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Direct Numerical Simulation of Conventional and Alternative Jet Fuel Mixing and Ignition in Compression Ignition Engine Environments[1]

JACOB TEMME, Army Research Laboratory, MARTIN RIETH, Sandia National Laboratories, SANG HEE WON, University of South Carolina, CHOL-BUM KWEON, Army Research Laboratory, JACQUELINE CHEN, Sandia National Laboratories — Unmanned Aerial Systems (UAS) powered by compression ignition engines are increasingly required to operate with a diverse range of fuels, from conventional jet fuels to bio-derived fuels (e.g., alcohol-to-jet fuel and ethanol). This poses challenges for reliable UAS operation at high-altitude, low-temperature conditions as different fuels exhibit very different ignition and combustion characteristics. Detailed mixing and ignition at UAS conditions are studied with different fuels by performing Direct Numerical Simulations (DNS) based on fuel injection and ignition experiments conducted at the Army Research Laboratory. The DNS results are compared with the experiments to ensure consistency in the global behavior. While the experiments provide invaluable insight into the dynamics of mixing and ignition processes, descriptions of small scale features are unattainable from experiments. DNS complements experiments by providing a wealth of data to understand turbulence-chemistry interactions and chemical pathways controlling ignition. Reference quasi one-dimensional counterflow simulations are also presented providing a broader parametric sweep to complement DNS and experimental findings.

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Martin Rieth
Sandia National Laboratories

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