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Title: Study on cetane number dependence of diesel surrogates/air weak flames in a micro flow reactor with a controlled temperature profile

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Abstract: Ignition and combustion characteristics of a stoichiometric gaseous diesel surrogates/air mixtures were investigated using a micro flow reactor with a controlled temperature profile. 5 diesel surrogates (n-cetane, n-decane, n-heptane, iso-cetane, and □-methylnaphtalene), which have low vapor pressures, were applied as fuel to the micro flow reactor.
By changing the mixture flow velocity at the inlet of the reactor, three kinds of flames were observed. At the low velocity region, multi-stage oxidation process of the fuel (weak flames) can be observed as separated multiple stationary flames. A cool flame was observed as 1st-stage oxidation in the weak flames around 780 K, when applying large n-alkanes as fuel. Focusing on this flow velocity condition, weak flame responses to cetane number variations were examined at atmospheric pressure. The cetane number was varied by two ways; changing mixing ratio of n-cetane and iso-cetane (diesel PRF); or using pure fuels with different cetane numbers. Trends of the observed weak flames at different cetane number in both cases showed that luminosity from the 1st oxidation (cool flame) became weaker, and the 1st and 3rd reactions shift to high temperature region with the decrease of the cetane number. The capability of the present reactor for examination of the general ignition and characteristics of various low-vapor-pressure fuels was demonstrated.
Gas sampling and analysis were conducted for n-cetane and iso-cetane. According to CH2O concentration profile, it was confirmed that the flame structure of n-cetane weak flame was similar to that of n-heptane.
The predictions of 1-D steady simulations with detailed reaction kinetics agreed with the trends of the multi-stage oxidation processes and the CH2O profiles except the iso-cetane case. Measured profile of iso-cetane showed that CH2O started increasing in the temperature much higher than the prediction and that the employed chemical model for iso-cetane overestimated the low temperature reaction.