INVESTIGATION OF THE COMPOSITION OF GASEOUS PRODUCTS OF LASER COAL OXIDATION BY MASS SPECTROMETRY

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At present, the issue of the negative impact of coal combustion products on the environment is acute. A large number of works are aimed at improving the combustion efficiency of coal fuel, and the possibility of using coal as a raw material for obtaining clean gaseous fuels, such as hydrogen, is also being considered.

In [5], three stages of the process of ignition and combustion of a coal particle were determined: as a result of the action of laser radiation, the coal particle is heated and the subsequent development of thermochemical reactions in the sample, then the release and ignition of various volatile substances, as well as the combustion of the non-volatile residue of the coal particle. In addition, each stage has a pronounced threshold character. In [6], studies of the thermal decomposition of brown coal under the influence of pulsed laser radiation in an inert medium were carried out. Using the method of mass spectroscopy, the following gaseous pyrolysis products were detected: H2, CH4, H2O, CO, and CO2. It was found that the concentration of hydrogen in the composition of gaseous pyrolysis products increases with increasing energy density in the pulse, while the concentration of carbon dioxide and water vapor, on the contrary, decreases. The concentrations of CO and CH4 remain constant. The yield of combustible gases increases linearly with an increase in the energy density of laser radiation.

In this work, mass spectroscopy was used to study the molecular composition of gaseous products of laser oxidation of coals of five different grades: long-flame (L), lean sintering (OS), weakly sintering (SS), lean (T), and anthracite (A) in air. The coals were ground in a ball mill. The resulting coal particles were subjected to dispersion through a vibrating sieve with a mesh size of 63 μm. Next, by pressing in a mold, tableted samples were obtained with a thickness of 2.5 mm, a diameter of 6.2 mm, and a weight of 70 mg. The source of laser radiation was a neodymium YAG:Nd3+ laser operating in the free-running mode at a wavelength of 1064 nm, with a pulse duration of 120 μs and a pulse repetition rate of 6 Hz. The diameter of the laser beam coincided with the diameter of the pelletized sample for complete radiation coverage of the sample surface. The samples were placed in an experimental sealed chamber filled with air. Laser radiation pulses were used, which are characterized by the following parameters: laser radiation pulse energy 438 mJ, energy density 1.5 J/cm2, pulse power 3.7 kW, pulse power density 12.7 kW/cm2. Gas sampling from the chamber was carried out continuously using a capillary, which was connected to a gas analyzer. An analysis of the experimentally obtained mass spectra made it possible to establish the presence of the following oxidation products: H2, CH4, H2O, CO, CO2.

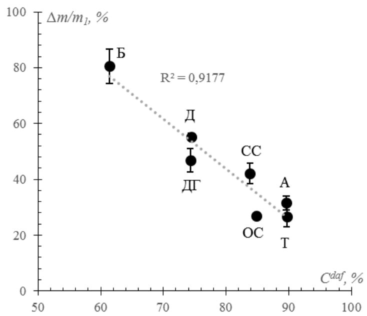

Fig.1. Dependence of the proportion of reacted coal samples on the atomic ratio of oxygen to carbon

On fig. 1 shows the dependence of the proportion of reacted coal samples on the carbon content. With an increase in the carbon content, the proportion of the reacted coal sample decreases.

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