Influence of Drop Spacing on Burning of an Emulsified-Drop Stream

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Abstract

Combustion characteristics of water-in-dodecane emulsion drops with various initial spacings were studied experimentally by using a free-falling drop burning apparatus. The initial drop spacings ($S_i$) were 2.5, 5, 10, 40, 75 (70), 100. $S_i (s/d_i)$ was defined as the ratio of the drop center-to-center distance ($s$) to the initial drop diameter ($d_i$). The water content ($\beta$) and the oxygen concentration ($\Omega_{O2}$) were fixed at 5% and 21%, while two drop sizes 550 $\mu$m and 450 $\mu$m were compared. The results showed that the transition of the drop flame occurred for all cases in the experiment. For $S_i > 10$ along the flow direction, the flame around the drops would change from a blue spherical flame to a yellow flame and a wake flame, and the drop flame extinguished later in the downstream region. Soot particles was generated and drops collision and merging occurred to form a flame tube for $S_i = 2.5$ in both cases of $d_i = 550 \mu$m and $450 \mu$m. Besides, drop expansion was observed in both cases of $d_i = 550 \mu$m and $d_i = 450 \mu$m, while micro-explosion only occurred in the far downstream region for $S_i = 40$, $d_i = 450 \mu$m. It was also shown that the emulsion drop evaporation rate was not a constant, and the trend of the drop evaporation rate was strongly influenced by changing the initial drop size.

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