Microjets for Thermoacoustic Instability Suppression in Combustors
Technology #14110

Applications

Combustion continues to be necessary for the world's energy demands, and irreplaceable within some domains of application. Combustion technologies are one of the most power-dense sources of energy, but the chemical processes involved lead to the creation and emission of pollutants. This technology will be useful in gas turbine design in the power generation and transportation fields by mitigating the emission of nitric oxides from combustors.

Problem Addressed

Even though combustors of continuous combustion systems have one of the highest available power densities, the chemical by-products of combustion are often undesirable pollutants such as nitric oxides. Nitric oxides, one of the major classes of pollutants emitted by combustors, are implicated in everything from environmental damage to global climate change. This technology substantially reduces nitric oxide emissions by using lean-premixed combustion, which in comparison to conventional non-premixed combustion is much better due to the improved mixing and lower flame temperature. However, lean-premixed combustion is very unstable due to strong pressure oscillations caused by a coupling of acoustics, flowfield, and reaction zones within the combustor. This technology uses a swirl-stabilized combustor that uses microjets to reduce the overall sound pressure level and thus eliminates any coherent pressure oscillations.

Technology

The invention provides a passive method for mitigating high-amplitude pressure oscillations within a certain window of operating conditions for a swirl stabilized combustor operating in the lean premixed mode. The swirl-stabilized combustor featuring Swirl-Counter-Swirl Microjets enables lean-premixed combustors to exhibit better stability by creating small ports through which secondary flow is injected immediately upstream of the combustion chamber. In existing designs, fuel and air are mixed upstream of a choke plate and the flow passes through a swirler before passing through a sudden expansion into the main combustion chamber. Swirl stabilization reduces the extent of the flame, measured along the longitudinal axis, compared to a bluff-body or expansion stabilized flame, allowing for the design of more compact combustors. Lean premixed combustion allows for a significant reduction in NO\textsubscript{x} emissions, making cleaner, more environmentally friendly combustors feasible.

Advantages

- Compact
- Environmentally friendly
- Passive
Categories For This Invention:

Energy
Energy Efficiency
Power Plants
Transportation
Engines/Motors

Intellectual Property:

Swirl-counter-swirl microjets for thermoacoustic instability suppression
Issued US Patent
8,708,696

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Publications:

Correspondence Between the Uncoupled Flame Configuration and Thermoacoustic Instability In Lean Premixed Swirl Stabilized Combustor
J Eng Gas Turbine Power
137(7), 071505 (2015)

Instability Suppression in a Swirl-Stabilized Combustor Using Microjet Air Injection
48th AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition
4 - 7 January 2010, Orlando, Florida

External Links:

Reacting Gas-Dynamics Laboratory
http://web.mit.edu/rgd/www/

Image Gallery: