CRADA facts

DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY

COMBUSTION
PROJECT

COMBUSTION OSCILLATION CONTROL

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Capabilities

Combustion oscillations have emerged as a significant consideration in the development of low emission gas turbine combustors. In natural gas combustion, very low NOx emissions can be produced by gas turbine fuel nozzles which employ premixing of the fuel and air. Premixing of fuel and air can avoid the high temperatures which produce thermal NOx, but the resulting nozzle configuration is often susceptible to oscillating combustion instability. Oscillating combustion must be eliminated over the entire range of engine operation, because the associated pressure fluctuations and vibration can damage engine hardware.

In Integrated Gasification Combined Cycle (IGCC) applications, premixed combustion may also be used to burn medium or low heating value fuel in the turbine. If premix combustion is used in IGCC turbines, combustion oscillations may occur via the same mechanisms as in premixed natural gas combustion. Methods to control oscillations in natural gas combustion may therefore apply to IGCC systems as well as other power systems.

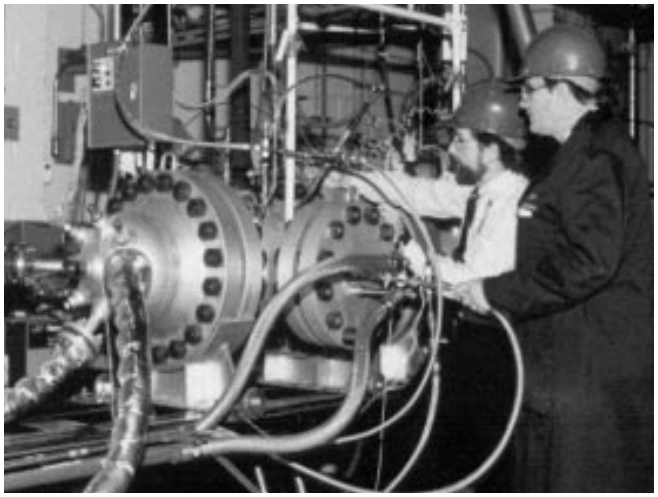
Techniques to eliminate oscillations include various design modifications to the fuel nozzle, or limiting the operating map to avoid oscillating conditions. Either approach is costly, especially when oscillations are encountered in the final stages of engine testing. As an alternative to design or operating modifications, METC is investigating the use of so-called “active” combustion control to eliminate oscillations. Active control uses repeated adjustment of some combustion parameter to control the variation in heat release that drives oscillations.

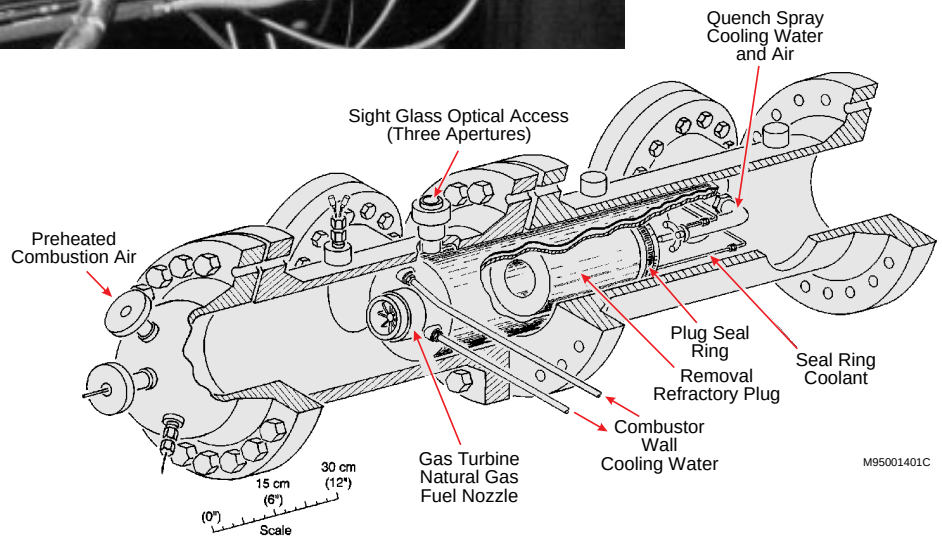
Opportunities

- Investigate stability features of proposed nozzle designs
- Sub- and full-scale nozzle testing for combustion stability
- Identify oscillating mechanisms in combustion systems

Combustion Oscillation Control

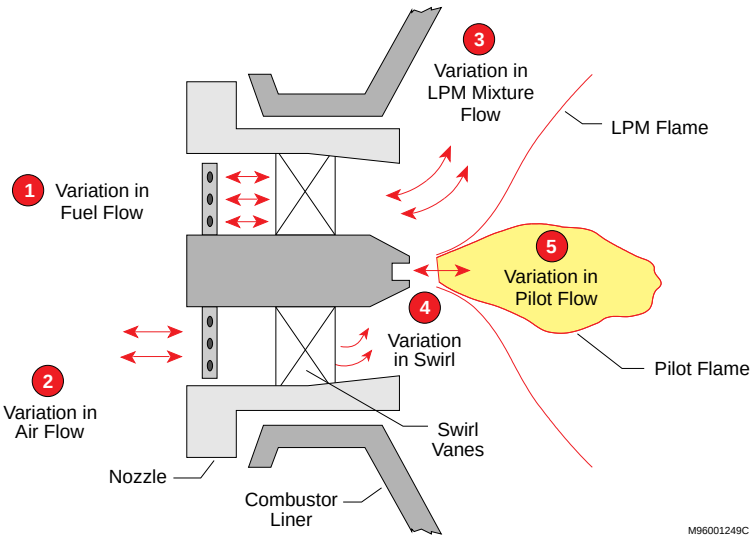
Dynamic Gas Turbine Combustor





COMBUSTOR DESCRIPTION

- Flow rate: 1.5 pounds per second (4 maximum), 10 atm.
- Preheat air temp: up to 650°F
- Novel features: Hard acoustic boundaries, variable frequency
- Limited optical and diagnostic access



OSCILLATIONS FROM LPM FUEL NOZZLES

- Five oscillation mechanisms identified in METC tests
- Simultaneous occurrence complicates mechanism identification
- Competing design requirements constrain stabilization options

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