the ENERGY lab

PROJECT FACTS

Gasification Technologies

Mitigation of Syngas Cooler Plugging and Fouling

Background

To improve cost competitiveness with conventional coal-fired power plants, gasification plants need to improve plant economics, efficiency, and increase plant availability. The current syngas coolers used in coal-fired integrated gasification combined cycle (IGCC) plants offer high efficiency, but their reliability is generally lower than other process equipment used in the gasification island.

The syngas cooler (SC) is a fire tube heat exchanger located after the coal gasifier before the syngas combustion turbine. The principle downtime events associated with the syngas cooler typically result from ash deposits that develop on surfaces upstream of the syngas cooler, break loose, and then lodge in the syngas cooler tubes causing plugging or increased erosion in the tube. Another system availability issue associated with the syngas cooler is deposits that form on the fireside surface of the syngas cooler tubes and lead to fouling of the syngas cooler. Both ash deposit mechanisms can result in reduced system availability and increased maintenance costs. Efforts to better manage ash deposition will help IGCC plants be more cost competitive with conventional coal-fired power plants.

The Department of Energy (DOE) National Energy Technology Laboratory (NETL) has partnered with Reaction Engineering International (REI) to explore ways to mitigate and better manage syngas cooler plugging and fouling.

Project Description

The project consists of three main areas: laboratory scale experimentation, modeling work, and field testing for validation of the selected technology developed under this project.

The laboratory scale testing will be conducted by the University of Utah. The experiments will consist of generating ash deposits from both the pilot scale gasifier and the Laminar Entrained Flow Reactor (LEFR), which will be used to evaluate deposit strength at a range of temperatures, surface materials, and fuel properties. The impinging jet experiments will determine the energy requirements for removal of ash material deposits that adhere to metallic and refractory surfaces. This work will evaluate the adhesion strength of ash deposits to the surface in tests using coal-derived syngas from the LEFR over a range of temperatures (700-1050 °C). An impinging jet blowing nitrogen will be used to dislodged the ash deposits and thus, determine the adhesion strength.

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COLLABORATORS

University of Utah
ConocoPhillips

PROJECT DURATION

Start Date
10/01/2011

End Date
09/30/2014

COST

Total Project Value
$1,441,250

DOE/Non-DOE Share
$1,130,386 / $310,864

Modeling will be performed by the recipient, Reaction Engineering International (REI). Process and engineering model calculations will assist in development of the test design and data interpretation. Computational fluid dynamic (CFD) modeling of commercial syngas cooler designs will be done to determine the conditions that cause plugging and fouling in the syngas cooler. In addition, by using CFD modeling, REI will evaluate methods to mitigate and better manage syngas cooler plugging and fouling. This will be accomplished by CFD modeling of alternative process conditions, syngas cooler geometry changes that could reduce fouling / plugging, and equipment changes (e.g., filters, traps, baffles, flow area expansions) upstream of the syngas cooler. Potential syngas cooler geometry changes include using larger diameter tubes and/or varying syngas cooler orientation (up, down, horizontal).

After the experimental testing, modeling, and economic evaluation for the proposed mitigation technology for syngas cooler improvements is completed, the last part of the project is to conduct testing at a commercial IGCC plant to test the applicability of the chosen technology. A reactor will be constructed with shakedown testing done at the University of Utah to then install at the plant to withstand a particulate syngas stream at high pressure and temperature.

Goals and Objectives

Project objectives include (1) developing a better understanding of ash deposition onto refractory and metal surfaces associated with syngas coolers used in IGCC plants that incorporate a two-stage gasifier; (2) evaluating plugging and fouling of syngas cooler designs; (3) developing methods to mitigate syngas cooler plugging and fouling; and (4) defining and beginning to validate specific means to implement mitigation methods. The successful completion of these objectives will result in improved availability and reliability of the syngas cooler thus improving the availability of the overall IGCC plant.

Benefits

Coal gasification has the potential to significantly reduce U.S. dependence on foreign energy sources and dramatically reduce the environmental impact of using coal for power generation. (Emissions from IGCC plants are significantly lower than those from conventional coal-fired power plants.) However, in order for IGCC plants to achieve widespread deployment, the technology will need to realize lower costs and improved availability. This project will aid with operating cost reductions through the increase in availability of the unit operation syngas cooler. Improving the performance of the syngas cooler through the mitigation of plugging and fouling occurrences in the plant will have a positive impact on the reliability, availability, and maintainability of IGCC plants.