Active Combustion Control
High-Frequency Liquid Fuel Modulation System

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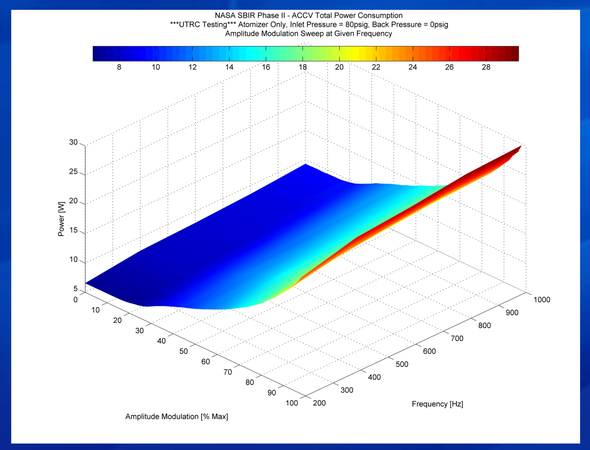
Description

An Active Combustion Control System for high-frequency modulation of atomized fuel flow via a proportional rotary valve that delivers at least ±10% modulation strength of point at the atomizer, has higher component reliability, and low electrical power consumption. This device is the first practical application of the concept in that it can be close-coupled to the atomizer – a key element in maintaining high-modulation strength at the injection site.

Benefits

Mitigates combustion instabilities at higher frequencies than have been previously achieved (~1000Hz) allowing gas turbines to run at operating points that produce lower emissions and higher performance.



Approach

Uses a high-efficiency frameless motor that continuously rotates to provide frequency and phase modulation (no back-and-forth motion, reducing power consumption).

Uses a low-power proportional solenoid to control fuel modulation amplitude by axially translating the modulating flutes with respect to the flow ports thereby varying flow (high-speed back-and-forth motion is not required).

Uses modulation flutes that pass in front of static flow ports to:
- Shape the fuel flow waveform
- Set the amplitude of the fuel flow waveform for a given axial position

Uses a Linear Voltage Transducer / Resolver (LVTRx) that senses:
- Angular position to close the loop on motor frequency and phase.
- Linear displacement to close the loop on fuel pulse rotor axial position.

Matched Digital Electronic Controller uses a Phase-Locked Loop scheme.

Flow design is matched to a given atomizer flow number optimizing modulation strength.

ACCV: Φ2.5” x 5.5”L, 2.9 lb

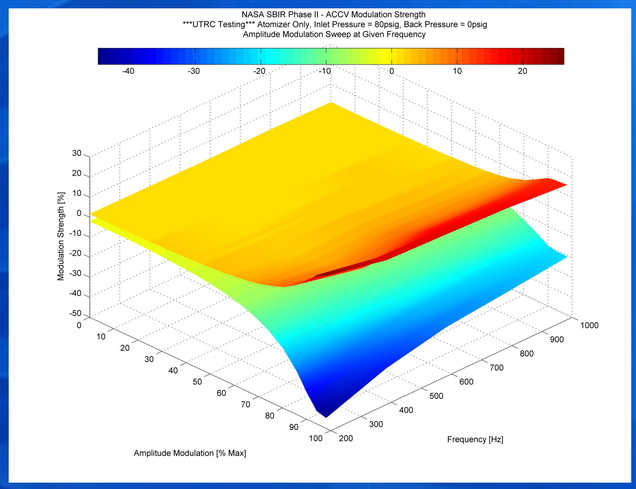
ECU: 5.0” x 4.0” x 1.5”, 1.5 lb

Recent Results

The System (ACCV+ECU) has completed cold-flow ET&E for FN=3 with varying fuel pressures, frequencies, tube configurations, and simulated combustor back pressures.

Modulation strength was excellent throughout the operating ranges tested, ranging from ±**10**% to as high as ±**45**% at the atomizer.

The System also demonstrated very low total power consumption, ranging from approximately **5** to **35** W continuous.



Future Work

Integrate ACCV System with engine controller and hot-fire test on combustor rig at NASA GRC (in progress).

Test System in FN=8 configuration.

Outfit a Gas Turbine engine with single or multiple units, integrate control electronics with FADEC and demonstrate operation in a real engine environment.

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