Atomization Performance of Algae-Derived Renewable Diesel in a Swirl-Stabilized Research Combustor

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Abstract

This study considers the atomization performance of an Algae-derived renewable diesel fuel in a twin-fluid airblast atomizer. Two other alternative liquid fuels, biodiesel and ethanol, are considered in addition to conventional petroleum-based fuels (#2 Diesel and F-76 Military Distillate). As the Algae-derived fuel is produced through hydrotreatment, its chemical composition and physical properties are very similar to the conventional fuels; in this study, this fuel was blended with the conventional F-76. To characterize the atomization performance, the breakup process was investigated using high-speed cinematography, and droplet sizes were measured using ensemble laser diffraction. The high-speed video of the spray also provided a basis for a Particle-Image Velocimetry (PIV) analysis, resulting in a velocity-field measurement of the atomizer. All of the fuels exhibited very similar atomization characteristics. Due to the atomizer geometry and flow conditions, prompt atomization was exhibited for all fuels, resulting in a relative insensitivity of liquid properties on the droplet sizes. The traditional jet-breakup effects of wavy-deformation were found to be insignificant, as the low liquid flow led the process to be dominated by aerodynamic effects. A relevant correlation for Sauter Mean Diameter (SMD) was selected, showing excellent agreement over a range of flow conditions for all fuels except biodiesel, due to its high viscosity. Despite this, at the best conditions all fuels exhibited very small drop sizes (10-25 microns). The velocity fields were very similar for all fuels, suggesting that for the prompt atomization process, the evaporation rates may be primarily controlled by the fuel volatility.

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