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Investigation of Entrainment during Combustion of Biodiesel Sprays

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Abstract

The oxygen ratio of a mixture is the amount of oxygen available in the reactants divided by the amount required for stoichiometric combustion, where "stable" species are neglected. The oxygen ratio at the lift-off length of a fuel spray stands for the oxygen entrainment up to the spray lift-off length as a percentage of the total oxygen required to completely burn the fuel being injected, and this has an important effect on combustion and emissions. The effects of ambient gas temperature on the flame lift-off length of direct-injection (DI) biodiesel sprays under quiescent conditions were experimentally investigated. This was determined from the time-averaged OH chemiluminescence imaging technique. Then the impacts of the observed lift-off length variations on oxygen ratio at the lift-off location were also studied. Pure diesel (B0), biodiesel (B100) and their blends (B20 and B50) were tested inside the constant volume combustion chamber capable of simulating the real diesel engine conditions with more flexibility in changing engine operating conditions. The effects of different ambient gas temperatures on spray lift-off length were investigated with fixed ambient density, oxygen concentration, injection pressure and duration. Then the oxygen ratio that occurs upstream of the lift-off length of the sprays was examined. The results show that as the ambient temperature increased, the lift-off length decreased for the four different fuel sprays. The reduction of the lift-off length from 800K to 900K ambient temperature is much larger than the reduction observed at higher temperatures. For different fuels, diesel spray had a more significant reduction in lift-off length as temperature increased when compared with B20, B50 and B100 sprays. With increasing biodiesel content in the fuel, the lift-off length increased under the same ambient temperature. The similar trends happened to the oxygen ratio at the lift-off length of sprays. The fuel sprays which had higher oxygen ratio at the lift-off length could burn more efficiently and have lower soot emission.

Key words: entrainment, biodiesel sprays, oxygen ratio, lift-off length, constant volume combustion chamber

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