GOAL

NETL has developed a real-time gas composition monitoring instrument using Raman laser spectroscopy, intended to improve the performance of power generation systems through better process control. The instrument provides state-of-the-art enhancements such as increased sensitivity and sample rate, which could help to meet the process control needs of advanced power systems. Industries that utilize natural gas, gasifier syngas, biogas, landfill gas, or any other type of fuel gas can benefit from knowing the composition of the fuel in real time. Natural gas, the most common fuel, can have significant variations in hydrocarbon composition due to the many sources feeding into the nation’s pipeline network. Other fuel gases can also vary significantly in quality, with natural gas typically used as a backup. These gases differ in their Btu content, flame speed, Wobbe number, dilution gases, and composition. The goal of this project is to continue incremental improvements to the Raman Gas Analyzer (RGA), test and demonstrate its capability through field testing, and support technology transfer to industry.
The NETL Raman Gas Analyzer provides a continuous readout of the relative mole fraction of all major fuel gases, including hydrogen, oxygen, nitrogen, carbon monoxide, carbon dioxide, methane, ethane, propane, water vapor, and additional gases as needed. These species have unique Raman spectral fingerprints with linear response, which are used as the basis of a rapid-response sensor that can measure all species simultaneously in one instrument. The sensor utilizes state-of-the-art optical waveguides, solid-state lasers, and compact spectrometers to increase the speed and sensitivity beyond commercially available Raman spectroscopic systems. The NETL Raman Gas Analyzer provides measurements of all the major species in the fuel gas in one second or less.

For gas turbines, the NETL Raman Gas Analyzer provides a rapid measurement at the temperatures and high pressures present in the turbine system. The instrument is selective to all typical fuel gas compositional components, and sensitive to better than 1 percent variations in concentration, which can then be converted to a heating value and Wobbe number. The NETL Raman Gas Analyzer provides a combination of multi-species measurement and speed that is a generation ahead of presently employed gas chromatography or mass spectroscopy techniques.

For fuel-flexible power systems, in which the supply gas includes syngas or biogas and natural gas, large compositional changes occur during fuel switching. Real-time measurement of the fuel composition feeding a power system enables smarter, optimal combustion control during a switchover or while blending fuels. The NETL Raman Gas Analyzer capabilities can be applied to today’s power generation technology as well as the research, development, and operations of future high-efficiency, clean-power generation systems. The multi-species measurement and speed of the NETL Raman Gas Analyzer can benefit the development of chemical looping combustion, hybrid power systems, and modular gasification technologies.