Influence of gel fuels composition on ignition and combustion characteristics under radiant heating

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One of the ways to improve the energy characteristics of fuels is to add fine particles into composition [1]. The presence of such particles in the gel fuel composition can affect microexplosive dispersion characteristics during gel fuel ignition and combustion processes [2]. In addition, gel fuels are characterized by higher energy characteristics, lower negative impact on the environment, and lower cost of the component base in comparison with widely known solid and liquid fuels. [3]. Thus, the purpose of the research is to experimentally study and establish the characteristics of the processes occurring during the ignition and combustion of gel fuel particles, including those with the addition of fine metallic and non-metallic particles, in a high-temperature motionless air medium.

Oil-filled cryogels (gel fuels) are prepared on the basis of a 10 wt% aqueous solution of polyvinyl alcohol with the addition of 30 wt% finely dispersed solid components: coal particles, inert particles, aluminum. The preparation of gel fuels was carried out according to the well-known method [4].

The characteristics of the micro-explosive dispersion of single gel fuel particles during ignition were explored using a well-tested experimental technique and setup [5], consisting of a tubular muffle furnace, a high-speed video camera and a minirobotic arm with a holder for introducing fuel particles into a high-temperature oxidizer medium.

The ignition delay times (t_d) of fuel particles and the average speed values of fine fragments (V_p), formed throughout the droplet dispersion of the fuel melt were recorded during experiments. The effect of microexplosive dispersion was observed during ignition of all gel fuel compositions. Unlike it is with liquid single-component fuels, combustion is initiated not in the immediate vicinity of the droplet but in a rather large area. This positively affects the development of subsequent combustion of the fuel and enhances the burnout of components.

By varying the heated air temperature in the range of 600–1000 °C the ignition delay times change from 1 to 10 s, and the fine particles velocities after the micro-explosive dispersion of fuel melt droplet change from 0.3 to 1.4 m/s. The most intense ignition of the composition with the addition of fine coal particles in the entire range of heating source temperature variation. Gel fuel with Al particles exhibits the worst ignition and combustion characteristics (highest value of t_d, lowest value of V_p). At temperatures above 900 °C, the composition of the fuel does not significantly affect the ignition delay times.

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References

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