Stabilized three-stage oxidation of gaseous *n*-heptane/air mixture in a micro flow reactor with a controlled temperature profile

Abstract

Ignition and combustion characteristics of a stoichiometric gaseous n-heptane/air mixture were investigated using a micro flow reactor with a controlled temperature profile which smoothly ramped from room temperature to ignition temperature. At atmospheric pressure condition, normal stable flames in high mixture flow velocity region, unstable flames with repetitive extinction and ignition (FREI) in intermediate velocity region, and stable weak flames in low velocity region were experimentally observed. Especially at low velocity condition, distinct two luminous weak flames and one broaden luminous zone were observed. Gas sampling and analysis were conducted to interpret this phenomenon and it was supposed that those luminous flames consist of three-stage oxidation process. Computational results also showed that there are co-existing three heat-release-rate peaks in the flow direction at low velocity condition, which qualitatively supported the experimental observations. From the concentration profiles of the species, these three reactions are confirmed so-called cool, blue and hot flames, respectively. In addition, the effect of pressure on the three-stage oxidation process was examined by conducting experiments and computations at high pressure conditions. With an increase of pressure, the first and second weak flames were intensified and the third flame was weakened. Moreover, the position of the first and second weak flames shifted to low temperature side with the increase of pressure. Consequently, the first and second flames in the three-stage oxidation process become more significant at higher pressure conditions.

Keywords

Micro flow reactor; Microcombustion; Primary reference fuel;
Weak flame; Three-stage oxidation

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