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Development of Coal Deposits by Underground Gasification Method

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Abstract: The article deals with the extraction of sulfur minerals from underground by non-traditional (geotechnological) methods. In particular, this method is effective due to its uniqueness and simple technology. This method is widely used in the extraction of small or deep sulfur bodies from sulfur mining. Low melting temperature of sulfur mineral, i.e., ease of movement is the basis for this method. Sulfur minerals brought to a state of motion are brought to the surface with the help of wells.

Keywords: Underground gasification of coal ,well, geotechnological method, autoclave, hydrothermal waters, cracks, shifts, tectonic disturbances, complex hypsometry of layers.

The idea of underground gasification of coal was first put forward by D. I. Mendeleev, who wrote in 1888: "Perhaps, over time, a period will come when coal will not be mined from the ground, and it will be burned on the ground, in the soil." can be converted to gas and sent over long distances through pipelines. He also developed the basic principle of underground gasification of coal: "Several wells are drilled in the layer, one of them for the entry of air and water, and the other for the release of gases formed during the reactions...". Underground coal gasification is a thermochemical process of converting solid fuel in the layers into gas. Gases released to the surface are cleaned of all kinds of unnecessary and toxic waste. The gas released to the surface can be used for energetic and chemical-technological purposes. Part of the coal seam where gasification is carried out is underground, the gas generator can be conditionally divided into five zones.

The process of underground gasification of coal is based on the chemical reactions of the interaction of oxygen with carbon, hydrogen and methane:

$C + O_2 = CO_2 + 394$ kJ/mol;

$2C + O_2 = 2CO + 221$ kJ/mol;

$H_2 + 0.5O_2 = H_2O + 242$ kJ/mol;

$CH_4 + 2O_2 = CO_2 + 2H_2O + 801$ kJ/mol;

$CO + 0,5O_2 = CO_2 + 286$ kJ/mol.

These reactions are characteristic of the combustion zone. They pass with a significant spread of heat, which is used to heat the gas and coal layer to a temperature of 1000-1500 ° C, which ensures the coal and its drying. In this area, actively formed CO and CO_2 oxides and methane CH_4 and water vapor originate from the layer.

In the recovery zone, coal mainly reacts with oxygen, so the reduction of the CO fraction and the reactions of water vapor are characteristic of the combustion zone:

$CO_2 + C = 2CO - 173$ kJ/mol;

$H_2O + C = CO + H_2$ - 130 kJ/mol;

$2H_2O + C = CO_2 + 2H_2$ - 80,3 kJ/mol.

These reactions significantly increase the heat of combustion of the gas (from 4-5 to 10-11 kJ/m3), but due to their endothermic nature, they reduce the gas temperature in the zone to an average of 700-800°C and at its limits - 500-600°C up to In the conversion part, reactions of conversion of CO and formation of methane take place:

$CO + H_2O = CO_2 + H_2$+ 41,8 kJ/mol;

$CO + 3H_2 = CH_4 + H_2O$+ 205 kJ/mol;

$C + 2H_2 = CH_4$+ 75,3 kJ/mol,

as well as processes of thermal decomposition of coal with the release of CO and CO_2. Due to the loss of CO and the postulation of water vapor, the heat of combustion of the gases decreases again sharply.

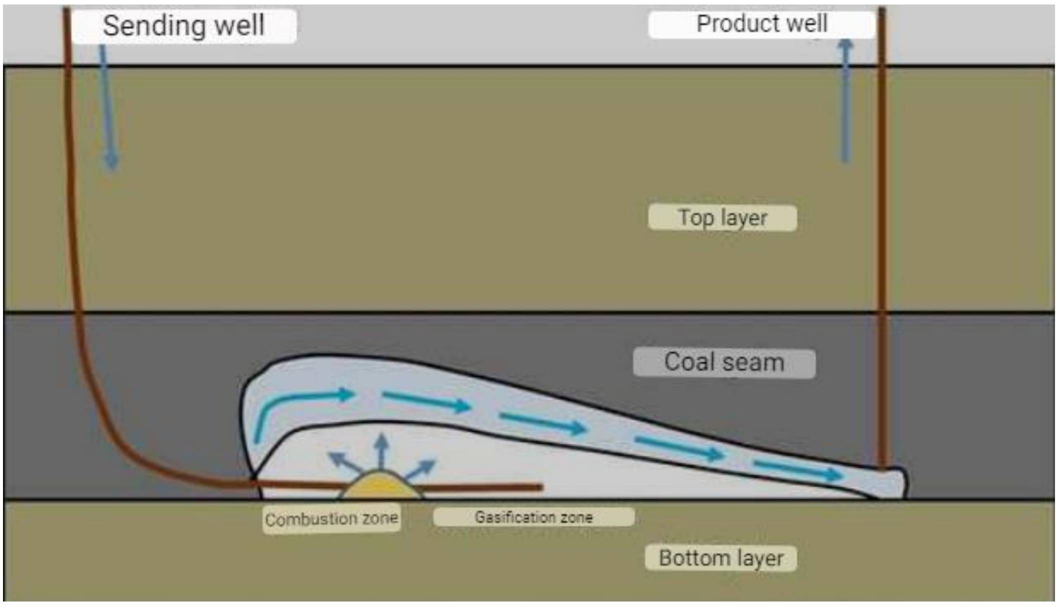
Due to the exogenous nature of the reactions, the small amount of heat received cannot cover the heat losses of the formation and surrounding rocks, as well as the costs of thermal decomposition of coal, so the temperature of gases and rocks in the conversion section decreases by 120-150 ° C - heat loss in the surrounding massif up to 100-110° C due to solidification and costs of drying coal and gases.

The main factors affecting the efficiency of underground gasification of coal can be divided into the following groups: mining-geological conditions of the mine; the amount of water involved in the process, the mineral composition of coal; ventilation parameters; location of wells.

Mining and geological conditions (thickness of the layer, its depth, water permeability and tectonic disturbance of the surrounding rocks) that limit the technical possibilities or determine the economic results of underground gasification of coal.

An increase in the thickness of the reservoir leads to a decrease in heat loss to the environment, a decrease in the specific water flow, and ultimately an increase in the heat of combustion of the gas and the efficiency of the underground coal gasification process. However, the specific yield of gas is probably reduced due to excess water content. Thus, according to the information provided by the South-Abinsk station:

Layer thickness, m	2	9
Net calorific value of gas, MJ/m^3	2,8-3,4	4,2-4,9
PI process of underground coal gasification	42-50	49-62
Relative consumption of gas, m^3/kg	4,2-4,9	3,2-3,9



Cracks, shifts, tectonic disturbances, complex hypsometry of layers make it difficult to create a reaction channel and control the combustion center. The amount of water involved in the process of underground coal gasification consists of the following: natural moisture of coal, water flow to the developed area, water contained in the explosion and formed during the combustion of carbon, hydrogen, methane and CO conversion. The total humidity has a significant effect on the efficiency of the existing process, because the intensity of the gasification process is determined by the heat loss for the evaporation of water and the composition of water vapor in the resulting gas - the heat of its combustion. Low water content of coal and lack of water flow can cause moisture deficiency, which slows the gasification process. Reduction, in particular, reduces the formation of CO during reduction reactions. A large amount of water reduces the rate of evacuation of the coal seam from the heat content of the gas by reducing the CO content and increasing the moisture content. Therefore, the amount of water involved in the process of underground gasification of coal should be optimized under specific conditions and strictly regulated.

The main measures to control the amount of water involved in the process (underground coal gasification) are reduced to pre-draining the area with drainage wells and processing areas, to increasing the air pressure supplied to replace (compress) the moisture from the firewall and the reaction channel . The mineral composition of coal, mainly the amount of ash, determines its heat of combustion, chemical composition and specific gas release. The amount and properties of ash characterize the permeability of the medium, the filter blowing on the coal surface and the resulting gases. An increase in the ash content clearly leads to a deterioration in the quality of produced gas and the performance of underground coal gasification.

The main factors determining the efficiency of underground coal gasification are explosion parameters: chemical composition, flow rate, injection pressure. Enrichment of the explosion with oxygen increases the temperature inside the rhenium, expands its boundaries and increases the combustion heat of the gas. The amount of CO and H2 in the produced gas increases by 1.5-2 times when the explosion is provided with oxygen content 2 times higher than in the atmosphere.

The dependence of the lower calorific value of the gas on its humidity and the specific water flow of the layer was calculated. Addition of 150-200 g/m^3 to air blast enhances water vapor (in dry deposits) reduction reactions and increases productivity of CO, H_2 and CH_4. An even more beneficial effect is the combined use of oxygen enrichment and steam addition - steam-oxygen explosion.

With an increase in air consumption (explosion intensity), the amount of oxygen entering the oxidation reactions and the rate of its falling to the coal surface increases, and the turbulent flow of gases in the gasification channel is also ensured. Up to a certain limit, this increases the efficiency of the underground coal gasification plant, but if it is too much, the CO_2 output increases dramatically with the air flow rate, resulting in a decrease in the heat content of the gas. Thus, at a low air flow rate, the combustion process ends, and at a high air flow rate, the coal burns into CO_2.

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