Session Overview: Fuel Sprays, Nozzles and Injector

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The evolution of fuel sprays plays a defining role in controlling both combustion efficiency and emission. The flow inside and outside of the injector nozzles dominates the breakup and atomization of the liquid fuel jet, a complex multiphase phenomenon difficult to visualize and model. While hydrodynamic instability is responsible for the breakup of a low-speed liquid jet, the high-speed fuel sprays are an extremely complex process and are governed by a large number of parameters such as nozzle geometry, turbulent flow, and cavitations inside the nozzle. The breakup mechanism has remained largely unknown primarily due to the dearth of experimental methods for probing the in- and near-nozzle flows, and to the lack of realistic multiphase hydrodynamic models. To overcome the difficulties, researchers have developed optical, x-ray and neutron visualization techniques to gain fundamental understanding of the physics associated with fuel spray process.

In this session, four speakers from industrial and government labs and universities are to discuss the recent research advances using the assorted methods to study spray applications in internal combustion engines, aerospace propulsion systems, and industrial energy systems. Dr. Scott Parish from General Motors Global Research will discuss the application of optical diagnostics for fuel spray characterization in the dense near-nozzle region where the early stages of spray development occur, the consequences of which govern subsequent events and ultimately impact fuel economy and emissions. His presentation will describe various conventional and advanced optical diagnostics for spray characterization with special emphasis on x-ray techniques. Dr. Kuo-Cheng Lin, from Air Force Research Laboratory and Taitech, Inc., will discuss photon tools for studying fuel sprays in aerospace propulsion systems. Dr. Lin and his collaborators used three x-ray diagnostic methods, including x-ray phase contrast imaging, x-ray radiography, and small angle x-ray scattering, available at the Advanced Photon Source of Argonne National Laboratory, to characterize the dense near fields of sprays relevant to the aerospace propulsion systems. Professor Mark Linne from Chalmers University will offer his thoughts on optical and x-ray measurements for fuel sprays with an evaluation of the advantages and disadvantages of both optical and x-ray techniques, the differences between x-ray and optical techniques. He will offer one or more potential new ideas to spark discussion and the generation of ideas. The talk by Professor Barbara Wyslouzil from Ohio State University will be on aerosol evolution in supersonic flows and how to exploit condensation in supersonic flows to remove water and higher hydrocarbons from raw natural gas. In her research, small angle x-ray scattering was used to investigate nanodroplet formation, growth, and freezing in supersonic flows.