Ignition and pyrolysis of coal microparticles under the action of pulsed laser radiation

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The paper presents the results of studies on establishing the patterns of development of thermal processes in coals of the Kuznetsk coal basin of marks B, DG, G, Zh and K (Russian coal classification system) in air and coal mark B in an inert medium under the action of laser pulses. Coal particles with a size of < 63 μm were used, the distribution maximum fell on a particle size of ~20 μm.

The emission spectra of the particles surface of the studied grades of coal were measured under the action of single laser pulses (1064 nm, 120 μs) with different energy densities in air medium. It has been established that the emission spectra of the surface of coal particles during the action of a single laser pulse in an air medium have a non-elementary character. At the energy density of the laser radiation corresponding to the ignition detection threshold, the emission of the CO flame and excited H_2^* and H_2O^* molecules contribute to the spectra. With an increase in the energy density of laser radiation, the emission of carbon particles contribute to the spectra. It is shown that for coal particles there are three stages of ignition with characteristic time intervals.

The results of a study of the pyrolysis of pelletized samples of coal mark B under the action of pulsed laser radiation (1064 nm, 120 μs, 6 Hz, 1.2–2.0 J/cm^2) are also presented. H_2, CH_4, H_2O, CO and CO_2 were found in the composition of gaseous pyrolysis products of coal samples. It has been established that with an increase in the energy density per pulse from 1.2 to 2.0 J/cm^2, the volume fraction of H_2 in the composition of gaseous pyrolysis products increases, while the volume fraction of CO_2, on the contrary, decreases. The volume fractions of CO and CH_4 are close to constant. It is shown that the volume of combustible gases formed per unit mass of the reacted sample increases linearly with increasing radiation energy density, while the volume fraction of combustible gases (H_2, CH_4, and CO) in the mixture of gaseous pyrolysis products at a laser radiation energy density of 2.0 J/cm^2 is 93%. It is also shown that with an increase in the energy density of laser radiation, the fraction of the reacted coal sample increases linearly. The influence of the coal mineral component on the yield of combustible gases during laser pyrolysis and on the structure of the coal sample surface, which is formed as a result of exposure to laser radiation, has been established.