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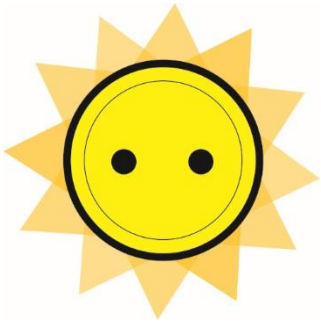

Toward higher efficiencies and lower emissions for Indian-origin biodiesel combustion: Developing a predictive CFD model with validated reduced kinetics for device-scale applications (BiofCFD)

Transportation is a major user of energy, burns most of the world's fossil fuels, and is essential for the world's economy. Concerns about limited fossil fuel supplies and global warming are driving the demand for renewable and carbon-neutral biofuels and fuel-efficient engines for transportation applications. Advanced low temperature combustion (LTC) strategies are the most promising approach to achieve ultra-low nitric oxides (NOx) and near-zero particulate matter emissions along with improved engine fuel economy. While fossil diesel fuel characteristics are tailor made to suit conventional high temperature combustion conditions, their usage pose significant problems in engines employing LTC strategies.

Biofuels, including biodiesel, has a greater potential to completely replace fossil diesel fuel in LTC engine applications. To enable biodiesel use in LTC engines an improved understanding of the effect of their composition on ignition properties of fuel-air mixture is required. In the current, interlinked project this is accomplished by developing a detailed and reduced reaction kinetic models for ignition chemistry using results from several kinetic measurements also performed in this work. The compact, reduced kinetic model will be further validated based on experimental data on ignition delays measured using Rapid Compression Machine and stable species profiles measured in Jet Stirred Reactors experiments in this work. Understanding ignition chemistry, determined by reaction kinetics of fuel – air mixture, is important since oxidation under LTC conditions is kinetically controlled based on fuel molecular composition etc. rather than by any external means and thus pose significant challenges.

The present work intends to develop an accurate, validated reduced chemical kinetic model for Indian origin biodiesel fuels, viz. Jatropha and Karanja based oils, to enable kinetic model implementation in a large eddy simulation (LES) -based computational fluid dynamics (CFD) program to understand biodiesel ignition, combustion, and emission formation under LTC conditions. The developed models will be further validated in real engine tests performed under LTC conditions and validated models provide an improved understanding of biodiesel ignition, combustion, and emission formation to enable their widespread applications in advanced LTC engines.

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