



Real-Time Raman Gas Composition Analyzer

Opportunity

The Department of Energy's National Energy Technology Laboratory (NETL) is seeking collaborative research partners interested in implementing United States Provisional Patent Application entitled "Gas Sensing System Employing Raman Scattering". Disclosed in this application is a gas analyzing sensor that characterizes gaseous fuel, exhaust gases, or other process gas streams. The sensor reports concentrations of all majority gases at better than 0.3% accuracy in 1 second or less, and can be used for real-time gas analysis and system control. The sensor relies on novel techniques to enhance usually weak spontaneous Raman emissions from sample gases, enabling the application of Raman spectroscopy to rapid gas analysis. No commercially available sensor or sensing system is able to measure all major natural gas components in an equally rapid and accurate manner. The present invention provides a gas detection system that is fast, accurate, cost effective, and capable of continuously measuring the concentrations of gases in a mixture such as natural gas. This invention will have multiple possible uses including real-time monitoring of natural gas composition which allows continual optimization of gas/air mixtures to increase efficiency of turbine generators.

Overview

Industries that utilize natural gas, gasifier syngas, biogas, landfill gas, or any type of fuel gas can benefit from knowing the composition of a fuel gas mixture in real-time. Natural gas, the most common fuel, can have significant variation in hydrocarbon composition in areas supplied by multiple sources. The "opportunity fuels" such as biogas and landfill gases, also have significant variation in quality and operators often use natural gas as a backup. All of these gases differ in their BTU content, flame speed, Wobbe Index, dilution gases, and composition. There is a need for a sensing system that is able to quickly and reliably identify, characterize, and determine the concentration of various gases in a gas mixture.

The current invention meets this need by providing a gas sensor system capable of accurate and continuous readout of the relative mole percent of all major fuel-gas components including H_2 , CO , CO_2 , CH_4 , C_2H_6 , and C_3H_8 , along with O_2 , N_2 , and water. The sensor is based on Raman spectroscopy and has been developed to utilize low laser powers and low-resolution spectrometers and detectors to give readouts in 1 second or less. The combination of speed, accuracy, and multiple species measurement makes the gas detection system well-suited for improving control of natural gas-fired turbines by measuring the input-fuel composition, or filtered exhaust gases in real-time. This sensor will greatly benefit the power industry, as well as other industries utilizing gaseous input or output streams by enabling smarter control to increase process efficiency and reduce emissions. Currently, NETL is deploying field prototype sensor systems for testing at private sector facilities to demonstrate durability and long-term operation. NETL is interested in further development and commercialization of this technology through collaborative research and licensing partners.

Significance

This gas analyzing sensor system provides the following advantages:

- Faster and lower cost than mass spectrometry and gas chromatography.
- Reports concentrations of all majority gases at greater than 0.3% accuracy in 1 second or less, and can be used for real-time gas analysis and system control.
- Capable of measuring eight or more gas-species simultaneously.
- Real-time capability enables turbine operators to switch from one fuel to another with continuous adjustment of the fuel/air ratio for optimum operation efficiency and flameout prevention.
- Measures difficult to detect homonuclear diatomics including H_2 , O_2 , and N_2 .
- Measurements are independent of temperature and pressure, although higher sample density gives greater dynamic range.
- Can be configured to yield higher sensitivities with longer response times.
- Current field-unit models are rated for pressures between 10 psi and 800 psi and gas temperatures up to 200° C for regulated or direct pipeline measurement. The high temperature sensing cell also permits direct measurement of steam concentration in a fuel stream without condensation.

Contact

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