ASCENT Project 67

Impact of Fuel Heating on Combustion and Emissions

Purdue University

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Cost Share Partner: Purdue University

Objective:

This project will characterize the global and local impact of hot fuel injection on the performance of aviation gas turbine combustion systems in high-OPR aircraft engines using extractive exhaust sampling and advanced optical and laser-based diagnostics.

Project Benefits:

The benefit of this project will be advancement of low emissions gas turbines to the next level of cycle efficiency by providing key insights needed to design combustion devices for operation with hot fuels.

Research Approach:

Purdue's COMRAD facility houses a high-pressure, liquid-fueled, swirl injector (GE TAPS) in an optically-accessible chamber that closely replicates engine conditions. An 81 kW fuel heater heats liquid fuel to temperatures up to 700 K. Optical diagnostics and exhaust gas sampling are performed. Advanced laser diagnostics include OH planar laser-induced fluorescence (PLIF) for reaction zone imaging, 3-component particle image velocimetry, fuel PLIF and Mie scattering for vapor and droplet imaging, laser-induced incandescence (LII), and coherent anti-Stokes Raman scattering (CARS) for temperature measurements.

Major Accomplishments (to date):

- Characterized effect of fuel temperature (370-580 K) and chamber pressure (1-2 MPa) on emissions with Jet A and Shell GTL GS190.
- Investigated effect of fuel temperature on reacting flow-field and dynamics using 10 kHz stereo-PIV, Mie scattering, and chemiluminescence.
- Flame-front tracking with 10 Hz OH-PLIF imaging.

Future Work / Schedule:

- Emissions characterization with selected SAFs, including FT-SPK mixed with 4-20% single-ring aromatics.
- Perform simultaneous 100 kHz PIV, OH PLIF.
- Characterize temperature field using CARS measurements in addition to PIV/OH PLIF/Mie scattering, soot field with 100 kHz LII.

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