Project 30
NJFCP Area #6: Referee Swirl-Stabilized Combustor Evaluation / Support

Motivation and Objectives

Motivation:

Requirement for a realistic combustor to be used as a reference (i.e. Referee Rig) for the effect of alternative fuels on combustion characteristics

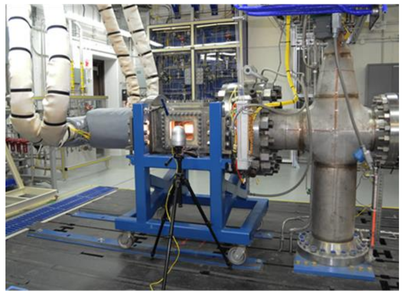
Objectives:

Develop, conduct, and analyze combustion experiments with emphasis on ignition and Lean Blowout (LBO) for fuels in the NJFCP program referee combustor

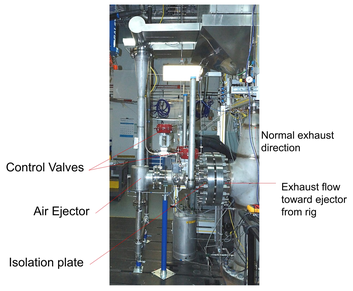
Provide high fidelity experimental initial condition and validation data for computational modeling teams

Methods and Materials

Experiments are performed in cooperation with Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base



Referee Combustor Rig at AFRL



Upgrade for High Altitude Ignition

Single Cup Combustor Incorporates:

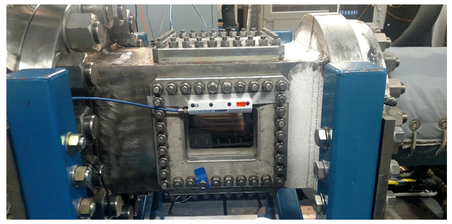
-Hybrid two-stage nozzle and swirler
-Two stages of dilution
-Advanced effusion cooling
-Provision for instrumentation and optical access

Rig enhanced with :

-Optical accessibility for diagnostics
-Development of low temperature fuel and air systems
-Fine control of air & fuel temperatures, pressures, and flowrates
-Instrumentation to measure spark energy
-Low pressure capability down to combustor pressures of 0.3 atm

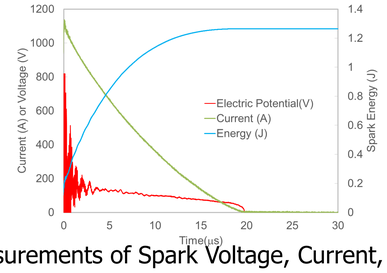
Summary

- Experimental comparison of combustion characteristics for alternate and conventional jet fuels in swirl-stabilized single-cup combustor
- Significant differences for LBO, and ignition characteristics measured between conventional baseline fuel (A-2) and alternative fuels



Referee Combustor Test at T_{fuel}= T_{air} =-30°F

- Cold fuel and cold air capability operational
- Initial studies show that the cold fuel and air temperatures affect the ignition characteristics
- Additional capability addition for high attitude and spark energy measurement in process



Measurements of Spark Voltage, Current, and Energy

Principal Investigators: Scott Stouffer (AFRL contract), Joshua Heyne (FAA grant)
Lead investigators: Scott Stouffer, UDRI, Tonghun Lee, University of Illinois
Project manager: Cecilia Shaw, FAA

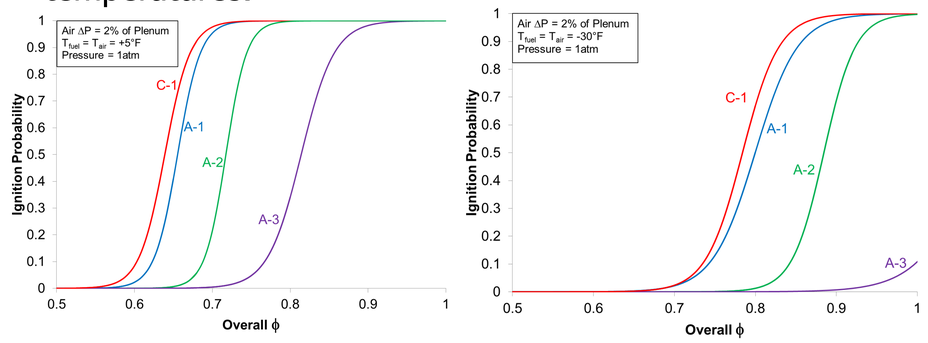
Sept 26-27, 2017

Results and Discussion

Previous lean blowout results have shows significant differences between fuels and a strong correlation with DCN

Initial results for cold fuel/air ignition study show that the ignition is more difficult at low fuel/air temperatures and highlights the detrimental effect of higher viscosity fuels on ignition

The plots below show a regression of ignition experiments at fuel air temperatures of +5 and -30 F. Ignition performance dependent on fuel type at low temperatures.



Cold Fuel/Air Ignition Test Results

Conclusions and Next Steps

Conclusions :

Ignition and LBO sensitivity to fuel type has been demonstrated Cold fuel and air systems functional and cold start experiments currently underway

Next Steps:

Further ignition experiments at fuel/air temperatures down to -30°F at atmospheric pressure.

Ignition experiments at pressures as low as 0.3 atm

Implementation of advanced optical diagnostics.

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