PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Advanced Research

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INNOVATIVE INSTRUMENTATION AND ANALYSIS OF THE TEMPERATURE MEASUREMENT FOR GASIFICATION SYSTEMS

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Description

The technical objective is to develop reliable and accurate instrumentation for temperature measurement in gasification systems by developing a thermocouple-based system with protective coating and self cleaning capabilities. The research will also show that the proposed instrumentation is a cost-effective temperature measurement technique for high temperature gasification through a reduction of the operation and maintenance cost.

According to the DOE Gasification Database Results Updated 2001, all gasifiers in the United States have the capacity of 37,375 MW. It can be assumed that 10% of the power generated is estimated as the operation/maintenance cost. Of the cost, one third (based on the previous statistical research done at the CAESECT at Morgan State University) is estimated as loss, being caused directly or indirectly by the unreliable temperature measurement in gasifiers. This could be calculated as $60,000 per unit year and explains why a reliable and accurate temperature measurement technique for gasifiers is needed. Normally, the operating temperature of gasifiers is in the range of 500-2600 °F while its operating pressure is in the range of 400–1000 psi. Harsh conditions inside the gasifiers, which include a dirty, reducing, corrosive, and high-pressure atmosphere, are major barriers to accurate temperature measurement.

Our proposed instrumentation for temperature measurement consists of a specially designed measuring device with thermal sprayed thermocouple with special coating and two cleaning methods: high-pressure gas injection cleaning, and ultrasonic dirt peeling, which make the instrumentation design unique. The on-line analysis and control system including its interacting software for this instrumentation will be developed for instrumentation self-cleaning/control purposes. In this proposed project, a gasifier cold model and a lab-scale gasifier simulator (hot model) will be designed and fabricated. A series of tests will be conducted on both the cold model and the gasifier simulator. The test results will be analyzed by using Analysis of Variances (ANOVA) and other numerical optimization methods to find out the important parameters, including appropriate oxygen injection pressure/velocity and frequency, appropriate ultrasonic frequency, appropriate thickness of the coating in according to the different thermocouples, and the life cycle of the coating for gasifier application.

PARTICIPANT / PRINCIPAL INVESTIGATOR

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PROJECT COST

$200,000

PROJECT DURATION

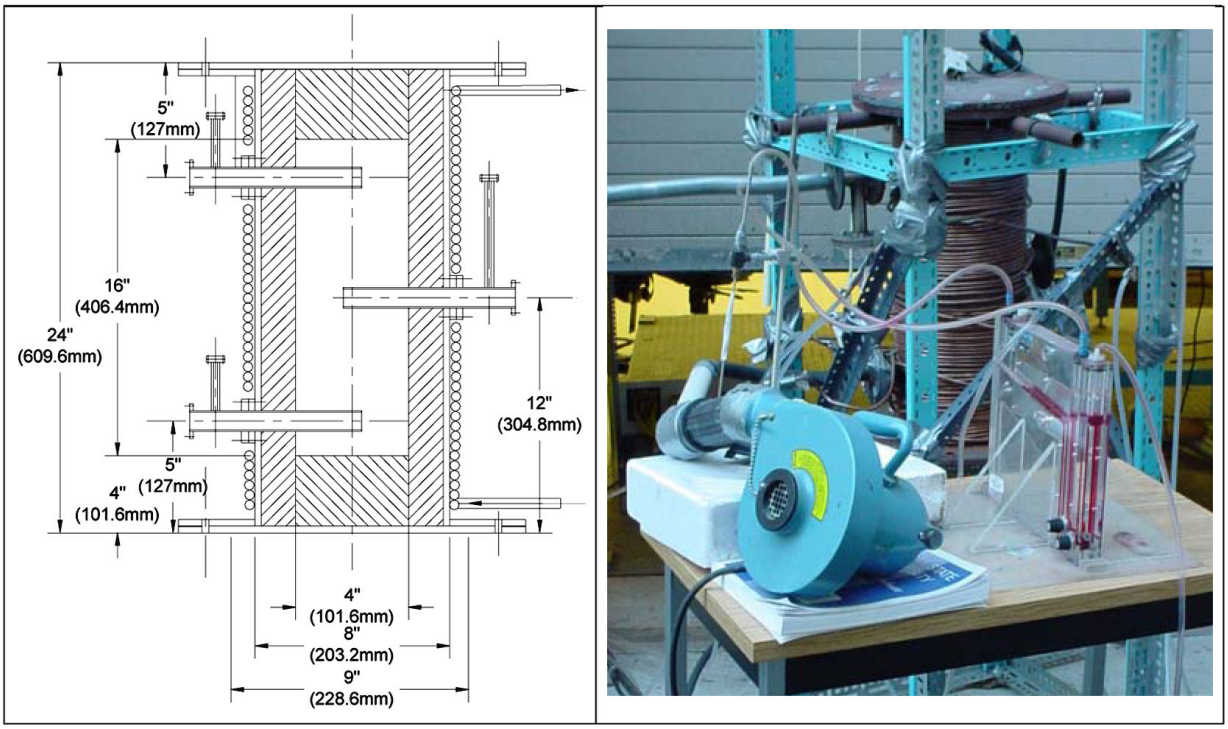
10/01/2002 – 9/30/2005

WEBSITES

www.netl.doe.gov/coal

Accomplishments

- The literature survey including the gasifier temperature measurement literature, the ultrasonic application and its background study in cleaning application, and spray coating process are completed.
- The thermocouple assembly and gasifier cold model have been designed and fabricated.
- The sample temperature curves have been obtained from the cold model shakedown testing. Cold model testing has been successfully conducted, and the Analysis of Variance (ANOVA) was applied to analyze the test data. The analysis showed that four significant factors affect temperature measurement: blower voltage, ultrasonic application, injection time intervals, and particle weight.
- The gasifier simulator (hot model) design and the fabrication are completed.
- The system tests of the gasifier simulator have been conducted and some modifications have been made. Based on the system tests and results analysis, the gasifier simulator has met the proposed design requirement and the ready for system test.
- The ultrasonic cleaning method is under evaluation and will be further studied for the gasifier simulator application.



The Design and Experimental Set-up of the Lab-Scale Gasifier Simulator and the Temperature/Flow Measurements Facilities