the ENERGY lab

PROJECT FACTS

Gasification Technologies

Real Time Flame Monitoring of Gasifier Burner and Injectors

Background

The Gasification Technologies Program at the National Energy Technology Laboratory (NETL) supports research and development (R&D) in the area of gasification—a process whereby carbon-based materials (feedstocks) such as coal are converted into synthesis gas (syngas), which is separated into hydrogen (H_2) and carbon dioxide (CO_2) gas streams in a combustion turbine-generator as a way to generate clean electricity while preventing the release of CO_2.

The R&D efforts of the Gasification Technologies Program for instrumentation materials as well as other areas focus on enhancing the performance of gasification systems, thus enabling U.S. industry to improve the competitiveness of gasification-based processes. One area in need of performance enhancement is that of scheduling gasifier coal injector replacement. Gas Technology Institute (GTI) has discovered that coal gasifier feed injectors tend to be replaced on a conservative schedule to limit unexpected gasifier failures. GTI realized that replacing injectors only when needed would result in less gasifier down time, resulting in more economical operation.

In an effort to advance this technology, NETL will collaborate with GTI, North Carolina State University, and ConocoPhillips Company (CP) to increase the life of coal gasifier feed through advanced condition monitoring.

Project Description

This project focuses on the development of a sensor that expands the capabilities of existing and emerging combustion sensors to produce a flame monitor to help minimize the maintenance costs of gasifier operation. The primary goal is to develop a reliable, practical, and cost-effective means of monitoring coal-gasifier feed-injector flame characteristics using a modified version of an optical flame sensor. The flame characteristics monitored by this sensor are flame shape, flame mixing patterns, flame rich/lean zones distribution, hydrocarbon oxidation dynamics, flame stability, and flame temperature. The sensor will be tested at lab-scale on a natural gas flame, at bench-scale in the vertical coal-slurry oxygen (O_2)-enriched air combustor, and at pilot-scale in an O_2-fired, high-pressure slagging gasifier. This project will result in a simplified, industrially robust flame-characteristics sensor able to provide reliable information on the wear of coal-gasifier feed injectors, thereby improving injector life in coal gasification systems.

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PARTNERS

ConocoPhillips Company
North Carolina State

PROJECT DURATION

Start Date
10/01/2002

End Date
12/31/2012

COST

Total Project Value
$ 1,683,394

DOE/Non-DOE Share
$ 1,247,896 / $ 435,498

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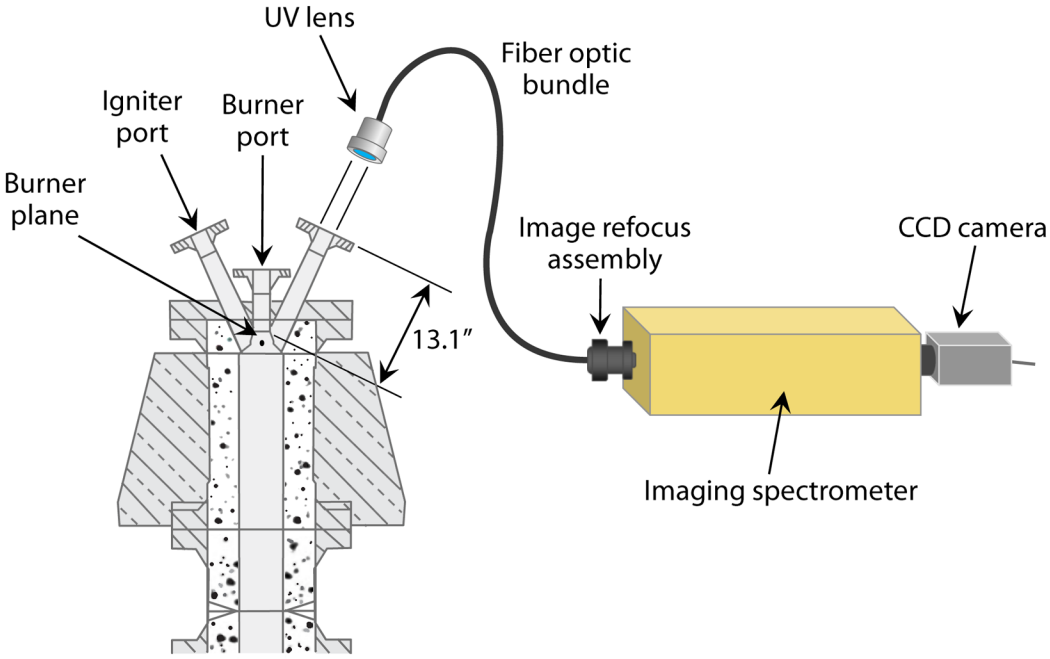

Conceptual Schematic of Sensor Installation on a Coal Gasifier

The bench- and pilot-scale work will be performed at CANMET Energy Technology Centre (CETC) in Ottawa, Canada. Then GTI will perform field demonstration tests in an O_2-fired commercial scale gasifier at Global Energy, Inc's Wabash facility, with CP as the industrial partner.

Goals and Objectives

The primary goal of this project is to develop a reliable, practical, and cost-effective means of monitoring coal gasifier feed injector flame characteristics using a modified version of an optical flame sensor already under development. Specific objectives include (1) testing the flame sensors at lab scale, (2) testing at bench and pilot scale at CETC, and (3) performing a field demonstration on an O_2-fired commercial scale gasifier.

Accomplishments

GTI was able to complete existing sensor modification to detect ultraviolet (UV), visible, and/or near infrared (NIR) wavelengths for optimum flame monitoring and laboratory testing equipment set-up., the sensor was modified following lab-scale testing on natural gas flames for pilot-scale testing at the CETC O_2-fired, high pressure, pilot-scale slagging gasifier, and was successfully tested on a natural gas mockup of this gasifier. Flame parameters, including swirl intensity, coal feed rate, coal feed velocity, and O_2 content in the oxidizer were varied during the tests. After pilot-scale tests were completed using the CETC pressurized entrained flow gasifier, researchers designed and built test equipment to evaluate spectroscopic and imaging properties of the fibers as well as to assess the capability of the fiber optic probe (FOP) enclosure to withstand high pressures. Tests showed that the video fiber capacity to transmit UV light is low; therefore, the spectroscopic fiber bundle was used in the prototype flame monitor. An eight hour test of the modified FOP lab-scale prototype at the GTI Combustion Laboratory demonstrated that it could survive long-term exposure to high temperatures and was able to collect images with sufficient resolution, viewing angle, focal depth, sensitivity, and contrast. The project also successfully tested the sensor at the Wabash facility and collected images of the gasifier for several hours including data that was used to estimate temperature.

Benefits

A reliable real-time flame monitor for gasifier injectors would allow gasifier operators to more accurately plan for injector replacement, thereby reducing maintenance costs and increasing gasifier reliability. The sensor data on flame characteristics may also assist in the development of better, longer-lasting injectors, which would also lead to gasifier operation savings. These sensors will allow furnace operators to manually adjust appropriate burner controls (e.g., flame length or firing rate) as well as maintain safe and stable combustion.