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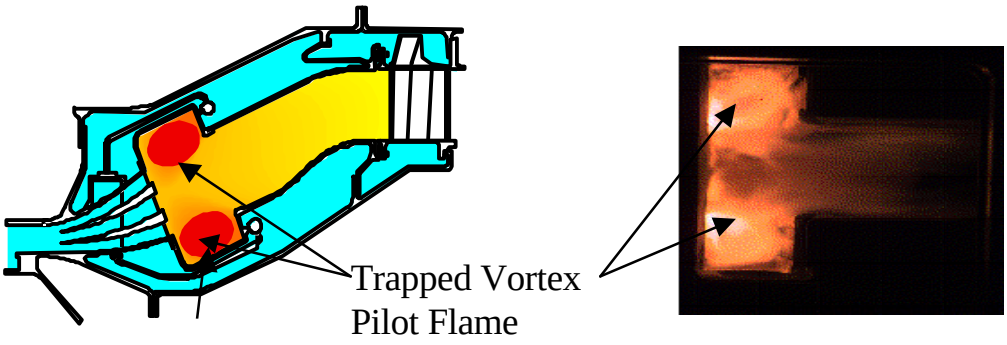
Success Story

Innovative Engine Technology Demonstrates Potential to Revolutionize Turbine Engine Performance.



The Trapped Vortex Combustion (TVC) technology developed by AFRL's Propulsion Directorate, in partnership with General Electric Aircraft Engines (GEAE), has demonstrated significant improvements in performance while drastically reducing emissions. A revolutionary approach to combustor design, the TVC has the potential to expand the flight envelope of Air Force aircraft by reducing lean blow-out while significantly reducing oxides of nitrogen ($NO_{x)}$ and volatile organic compound (VOC) emissions. Turbine-powered Navy ships using TVC could also benefit from the improved overall performance provided by trapped vortex combustors. A TVC designed for ultra-high performance will be used in GEAE's Integrated High Performance Turbine Engine Technology Phase III engine.

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Accomplishment

The Combustion and High Speed Systems Branch of AFRL's Propulsion Directorate has been working with General Electric on a radically new combustor design based on the trapped vortex principle. The 12 inch trapped vortex combustor sector prototype being tested at the Propulsion Directorate's Wright-Patterson AFB facility has demonstrated a 55% reduction in aircraft NO_x emissions and a 50% reduction in VOCs based on typical in-service engine experience. Performance wise, the TVC test article demonstrated a 58% reduction in the lean blow-out limit and a 42% increase in altitude re-light capability. In addition, data from these tests indicate that Navy turbine-powered ships could reduce yearly NO_x emissions by 55% and VOCs by 50% compared to the LM2500 turbine engine in common use.

Background

The TVC concept grew out of fundamental studies of flame stabilization sponsored by AFOSR and conducted by the Propulsion Directorate. The TVC is a radical departure in combustor design from the 40 year tradition of using swirl cups to stabilize the flame inside the gas turbine engine combustors. While swirl stabilized combustors perform well, they have somewhat limited combustion stability and therefore can blow out in certain parts of the engines operating envelope. The trapped vortex combustor maintains a high degree of flame stability because the vortex trapped in a cavity provides a stable recirculation zone that is protected from the main flow of the combustor. The cavity serves as a pilot flame and provides a continuous ignition source for the main combustor, helping to keep the flame lit throughout the operating envelope. This interaction between the cavities and main combustor significantly enhances mixing, allowing for a short length, compact combustor. The low NO_x emissions are primarily the result of improved fuel and air mixing in the cavity and the front end of the main combustion zone. The current program is a partnership between the Air Force, Navy, DOE, and the Strategic Environmental Research and Development Program (SERDP) and General Electric Aircraft Engines.

Propulsion Directorate

Additional information

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