Towards H2ICE: Characterization of Hydrogen Injection, Mixing, and Combustion

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Hydrogen-fueled internal combustion engines (H2ICE) have great potential for future carbon-free transportation but have not yet reached production due to a number of technical challenges. One of the most important issues is the design of hydrogen injector systems that achieve rapid mixing to fuel-lean mixtures while also ensuring stable combustion without combustion anomalies such as pre-ignition and knocking. The ILASS community has been at the forefront of research on liquid injection systems and is now encouraging needed research on hydrogen injection. This presentation will provide an overview of ongoing FUELCOM4 project with KAUST and Saudi Aramco in an effort to enhance our knowledge in hydrogen injection, mixing, and combustion characteristics by utilizing high fidelity laser diagnostics and simulations. First, hydrogen jet injection and mixing characteristics are investigated in high pressure constant volume chamber experiment with accompanying simulations for validation. Jet penetration and dispersion characteristics depending on different injector configurations are examined. Recent development in advanced laser diagnostic technique to quantify the hydrogen fuel distribution is also discussed. Finally, parametric studies of the effects of jet dispersion and mixing on engine combustion characteristics are presented.

Biosketch

Hong G. Im received his B.S. and M.S. in from Seoul National University, and Ph.D. from Princeton University. After postdoctoral researcher appointments at the Center for Turbulence Research, Stanford University, and at the Combustion Research Facility, Sandia National Laboratories, he held assistant/associate/full professor positions at the University of Michigan. He joined KAUST in 2013 as a Professor of Mechanical Engineering. He is a recipient of the NSF CAREER Award and SAE Ralph R. Teetor Educational Award, and has been inducted as an International Member of the National Academy of Engineering of Korea, a Fellow of the Combustion Institute and American Society of Mechanical Engineers (ASME) and an Associate Fellow of American Institute of Aeronautics and Astronautics (AIAA). He has also served as an Associate Editor for the Proceedings of the Combustion Institute, and currently on the Editorial Board for Energy and AI. Professor Im's research and teaching interests are primarily fundamental and practical aspects of combustion and power generation devices using high-fidelity computational modeling. Current research activities include direct numerical simulation of turbulent combustion at extreme conditions, large eddy simulations of turbulent flames at high pressure, reduced order models using machine learning, combustion of hydrogen and e-fuels, spray and combustion modeling in advanced internal combustion engines, advanced models for pollutant formation, and plasma-assisted combustion.