Experimental Investigation of Ignition of Second-Generation Biofuels at High Pressures

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In recent years, the interests in biomass derived fuels as alternatives or additives to conventional fuels have been increasing to reduce the dependence on fossil fuels supplies and address the increasing concern of global warming. Especially the interest of using second-generation biofuels, as oxygenates in gasoline has increased over the years due to their significant advantages over first-generation biofuels. As an example, 2,5-dimethylfuran(DMF) has an energy density 40% higher than ethanol [1]. More attractively, 2,5-DMF consumes only one-third of the energy in the evaporation stage of its production. Additionally recent remarkable breakthroughs in the mass production technology of 2,5-DMF have been reported [2]. Our interests are to assess the combustion characteristics of furan based biofuels for their optimal performance in advanced combustion technologies by developing detailed, highly validated and predictive chemical kinetic models.

This work presents the experimental determination of auto-ignition delay times of several saturated & unsaturated furan derivates (Furan, 2-Methylfuran, 2,5-DMF, Tetrahydrofuran) at intermediate and low temperatures and high pressures. Experiments are performed in a Rapid Compression Machine (RCM) and ignition delay times are determined using pressure histories in the temperature range from 650 – 920 K and pressures from 10 – 40 bar. Variable fuel-oxygen concentrations are used in order to determine the influence of equivalence ratios on the ignition delays.

Detailed chemical kinetic models are developed and optimized by refining rate parameters of sensitive reactions based on first principles. A comparison of the performance of the optimized kinetic models with diverse experimental data is presented.

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References

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