An Aerosol Rapid Compression Machine for Studying Energetic-Nanoparticle-Enhanced Combustion of Liquid Fuels

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The use of energetic nanoparticles offers a promising means of adjusting the reactivity of liquid fuels for enhanced combustion stability in next generation propulsion systems. This work outlines the development of a novel aerosol rapid compression machine (RCM) for studying the impact of energetic nanoparticles on reducing the ignition delay of liquid fuels, and a proof-of-concept demonstration is presented using ethanol and JP-8. Fuel droplets are generated using an ultrasonic nozzle. The seeding of 50 nm aluminum nanoparticles in the liquid fuel is achieved by using a combination of chemical surfactants in addition to mixing in an ultrasonic bath. The autoignition delay is measured for neat and nanoparticle-enhanced mixtures at compressed conditions of 772?830 K and 12?28 bar in the RCM. The results show that significant changes in the ignition delay can be observed using a low concentration (2%-weight) of energetic nanoparticles. For ethanol and JP-8, ignition delays were reduced by 32% and 50%, respectively. Measurements to verify the uniformity of aerosol dispersion in the RCM, the reproducibility of the RCM data, and a method for approximating compressed temperature are also presented.

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