Investigation of Atomization and Combustion Characteristics of Novel Fuel-Flexible Injection Using Advanced Laser Diagnostics

Dr. Lulin Jiang, Department of Mechanical Engineering, University of Louisiana at Lafayette

Fuel combustion supplies most of the energy for power generation and transportation, yet is the main contributor to emissions. Fossil fuels remain as the largest cause of greenhouse gas emissions (GHGs) and are predicted to be the major energy source for the coming decades. The status quo of energy structure and ever stricter emission standards necessitate exploration of novel combustion technology for cleaner and efficient consumption of fossil fuels and enable cost-effective alternative fuel application. The presented research focuses on facilitating liquid fuel combustion for engines used in power generation and propulsion. Clean and efficient combustion of liquid fuels highly depends on spray fineness, resulting in fast fuel prevaporization, better fuel-air mixing and thus complete clean premixed combustion. The study has developed novel fuel-flexible injectors with superior atomization capability, fundamentally transforming conventional fuel injection mechanism. Investigation of sprays in the near injector field by Particle Image Velocimetry (PIV) has shown that the novel fuel injectors generated fine droplets immediately at the injector exit, rather than a typical liquid jet that gradually disintegrated into ligaments and ultimately, droplets. Success of the novel fuel atomization has resulted in ultraclean and efficient combustion of various fossil and bio- fuels with a wide range of fuel properties, without fuel preheating or hardware modification, at lower injection pressure and minimized fuel coking. Those fuels include conventional diesel, kerosene, and biodiesel, as well as viscous source oils of biodiesel such as vegetable oil and algae oil (more than 20 times more viscous than diesel). Ultra-low-emission combustion of biofuel source oils signifies that the conversion cost of source oils into biodiesel can be greatly saved or potentially eliminated. Furthermore, the superior injection has led to clean and complete combustion of biodiesel byproduct – non-preheated glycerol that has about 200 times higher viscosity than diesel, potentially transforming waste into energy source and thus further enhancing biofuel economic viability.