Characteristics of *n*-butane weak flames at elevated pressures in a micro flow reactor with a controlled temperature profile

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Abstract

The very first successful experiments at elevated pressures up to 12 atm by "in-pressure-chamber"-type micro flow reactor with controlled temperature profile are demonstrated. *n*-Butane was applied to the micro flow reactor and the ignition characteristics at pressures of 1–12 atm were investigated by observing weak flames. Among three kinds of the separated weak flames which can be observed by the present reactor, the blue flame was only observed at higher pressures than 2 atm and the cool flame was only observed at higher pressures than 3 atm. This interprets the multi-stage oxidation for *n*-butane was confirmed experimentally and computationally. The positions of the blue and cool flames shifted towards the lower temperature side along with the increase of pressure in the experiment. Computation results reproduced the experimental tendency of the blue and cool flames. Wall temperature of the position of the cool flame in the experiment agreed with that in the computation at all pressures studied, and that at 10 atm agreed with the compressed temperature in which the cool flame was observed in rapid compression machine at compressed pressure at 10 bar. The computational weak flame structure at 1 atm with that of 10 atm was compared. The high-temperature oxidation is important at 1 atm while the low temperature oxidation is important at high pressures. At 10 atm, most of the fuel is consumed at the cool flame. The separated cool flames were found at 12 atm and four-stage oxidation was produced in the computation. Rate of production analysis indicated that the first cool flame was formed by fuel oxidation through low-temperature oxidation and the second cool flame was formed by reaction of peroxyl radicals with H_2O_2.