the ENERGY lab

PROJECT FACTS

Advanced Research

Online, In Situ Monitoring of Combustion Turbines Using Wireless, Passive, Ceramic Sensors

Description

The United States Department of Energy (DOE) National Energy Technology Laboratory (NETL) is committed to strengthening America's energy security. Central to this mission is to increase the percentage of domestic fuels used to provide for the Nation's energy needs. To this end, DOE-NETL is supporting projects to develop technologies that will improve the efficiency, cost, and environmental performance of complex power generation systems, such as Integrated Gasification Combined Cycle (IGCC) plants, which produce power from domestic fuels. For IGCC plants and the combustion turbines used within the plant to be more efficient and less costly, sensors used in the process need to be sturdier and more accurate than those currently available.

Researchers at the University of Central Florida (UCF) are developing wireless, passive, ceramic microsensors for in situ temperature and pressure measurements inside combustion turbines. These sensors will be designed to operate in high-temperature (>1300 °C), elevated-pressure (300–700 psi), harsh environments. The UCF team will investigate one temperature sensor and one pressure sensor that were recently developed with multifunctional polymer-derived ceramics (PDCs).

Goals

The primary goal of this program is to establish a solid foundation for the development of commercially viable advanced sensor technologies for in situ, real-time, operational monitoring of power generation systems. The primary objective of this project is to develop a set of high-temperature, wireless, passive, ceramic, micro-electro-mechanical systems (MEMS) sensors for online, real-time monitoring applications in turbine systems where the sensors will be required to survive extremely harsh work conditions. The project team will provide precise operational parameters in real time for optimal system control for higher efficiency, increased reliability, and improved emissions.

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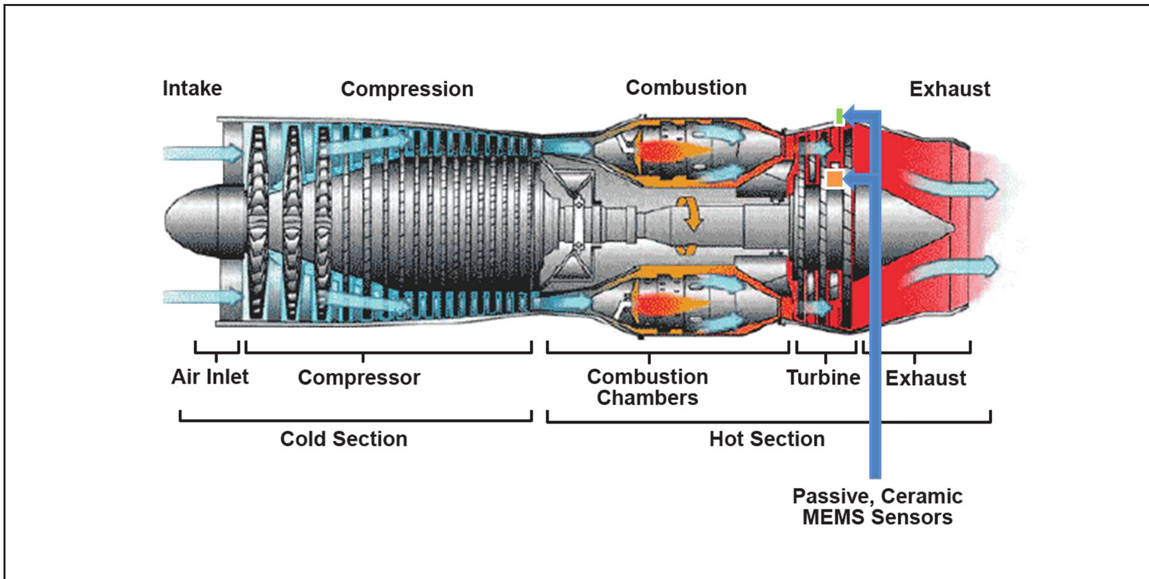
PERIOD OF PERFORMANCE

01/01/2010 to 12/31/2012

COST

Total Project Value
$1,013,994

DOE/Non-DOE Share
$811,193 / $202,801



Conceptual View of Employing Wireless Passive Ceramic Sensors for In Situ Monitoring of Combustion Turbines, Both Aerospace and Ground Power Turbines

Technological Approach

Research on PDCs shows they possess outstanding multi-functionality including excellent thermo-electrical properties at high temperatures (up to 1500 °C) with potential for use in the design and fabrication of high-temperature sensors. In addition, PDCs offer unique advantages such as ease of micro-fabrication and excellent corrosion resistance. These properties make PDCs suitable for microsensors that can be used in the high-temperature environments found in combustion turbines.

UCF will develop several PDC-based MEMS high-temperature sensors for applications in turbine combustors, transition pieces, turbine vanes, and end-walls where sensors are required to withstand severe environments. To achieve this, the team will (1) design pressure sensors using evanescent-mode resonators and design temperature sensors using dielectric resonators; (2) fabricate the sensors using ceramic MEMS microfabrication; (3) characterize and calibrate the performance of the sensors under various environments that simulate real service conditions; and (4) develop reader units for wireless passive sensing.

Benefits

Advanced, near-zero-emission power systems currently under development require sensing and control technologies that allow real-time, in situ monitoring of system operations involving highly automated process controls. The development of sensors and controls capable of withstanding high-temperature and high-pressure conditions will help integrate and optimize complex power systems. The sensors being developed under this project possess specific advantages when compared to existing sensors. These include being (1) wireless, (2) passive, (3) accurate, (4) robust, (5) of very small size, and (6) able to network with other sensors. These features permit sensor placement in areas which are difficult or impossible to place existing sensors and enable simultaneous readings by multiple sensors connected to a single display. Sensor use in combustion turbines will permit gasification plants to produce power from various fuels cleanly and efficiently. This research supports DOE's goals to increase the availability of power from domestic fuels and decrease the negative environmental effects of power production.

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