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STUDY OF THE ELECTROPHYSICAL INTRA-STRATAL METHOD OF GASIFICATION AT DIFFERENT HEATING RATES OF COAL

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Due to the constant rise in prices, the reduction of natural gas and the high cost of exploring new fields, there are many countries working on the improved technology of coal gasification. The product thus obtained can fully replace natural gas [1].

One of the most promising technologies to produce gas from coal is underground gasification. This type of gasification is to conduct physical and chemical processes in untouched coal beds. The result is syngas with sufficient thermal properties for energy and industrial purposes [2] and its use in the energy industry is environmentally friendlier compared to the direct combustion of solid and liquid fuels. Furthermore, its cost is significantly lower than the cost of natural gas [3].

This paper presents the study of the syngas produced by electrophysical intra-stratal method of gasification at different heating rates of “Krasnogorsk” deposit anthracite.

Installation, the main element of which is a chamber, presented in figure 1, was used for the experiment. The chamber is made as a cylinder with the volume of 0.06 m^3 and the pressure up to 5 MPa. Conditions created inside the chamber are similar to the conditions of subterranean formation.

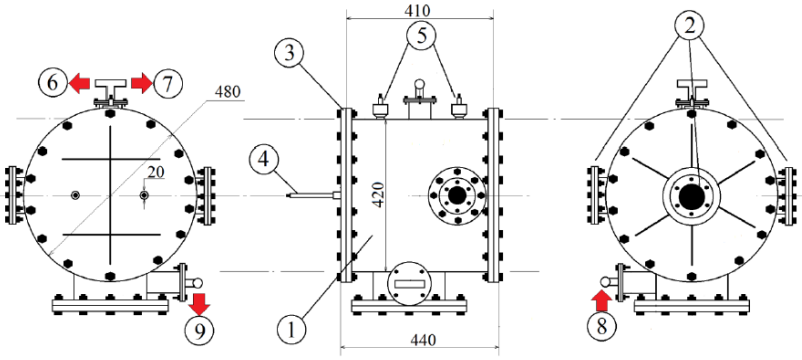

Fig.1. Experimental chamber (1 – chamber case, 2 – flanges, 3 – end caps, 4, 5 – electrical inputs, 6, 7, 8, 9 – tubes)

Prepared coal sample was placed in the experimental chamber. After that, it was sealed and filled with nitrogen N_2 with pressure of 0.3 MPa. Then, electrodes injected in the sample were put under voltage with gradual increase from 1 to 10 kV. Next, heating was continued by adjusting the current, and while maintaining a constant voltage.

During the experiment, samples the syngas were taken directly from the chamber using a polymer pneumatic hose connected to the filter regulator LFR-1/4-D-5M-MINI, which allows taking out gas sample, without affecting the pressure in the chamber. Then, the gas was fed to the chromatograph Agilent 7890A for the quantitative determination of the composition.

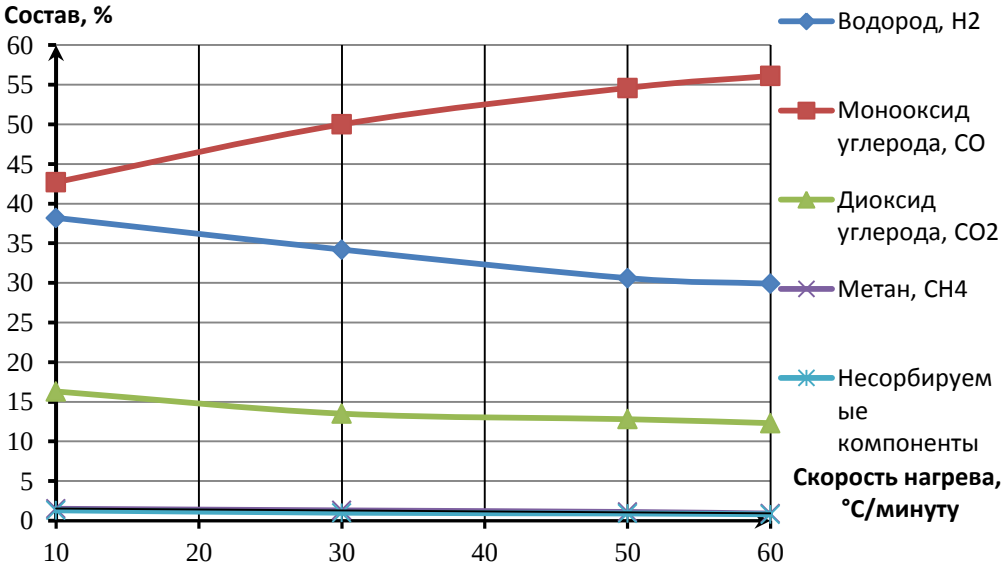

Fig. 2. Quantitative composition of the syngas from “Krasnogorsk” deposit anthracite

Four experiments with different heating rate (10, 30, 50, 60°C/min) were performed. The duration of the experiment was limited by the obtaining of maximum temperature of 800°C.

Figure 2 shows that increasing the heating rate leads to:

- decrease of carbon dioxide CO_2 output, which favorably affects the heat of combustion of the syngas;
- reduction of hydrogen H_2 and methane CH_4 outlet;
- increase of carbon monoxide concentration, which causes a higher rate of oxidation reaction of CH_4 and H_2 with moisture and oxygen O_2 released from the coal during the heating process;
- reduction of non-sorbing components content (water vapor content, impurities of nitrogen oxide, sulfur oxides, hydrogen sulfide and other ballast compounds).

Knowing the quantitative composition of the syngas the heat of combustion can be calculated as [4]:

$$Q = \sum_{i=1}^{n} Q_i \cdot C_i, \quad (1)$$

Q_i – calorific value of the gas of i-th component, MJ/m^3; C_i – quantity of i-th component.

The results of calorific value calculations of the received syngas are presented in figure 3.

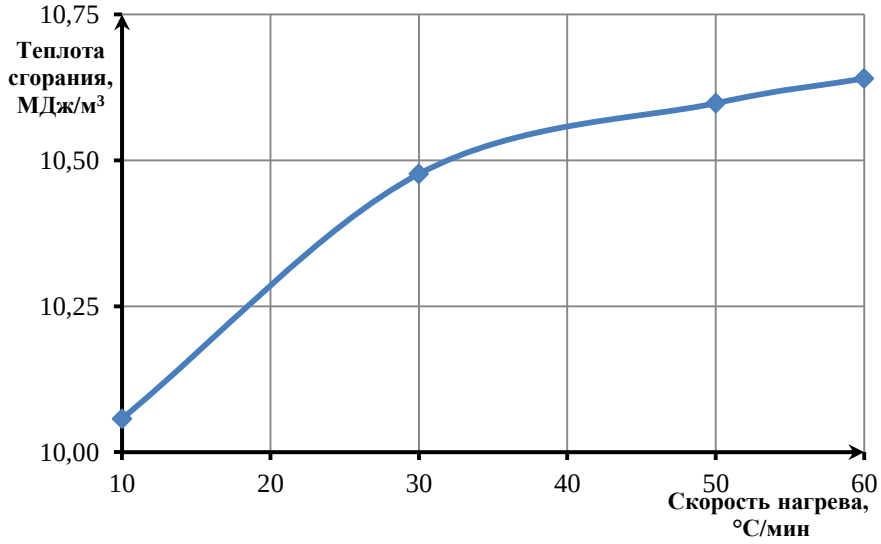

Fig. 3. Calorific value of syngas at different heating rates

From the results shown in figure 3 is clear, that the maximum calorific value is obtained at a heating rate of 60°C/min.

The results of experiments to determine the composition of synthesis gas by the electrophysical intra-stratal gasification method showed that with the increase of intensity of heating decreases concentration of carbon dioxide CO_2, hydrogen H_2 and methane CH_4. In addition, an increase in the

content of carbon monoxide CO is observed. Its value compensates the concentration of combustible components and increases the rate of calorific value of produced syngas.

Based on the calorific value of the received syngas, it can be concluded that the effectiveness of the proposed method of underground gasification of coal is much higher than the existing technology where the air blowing is applied [5].

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ЧИСЛЕННЫЙ АНАЛИЗ ДВИЖЕНИЯ ЧАСТИЦ ЖИДКОСТИ В КРИВОЛИНЕЙНЫХ КАНАЛАХ

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В турбинах АЭС большая часть ступней работает в области ниже кривой насыщения. Экономичность, а также их эрозионный износ этих ступней в значительной степени зависит от степени влажности