

Combustion chemistry from the perspective of characteristic chemical time scales

Abstract:

Design of advanced thermal energy conversion systems requires accurate analysis of the associated combustion flows. These flows are complicated by the kinetics of numerous chemical reactions that accompany conversion of fuel and oxidizers to combustion products. Detailed models for prediction of the underpinning chemical transformations have turned out to be rather too large for realistic implementation in computational analysis of combustion. In some cases, such models also exhibit significant deviations in predictions of relevant combustion properties. Despite the complexity of the models, kinetically controlled combustion phenomena such as ignition, can be captured reasonably well by means of characteristic time scales that capture the relaxation of non-equilibrium chemical reactors toward new chemical equilibrium states.

This talk will review the challenges associated with science-based combustion modeling and the various attempts suggested to overcome them. It will then focus on experimental studies of fuel ignition (oxidative) and pyrolysis (non-oxidative) kinetics. Emphasis will be on their global chemical time scales as a means of capturing the effects of various thermodynamic parameters on the overall kinetics of combustion processes. The supporting experimental facilities include a shock tube reactor equipped with laser diagnostics and a constant volume reactor for the study of ignition arising from spark-discharge or laser-induced breakdown. The talk will conclude with some thoughts on how time scales obtained from such experimental studies can be used for more realistic computational analysis of combustion.

Bio-sketch:

Dr. Ben Akih-Kumgeh is an Assistant Professor in the Department of Mechanical and Aerospace Engineering at Syracuse University. He holds a PhD in Mechanical Engineering from McGill University, Canada. His university education began at the Samara State Aerospace University, Russia, focusing on Aircraft Engines and Power Plants. He later moved to the Aachen University of Applied Sciences (Fachhochschule Aachen), Germany, where he obtained a *Diplom-Ingenieur* (FH) in Mechanical Engineering. He then graduated with a Master of Science degree in Energy Engineering from RWTH Aachen University, Germany. Prior to joining Syracuse University, Dr. Akih-Kumgeh was a post-doctoral scholar at McGill University, collaborating with Rolls-Royce Canada (now Siemens Canada) on combustion chemistry for gas turbine applications.