural protective layers (i.e. disjunctive disturbances) at the boundaries of the strata. The layers provide tightness of underground gas generators in terms of stratification. Occurrences depths, being 65-390 m, and 26-45 m distances between the coal seams make their underground gasification safe, taking into consideration 0.77-1.4 m gasification thickness. Water inflow into an underground gas generator is 0.86-3.24 m^3/hour involving extra expenditures connected with the preparation and operation of the underground gas generators within such UCG sites as #1, 7, 8, and 9.

It is recommended to place an experimental gas generator within coal seam C_5 of UCG site #4 where there is the most developed infrastructure, and criteria of applicability for gasification are optimal. Development practices of UCG site #4 will help correct the technological parameters for further industrial expansion.

The practical significance of the research is in the fact that the experience of mining the UCG # 4 site of the experimental gas generator allows adjusting the technology parameters for subsequent industrial replication. The proposed approach to the selection of a site and a coal seam can also be tested in other coal deposits with similar mining-geological and mining-technical conditions.

Author contributions

Conceptualization: VSF, ROD; Data curation: PBS, MIL; Formal analysis: PBS, VHL, MIL; Funding acquisition: ROD, VHL; Investigation: VSF, VHL; Methodology: VSF; Project administration: ROD; Resources: PBS, MIL; Supervision: ROD; Validation: PBS, MIL; Visualization: VSF, VHL; Writing – original draft: VSF, ROD, VHL, PBS, MIL; Writing – review & editing: ROD, VHL. All authors have read and agreed to the published version of the manuscript.

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Conflicts of interests

Author VHL declared that he was an editorial board member of the Engineering Journal of Satbayev University at the time of submission. This had no impact on the peer review process and the final decision. The remaining authors declare no conflict of interest.

Data availability statement

The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

References

[1] Salieiev, I. (2024). Organization of processes for complex mining and processing of mineral raw materials from coal mines in the context of the concept of sustainable development. *Mining of Mineral Deposits*, 18(1), 54-66. https://doi.org/10.33271/mining18.01.054

[2] Starodubets, K.M., Dubosarskyi, V.R., & Mamyshev, I.Y. (2023). The state of reserves and prospective resources of the Southern oil and gas region of Ukraine. *Mineral Resources of Ukraine*, (2), 36-41. https://doi.org/10.31996/mru.2023.2.36-41

[3] Astrov, V., Ghodsi, M., Grieveson, R., & Holzner, M. (2022). Russia's invasion of Ukraine: assessment of the humanitarian, economic, and financial impact in the short and medium term. *International Economics and Economic Policy*, *19*(2), 331-381. https://doi.org/10.1007/s10368-022-00546-5

[4] Lytvyniuk, S.F., & Kurylo, M.M. (2024). Substantiation of condition parameters for the calculation of reserves of iron ore deposits to optimize development systems. *Mineral Resources of Ukraine*, (2), 16-20. https://doi.org/10.31996/mru.2024.2.16-20

[5] Bielov, O.P., & Adamchuk, A.A. (2018). Substantiation of the ways to use lignite concerning the integrated development of lignite deposits of Ukraine. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, (3), 5-13. https://doi.org/10.29202/nvngu/2018-3/6

[6] Bondarenko, V., Salieiev, I., Kovalevska, I., Chervatiuk, V., Malashkevych, D., Shyshov, M., & Chernyak, V. (2023). A new concept for complex mining of mineral raw material resources from DTEK coal mines based on sustainable development and

ESG strategy. *Mining of Mineral Deposits*, *17*(1), 1-16. https://doi.org/10.33271/mining17.01.001

[7] Makarov, V., Perov, M., Bilan, T., Novoseltsev, O., & Zaporozhets, A. (2024). Technological State of Coal Mining in Ukraine. *Geomining: Systems and Decision-Oriented Perspective*, 31-41. https://doi.org/10.1007/978-3-031-70725-4_2

[8] Lozynskyi, V. (2023). Critical review of methods for intensifying the gas generation process in the reaction channel during underground coal gasification (UCG). *Mining of Mineral Deposits*, *17*(3), 67-85. https://doi.org/10.33271/mining17.03.067

[9] Saik, P., Petlevanyi, M., Lozynskyi, V., Sai, K., & Merzlikin, A. (2018). Innovative approach to the integrated use of energy resources of underground coal gasification. *Solid State Phenomena*, (277), 221-231. https://doi.org/10.4028/www.scientific.net/SSP.277.221

[10] Koval, V., Kryshtal, H., Udovychenko, V., Soloviova, O., Froter, O., Kokorina, V., & Veretin, L. (2023). Review of mineral resource management in a circular economy infrastructure. *Mining of Mineral Deposits*, *17*(2), 61-70. https://doi.org/10.33271/mining17.02.061

[11] Abbas, Q., Yaqoob, H., Sajjad, U., Ali, H. M., & Jamil, M. M. (2025). Utilization of Local Coal in Pakistan Oil-Fired Power Plants and Future Clean Technologies for Power Generation. *Case Studies in Chemical and Environmental Engineering*, 101132. https://doi.org/10.1016/j.cscee.2025.101132

[12] Keboletse, K.P., Ntuli, F., & Oladijo, O.P. (2021). Influence of coal properties on coal conversion processes-coal carbonization, carbon fiber production, gasification and liquefaction technologies: a review. *International Journal of Coal Science & Technology*, *8*(5), 817-843. https://doi.org/10.1007/s40789-020-00401-5

[13] Dychkovskyi, R., Falshtynskyi, V., Lozynskyi, V., & Saik, P. (2015). Development the concept of borehole underground coal gasification technology in Ukraine. *New Developments in Mining Engineering*, 91-95. https://doi.org/10.1201/b19901-18

[14] Lozynskyi, V. (2024). Numerical simulation of carbonaceous raw material combustion in a coal seam channel. *Mining of Mineral Deposits*, *18*(4), 109-124. https://doi.org/10.33271/mining18.04.109

[15] Falshtynskyi, V., Dychkovskyi, R., Lozynskyi, V., & Saik, P. (2015). Analytical, laboratory and bench test researches of underground coal gasification technology in National Mining University. *New Developments in Mining Engineering*, 97-106. https://doi.org/10.1201/b19901-19

[16] Feng, Y., Chen, J., & Luo, J. (2024). Life cycle cost analysis of power generation from underground coal gasification with carbon capture and storage (CCS) to measure the economic feasibility. *Resources Policy*, *92*, 104996. https://doi.org/10.1016/j.resourpol.2024.104996

[17] Wiatowski, M., Basa, W., Pankiewicz-Sperka, M., Szyja, M., Thomas, H. R., Zagorscak, R., & Kapusta, K. (2024). Experimental study on tar formation during underground coal gasification: Effect of coal rank and gasification pressure on tar yield and chemical composition. *Fuel*, *357*, 130034. https://doi.org/10.1016/j.fuel.2023.130034

[18] Su, F.Q., He, X.L., Dai, M.J., Yang, J.N., Hamanaka, A., Yu, Y.H., & Li, J.Y. (2023). Estimation of the cavity volume in the gasification zone for underground coal gasification under different oxygen flow conditions. *Energy*, *285*, 129309. https://doi.org/10.1016/j.energy.2023.129309

[19] Yin, Z., Xu, H., Chen, Y., Zhao, T., & Wu, J. (2023). Experimental simulate on hydrogen production of different coals in underground coal gasification. *International Journal of Hydrogen Energy*, *48*(19), 6975-6985. https://doi.org/10.1016/j.ijhydene.2022.03.205

[20] Borgulat, J., Ponikiewska, K., Jałowiecki, Ł., Strugała-Wilczek, A., & Płaza, G. (2022). Are Wetlands as an Integrated Bioremediation System Applicable for the Treatment of Wastewater from Underground Coal Gasification Processes?. *Energies*, *15*(12), 4419. https://doi.org/10.3390/en15124419

[21] Wiatowski, M., Muzyka, R., Kapusta, K., & Chrubasik, M. (2021). Changes in properties of tar obtained during underground coal gasification process. *International Journal of Coal Science & Technology*, *8*(5), 1054-1066. https://doi.org/10.1007/s40789-021-00440-6

[22] Grabowski, J., Korczak, K., & Tokarz, A. (2021). Aquatic risk assessment based on the results of research on mine waters as a part of a pilot underground coal gasification process. *Process Safety and Environmental Protection*, (148), 548-558. https://doi.org/10.1016/j.psep.2020.10.003

[23] Laciak, M., Kačur, J., & Durdán, M. (2022). Modeling and Control of Energy Conversion during Underground Coal Gasification Process. *Energies*, *15*(7), 2494. https://doi.org/10.3390/en15072494

[24] Gao, W., Zagorščak, R., & Thomas, H. R. (2022). Insights into ground response during underground coal gasification through thermo-mechanical modeling. *International Journal for Numerical and Analytical Methods in Geomechanics*, *46*(1), 3-22. https://doi.org/10.1002/nag.3287

[25] Kačur, J., Laciak, M., Durdán, M., & Flegner, P. (2023). Investigation of underground coal gasification in laboratory conditions: A review of recent research. *Energies*, *16*(17), 6250. https://doi.org/10.3390/en16176250

[26] An, N., Zagorščak, R., Thomas, H. R., & Gao, W. (2021). A numerical investigation into the environmental impact of underground coal gasification technology based on a coupled thermal-hydro-chemical model. *Journal of Cleaner Production*, (290), 125181. https://doi.org/10.1016/j.jclepro.2020.125181

[27] Biswas, A. K., Islam, M. R., & Habib, M. A. (2023). An analytical investigation of critical factors to prioritize coalfields for Underground Coal Gasification–Bangladesh case. *Heliyon*, *9*(7). https://doi.org/10.1016/j.heliyon.2023.e18416

[28] Bazaluk, O., Lozynskyi, V., Falshtynskyi, V., Saik, P., Dychkovskyi, R., & Cabana, E. (2021). Experimental studies of the effect of design and technological solutions on the intensification of an underground coal gasification process. *Energies*, *14*(14), 4369. https://doi.org/10.3390/en14144369

[29] Mandal, R., & Maity, T. (2023). Operational process parameters of underground coal gasification technique and its control. *Journal of Process Control*, *129*, 103031. https://doi.org/10.1016/j.jprocont.2023.103031

[30] Saik, P., & Berdnyk, M. (2022). Mathematical model and methods for solving heat-transfer problem during underground coal gasification. *Mining of Mineral Deposits*, *16*(2), 87-94. https://doi.org/10.33271/mining16.02.087

[31] Gu, Y., Li, H., Dou, L., Wu, M., Guo, H., Huang, W., & Feng, L. (2024). Advance in detection and management for underground coal fires: A global technological overview. *Combustion Science and Technology*, 1-38. https://doi.org/10.1080/00102202.2024.2365260

[32] Qin, B., Li, H., Wang, Z., Jiang, Y., Lu, D., Du, X., & Qian, Q. (2024). New framework of low-carbon city development of China: Underground space based integrated energy systems. *Underground Space*, *14*, 300-318. https://doi.org/10.1016/j.undsp.2023.06.008

[33] Wei, Z., Jiang, L., Chen, S., Dong, Z., Chen, Y., Liu, B., ... & Ali, S. F. (2024). Towards A hydrogen economy: Understanding pore alterations in the context of underground coal gasification. *Journal of Cleaner Production*, *484*, 144325. https://doi.org/10.1016/j.jclepro.2024.144325

[34] Zou, C., Chen, Y., Kong, L., Fenjin, S., Shanshan, C., & Zhen, D. (2019). Underground coal gasification and its strategic significance to the development of natural gas industry in China. *Petroleum Exploration and Development*, *46*(2), 205-215. https://doi.org/10.1016/S1876-3804(19)60002-9

[35] Tabachenko, M., Saik, P., Lozynskyi, V., Falshtynskyi, V., & Dychkovskyi R. (2016). Features of setting up a complex, combined and zero-waste gasifier plant. *Mining of Mineral Deposits*, *10*(3), 37-45. http://dx.doi.org/10.15407/mining10.03.037

[36] Pivnyak, G., Dychkovskyi, R., Bobyliov, O., Cabana, E. C., & Smoliński, A. (2018). Mathematical and Geomechanical Model in Physical and Chemical Processes of Underground Coal Gasification. *Solid State Phenomena*, (277), 1-16. https://doi.org/10.4028/www.scientific.net/ssp.277.1

[37] Falshtynskyi, V., Dychkovskyi, V. Lozynskyi, V., & Saik, P. (2012). New method for justification the technological parameters of coal gasification in the test setting. *Geomechanical Processes During Underground Mining – Proceedings of the School of Underground Mining*, 201-208. https://doi.org/10.1201/b13157-35

[38] Falshtynskyi, V., Dychkovskyi, R., & Illiashov, M. (2011). Engineering support of BUCG process in Solenovsk coal deposits. *Technical and Geoinformational Systems in Mining*, 47-56. https://doi.org/10.1201/b11586

[39] Saik, P.B., Dychkovskyi, R.O., Lozynskyi, V.H., Malanchuk, Z.R., & Malanchuk, Ye.Z. (2016). Revisiting the underground gasification of coal reserves from contiguous seams. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, (6), 60-66.

[40] Pivnyak, G., Falshtynskyi, V., Dychkovskyi, R., Saik, P., Lozynskyi, V., Cabana, E., & Koshka, O. (2020). Conditions of Suitability of Coal Seams for Underground Coal Gasification. *Key Engineering Materials*, (844), 38-48. https://doi.org/10.4028/www.scientific.net/kem.844.38

[41] Lozynskyi V. (2025). Multi-Criteria Assessment of Coal Seams Suitability for Co-Gasification Using the Preference Selection Index. *Heliyon*. Preprint.

[42] Stovba, S.M., & Stephenson, R.A. (1999). The Donbas Foldbelt: its relationships with the uninverted Donets segment of the Dniepr–Donets Basin, Ukraine. *Tectonophysics*, *313*(1-2), 59-83. https://doi.org/10.1016/S0040-1951(99)00190-0

[43] Stovba, S., Khriashchevska, O., Mazur, S., Stephenson, R., Vengrovych, D., & Drachev, S. (2024). Hydrocarbon prospects in the Dniepr-Donets Basin, Ukraine, and the Ukrainian Carpathians: an overview. *Annales Societatis Geologorum Poloniae*, 94. https://doi.org/10.14241/asgp.2024.07

[44] Van Hinsbergen, D.J., Abels, H.A., Bosch, W., Boekhout, F., Kitchka, A., Hamers, M., & Stephenson, R.A. (2015). Sedimentary geology of the middle Carboniferous of the Donbas region (Dniepr-Donets basin, Ukraine). *Scientific Reports*, *5*(1), 1-8. https://doi.org/10.1038/srep09099

[45] Sachsenhofer, R.F., Privalov, V.A., & Panova, E.A. (2012). Basin evolution and coal geology of the Donets Basin. *International Journal of Coal Geology*, (89), 26-40. https://doi.org/10.1016/j.coal.2011.05.002

[46] Haidai, O., Ruskykh, V., Ulanova, N., Prykhodko, V., Cabana, E.C., Dychkovskyi, R., & Smolinski, A. (2022). Mine Field Preparation and Coal Mining in Western Donbas: Energy Security of Ukraine – Case Study. *Energies*, *15*(13), 4653. https://doi.org/10.3390/en15134653

[47] Saik, P., Maksymova, E., Lozynskyi, V., Cabana, E., & Petlovanyi, M. (2021). Synergistic approach as an innovative basis for obtaining a natural gas substitute. *E3S Web of Conference*, (230), 01022. https://doi.org/10.1051/e3sconf/202123001022

[48] Nehrii, S., Nehrii, T., Bachurin, L., & Piskurska, H. (2019). Problems of mining the prospective coal-bearing areas in Donbas. *E3S Web of Conferences*, (123), 01011. https://doi.org/10.1051/e3sconf/201912301011

[49] Symanovych, H., Lisovytska, I., Odnovol, M., Ahaiev, R., & Poimanov, S. (2024). Rationale and modeling of technology for complex bottom-hole zone de-stressing of gas-dynamically active rock mass. *Mining of Mineral Deposits*, *18*(2), 83-92. https://doi.org/10.33271/mining18.02.083

[50] Sdvizhkova, Ye.A., Babets, D.V., & Smirnov, A.V. (2014). Support loading of assembly chamber in terms of Western Donbas plough longwall. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, (5). 26-32.

[51] Law, B.E., Ulmishek, G.F., Clayton, J.L., Kabyshev, B.P., Pashova, N.T., & Krivosheya, V.A. (1998). Basin-centered gas evaluated in Dnieper-Donets basin, Donbas foldbelt, Ukraine. *Oil and Gas Journal*, *96*(47), 74-78.

[52] Bondarenko, B., Kovalevska, I., Krasnyk, V., Chernyak, V., Haidai, O., Sachko, R., & Vivcharenko, I. (2024). Methodical principles of experimental-analytical research into the influence of pre-drilled wells on the intensity of gas-dynamic phenomena manifestations. *Mining of Mineral Deposits*, *18*(1), 67-81. https://doi.org/10.33271/mining18.01.067

Батыс Донбасс (Украина) көмір қабаттарының көмірді жерасты газдандыруға жарамдылығының негіздемесі

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Аңдатпа. Мақалада көмірді жерасты газдандыру технологиясына (Пгв) жарамды болуы мүмкін Батыс Донбасс (Украина) көмір қабаттарының учаскелері қарастырылған. Бұл технология Украинаның күрделі энергетикалық жағдайы жағдайында энергия тұтынушыларының нарығына айтарлықтай әсер етуі мүмкін. Он учаскенің тау-кен-геологиялық және тау-кен техникалық жағдайларын егжей-тегжейлі зерделеу негізінде олардың ПГВ-ға жарамдылық критерийлері бойынша оңтайлы учаске мен көмір қабатын таңдау жүзеге асырылды. Көмір қабаттарының, бүйірлік жыныстардың (шатыр, табан) құрылымдары, тектоникалық бұзылулардың орналасуы мен мөлшері, гидрогеологиялық жағдайлар, сондай-ақ көмірдің техникалық және элементтік құрамы талданады. Жүргізілген зерттеу негізінде эксперименттік жерасты газ генераторын ең дамыған инфрақұрылымы және газдандыруға жарамдылығының оңтайлы критерийлері бар аумақта орналасқан №4 учаскенің C5 көмір қабатына орналастыру ұсынылады. Зерттеудің практикалық маңыздылығы эксперименттік газ генераторының №4 пгв учаскесін пысықтау тәжірибесі кейінгі өнеркәсіптік таралым үшін технология параметрлерін түзетуге мүмкіндік береді. Учаске мен көмір қабатын таңдауға ұсынылған тәсілді тау-кен геологиялық және тау-кен техникалық жағдайлары ұқсас басқа көмір кен орындарында да тексеруге болады.

Негізгі сөздер: *көмірді жерасты газдандыру, қабат, газ генераторы, тас көмір, кен орны*.

Обоснование пригодности угольных пластов Западного Донбасса (Украина) к подземной газификации угля

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Аннотация. В статье рассмотрены участки угольных пластов Западного Донбасса (Украина), которые могут быть пригодны к технологии подземной газификации угля (ПГВ). Данная технология в условиях сложного энергетического положения Украины может существенно повлиять на потребительский рынок энергоносителей. На основе детального изучения горно-геологических и горнотехнических условий десяти участков по критериям их пригодности к ПГВ осуществлен выбор оптимального участка и угольного пласта. Проанализированы структуры угольных пластов, боковых пород (кровли, подошвы), расположение и размер тектонических нарушений, гидрогеологические условия, а также технический и элементный состав угля. На основе проведенного исследования установлено, что экспериментальный подземный газогенератор рекомендуется разместить на каменноугольном пласте C_5 участка №4, расположенного на территории с наиболее развитой инфраструктурой и оптимальными критериями пригодности к газификации. Практическое значение исследования состоит в том, что опыт отработки участка ПГВ №4 экспериментального газогенератора позволит скорректировать параметры технологии для последующего промышленного тиражирования. Предложенный подход к выбору участка и угольного пласта может быть апробирован также на других угольных месторождениях с похожими горно-геологическими и горнотехническими условиями.

Ключевые слова: *подземная газификация угля, пласт, газогенератор, каменный уголь, месторождение*.

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