Kinetics of heating coals prone and not prone to spontaneous combustion

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The thermogravimetric method of analysis (TGA) reflects the kinetics of processes occurring when coal samples are heated, and is suitable for studying low-temperature oxidation of coals to determine the propensity of coals to spontaneous heating and spontaneous combustion, as well as calculating kinetic parameters at the oxidation stage.

It is known that by changing the mass of coal samples, it is possible to judge the sorption of oxygen by coal and the phenomena occurring during the transformation of coal matter with increasing temperature. An increase in the mass of coal in the temperature range of 100-250 °C, exceeding the evaporation temperature of moisture, but below the temperature of active decomposition of coal, is interpreted as oxygen sorption with the formation of carbon-oxygen complexes, which can be used to assess the propensity of coal to spontaneous combustion by its chemical activity to oxygen.

To date, there is no experimental thermogravimetric parameter that could reliably characterize the propensity of coal to spontaneous heating. This is due to the inconsistency of the results, since the values characterizing the propensity of coals to spontaneous combustion: the maximum mass gain (M), the self–heating temperature of the sample (Tnagr) and the ignition temperature (Tcr) - vary depending on the selected fraction and weight of the coal, the heating rate of the chamber, as well as the type and speed of gas supply to the chamber the analyzer.

We conducted experiments on the choice of the heating rate of coal samples in the selected temperature range. The behavior of coal samples from the Pechersk coal basin, prone and not prone to spontaneous combustion, was studied at heating rates of 3, 5 and 10 °C/min with a constant heating rate up to 1000 °C.

As a result of the experiment, the following patterns were revealed.

The heating rate of the sample has a significant impact on all indicators of the propensity of coal to spontaneous combustion and on the criteria for dividing coals into categories prone and not prone to spontaneous combustion.

With an increase in the heating rate, the amount of sorbed oxygen (without combustion) M is decreasing.

For samples of coals not prone to spontaneous combustion, the value of M does not exceed 0.6 % at a heating rate of 3 0C/min, 0.2% at 5 °C/min and at a heating rate of 10 °C/min is hundredths of a percent.

For samples of coals prone to spontaneous combustion, the value of M at heating rates of 3, 5 and 10 °C /min, respectively, is equal to or greater than 1, 0.6 and 0.4 % of the initial mass of the sample.

For samples of coals prone to spontaneous combustion, the average temperature of the beginning of the reaction (Tnach) is 140, 162 and 173 °C, at a heating rate of 3, 5 and 10 °C /min; for those not prone to spontaneous combustion, the oxidation reaction begins on average at 180, 199 and 205 °C, respectively.