Biofuel Droplet Evaporation Rate of a DISI Spray by Laser-induced Fluorescence and Phase Doppler Anemometry

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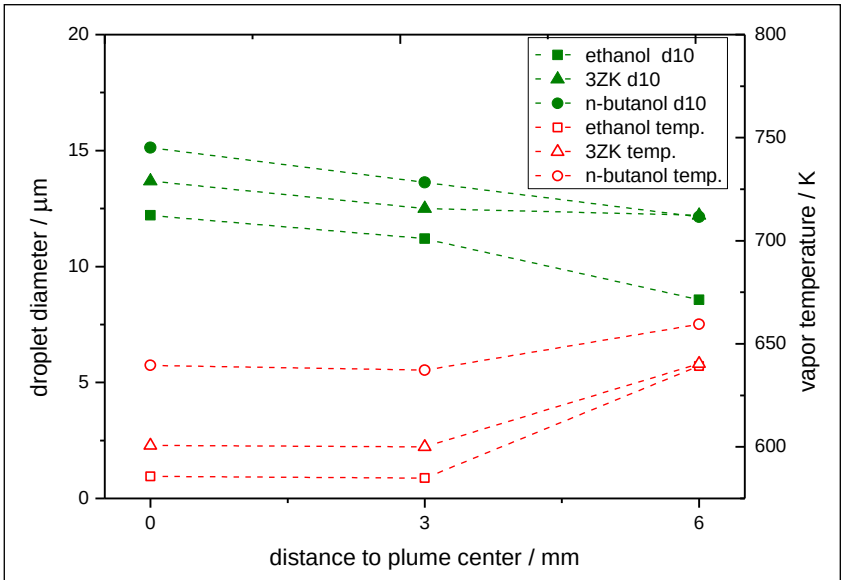
Abstract

The atomization and evaporation of gasoline sprays with bio-components differs depending on the respective alternative fuel blend physiochemical properties. This work focuses on estimating the biofuel evaporation rate of sprays at stratified charge conditions. One specific spray plume is analyzed in terms of local droplet size verified by local vapor concentration and temperature. Depending on the operating conditions different physiochemical properties were found to dominate the atomization and evaporation behavior. For moderate ambient temperature and pressure high-boiling point components show a strong influence on the droplet size and temperature distribution in the sprays. However, at elevated temperature the evaporation rate changes completely. Due to a high degree of evaporation taking place, cold spots of 125 K temperature difference appear inside the spray and during the spray process. In the center of the spray plume a maximum cooling of 89 K due to the higher droplet density in those areas compared to the more dilute outer positions are detected. However, when comparing data of two diffident boundary conditions with an ambient temperature difference of 200 K, the measurement positions in the outer regions of a spray cone always show higher temperatures. Smaller droplets as a measure of progressed evaporation are found there. For fuel mixtures with higher evaporation enthalpy the temperature difference between spray center and spray boundary is more pronounced than for fuels with a lower evaporation enthalpy – despite their higher boiling point. Overall, it can be stated that for the droplet evaporation at stratified supercharged conditions, the evaporation enthalpy is a dominating physiochemical property.



fuel	boiling point / °C	evap. enthalpy / kJ/kg
ethanol	78	938.2
3ZK	69-118	844.6
n-butanol	118	637.7

Figure 1 Absolute droplet sizes and spray vapor temperatures at 30 mm distance to the nozzle tip for increased gas pressure and temperature (0.8MPa, 673K) with corresponding key physiochemical parameters at ambient conditions (table)

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