Micro-explosive droplet fragmentation of promising biofuels

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Rapeseed oil is a promising biofuel and it significantly improves the environmental indicators of working engines and power facilities. It is possible to increase the efficiency of combustion of slurry based on rapeseed oil by implementing micro-explosive breakup of fuel droplets. To identify the outcome of the micro-explosion, it is necessary to modify the composition through an increase in the proportion of the liquid combustible component [1].

In this study, at the first stage, the optimal concentrations of slurry components to provide the micro-explosive breakup were determined. The initial composition was as follows: 55 wt% coal slime, 35 wt% water, 10 wt% rapeseed oil. Then we varied the concentration of the slurry components. According to the experimental results, the composition with 9 wt% coal slime, 10wt% water, 81 wt% rapeseed oil provided the sufficient conditions for the sustainable explosive breakup and atomization (at above 900°C). We used this slurry for all further studies. The key regimes of droplet behavior under intense heating were evaporation, puffing, and micro-explosion. A droplet of slurry is found to evaporate steadily at the heating medium temperatures below 900°C. The minimum puffing temperature is 900°C. The occurrence of micro-explosion requires the minimum temperature of 1050 °C. Fig. 1 shows the liquid surface area ratios before and after the slurry droplet breakup with varying air temperature in the muffle furnace.

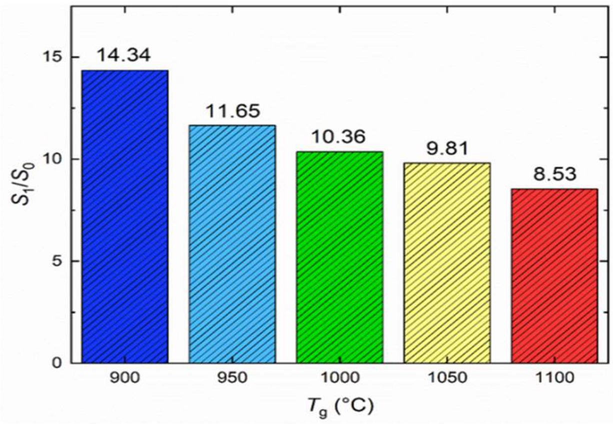

Fig. 1. Liquid surface area ratios before and after the breakup of a slurry droplet (9 wt% coal slime, 10wt% water, 81 wt% rapeseed oil, $D_0 \approx 2.35$ mm) with varying air temperature in the muffle furnace.

An analysis of the experiments showed that the micro-dispersion of heterogeneous droplets may provide a more than 10-fold increase in the evaporation surface area. An increase in the air temperature from 900 to 1100°C leads to the enlargement of child droplets and hence to the reduction of the evaporation area ratio before and after the breakup. This effect stems from the agglomeration of solid particles in the near-surface layer of the droplet at high temperatures as well as the fast evaporation of smaller droplets in the gas phase [2].

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References

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