R & D facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Sensors and Control

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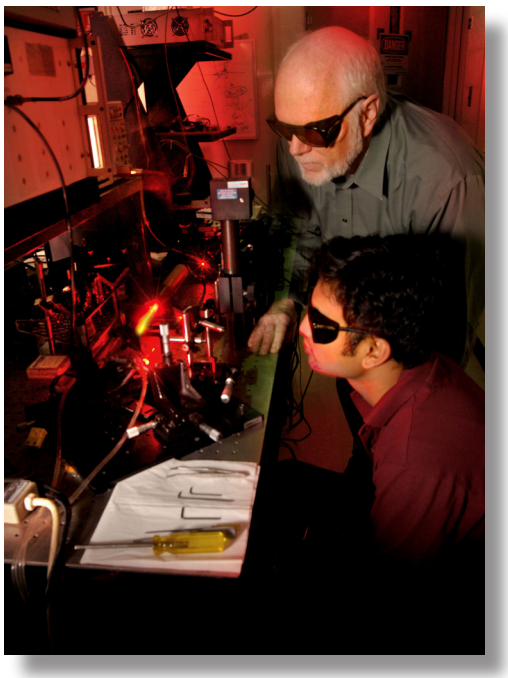
Raman Gas Composition Sensor System for Natural Gas and Syngas Applications

Relevancy

Facilities based on natural gas fired turbines represent an increasing share of both new and retrofitted energy generation capacity. As such, they are an important target for studies seeking to positively affect both the efficiency and environmental impact of U.S. energy production. Natural gas and liquid natural gas are attractive because of the diversity of available sources. However, this diversity has also created significant challenges for achieving efficient control of the combustion process. In general, the composition of natural gas feeding a particular plant can vary widely. Due to this wide variability, power system operating point tolerances must be set broadly enough to accommodate a wide range of fuel compositions as well as abrupt fuel compositional changes or transients during operation. As a result of this wide variability, advanced power system optimization of efficiency and low emissions is problematic.

Measuring natural gas composition and adaptive control of combustion is critical to achieving the effective control of natural gas turbine systems necessary for maximum efficiency and near zero-emission operation. Sensor systems should be situated at both high and low pressure points of the system before and after preheating stages. These requirements imply a rapid and reliable sensing mechanism in a configuration capable of operating at high temperatures and pressures. The sensor should be selective to all gas compositional components, sensitive to at least 1 percent concentration variation, and capable of integration and cost-effective manufacture. Presently employed gas chromatography or mass spectroscopy techniques are either time consuming or require bulky, expensive equipment.



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Project Description

This project will develop and test a Raman laser spectroscopy system for responsive gas composition monitoring. The instrument provides state-of-the-art improvement of reduced size and increased sensitivity and sample rate to facilitate the process control needs of advanced power systems. The target application is to monitor the natural gas species methane, ethane, and propane, as well as nitrogen. These species have unique Raman spectral fingerprints with linear response which can be used to base a rapid response sensor.

The National Energy Technology Laboratory (NETL) has developed a small neodymium yttrium aluminum garnet (Nd:YAG) laser that offers high laser power from a small substrate mounted package, suitable for the objectives of this development effort. Raman sensing is enhanced at shorter wavelengths and the frequency doubled Nd:YAG beam at 532 nm is a suitable excitation source.

State-of-the-art fiber optics, solid state lasers, and wavelength specific detectors will be integrated to reduce the size and increase the sensitivity beyond state-of-the-art spectroscopic systems.

Part of NETL's University Research Initiative Program, experts from West Virginia University and the University of Pittsburgh will collaborate with NETL researchers for this project.