Formulating and Kinetic Modeling of Alternative Aviation Fuel Surrogates

Peter S. Veloo[1], Sang Hee Won[1], Stephen Dooley[2], and Frederick L. Dryer[1]

[1]*Department of Mechanical and Aerospace Engineering Princeton University, New Jersey 08544, USA*
[2]*Department of Chemical and Environmental Sciences University of Limerick, Ireland*

Improving energy security has led to a more diversified energy portfolio, especially with regards to aviation fuels. Alternative aviation fuels can be readily produced (e.g., Fischer-Tropsch or hydrotreatment) using a variety of feedstock's including natural gas, coal, animal fats and plant oils. Typically, blends of alternative and petroleum derived fuels are certified for use in existing jet engines. Accurate chemical kinetic models will be needed to better understand and predict phenomena such as combustion stability, flame-out, and emissions of nitrogen oxides and soot. Petroleum derived and alternative aviation fuels typically consist of hundreds of individual species over a wide range of chemical classes. Surrogate fuels are typically employed to reduce this complexity. Typically a surrogate fuel is a carefully selected mixture of a limited number of compounds that emulate desired properties of the real jet fuel. In this presentation the surrogate fuel methodology developed at Princeton University which utilizes a set of well-defined combustion property targets to emulate the fully prevaporized combustion properties of a specific jet fuel will be discussed in detail. The combustion property targets include the ratio of hydrogen to carbon, threshold sooting index, molecular weight, and cetane number. This methodology was initially developed and successfully validated for petroleum derived JP-8 and Jet-A, and Fisher-Tropsch fuels. The difficulties of modeling emerging alternative fuels such as alcohol to jet fuels which have a chemical composition outside our present experience envelope will be discussed.