the ENERGY lab

PROJECT FACTS

Gasification Technologies

RECOVERY ACT: Scale-Up of High-Temperature Syngas Cleanup Technology

Background

Coal gasification generates a synthesis gas (syngas)—predominantly a mixture of carbon monoxide (CO) and hydrogen (H_2)—that can be used for chemical production of hydrogen, methanol, substitute natural gas (SNG), and many other industrial chemicals, or for electric power generation. Conventional integrated gasification combined cycle (IGCC) power plants use this syngas as a fuel for a combustion turbine to produce power.

In an effort to advance these technologies, the Department of Energy (DOE) has awarded funds from the American Recovery and Reinvestment Act (ARRA) for expanding advanced projects to accelerate the development of technology. Specifically, the DOE's National Energy Technology Laboratory (NETL) is partnering with RTI International (RTI) to develop and scale up a high-temperature syngas cleanup technology for commercial deployment enabling improved thermal and environmental performance with lower costs in IGCC power and chemical production plants.

This project also includes Carbon Capture and Sequestration (CCS) supporting the DOE's vision of coal plants with near-zero emissions by reducing the cost and improving the efficiency of capturing and sequestering carbon dioxide (CO_2) and removing impurities from syngas derived from coal. This project will be the first to accomplish large-scale testing of high-temperature syngas cleanup technology enabling subsequent commercial deployment.

Description

RTI and its project partners will mitigate the technical risk associated with scale-up of high-temperature syngas cleanup and CCS technologies for coal gasification by designing, constructing, and operating a pre-commercial scale high-temperature syngas cleanup unit with integrated CCS technology. This pre-commercial high-temperature syngas cleanup system will clean part of the syngas from a 250 megawatt (MW) commercial IGCC power plant. The RTI cleanup unit will

CONTACTS

Jenny B. Tennant
Gasification Technology Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4830
jenny.tennant@netl.doe.gov

K. David Lyons
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4379
k.david.lyons@netl.doe.gov

Raghubir Gupta
Principal Investigator
RTI International
P.O. Box 12194
Research Triangle Park, NC 27709
919-541-8023
gupta@rti.org

PARTNERS

RTI International
Tampa Electric Power Company
CH2M Hill
The Shaw Group, Inc.
Sud Chemie, Inc.
BASF Corporation
Eastman Chemical Company
AMEC, plc.
Technip

PERIOD OF PERFORMANCE

7/20/2009 to 9/30/2015

COST

Total Project Value

$177,756,400

DOE/Non-DOE Share

$171,792,957 / $5,963,443

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

clean about 20% of the total plant syngas, qualifying operation under actual commercial conditions. CCS technology scale-up will encompass CO_2 capture from the syngas, and injection into a deep saline aquifer for long-term geologic storage. The syngas cleanup system produces a syngas product that is suitable for chemical production and a CO_2 by-product that may be easily sequestered or used for enhanced oil recovery.

The high-temperature syngas cleanup system will consist of the High Temperature Desulfurization Process (HTDP). The high-temperature syngas cleanup system will remove more than 99.9 percent of the sulfur (S) from coal-derived syngas. A smaller scale Trace Contaminant Removal Process (TCRP) unit to remove multiple trace impurities will also be tested at temperature and pressure to seamlessly integrate with the HTDP. Separation of CO_2 from the clean syngas will be accomplished using activated methyl-diethanolamine (MDEA) solvent technology. Integration of an activated MDEA process with high-temperature syngas cleanup provides both economic and performance benefits.

The site for this project is the Tampa Electric Company (TECO) IGCC facility at Polk Power Station located near Tampa, Florida, which is fueled by a blend of petroleum coke and coal. Data on thermal efficiency, emissions, and cost benefits will be gathered during 8,000 hours of testing the high-temperature syngas cleanup system. Operation of the CCS system will entail capture of 90% of the CO_2 present in syngas and subsequent sequestering of 210,000 tons of CO_2 per year in a deep saline aquifer present at the Polk Power Station site for long-term geologic storage.

Tampa Electric Company's IGCC Plant, Polk Power Station

Goals and Objectives

The primary goal of this project is to mitigate the technical risk associated with scale-up of high-temperature syngas cleanup and CCS technologies for coal gasification to facilitate subsequent commercial deployment. The project team will commission the syngas cleanup system and operate the system for at least 5,000 hours. During operation, at least 300,000 tons of CO_2 will be captured by the syngas cleanup system and sequestered into a deep saline aquifer. In addition, operation of the syngas cleanup system will be used to establish reliability, availability, and maintenance targets for a full-scale commercial system; establish commercial operating experience; provide operator training for a commercial system; and develop process designs to meet the DOE contaminant removal performance goals for chemical production from syngas for impurities listed in the table below.

DOE Performance Goals

Impurity	Maximum After Cleanup
Total Sulfur	50 parts per billion (ppb)*
Mercury	5 ppb by weight *
Selenium	200 ppb*
Arsenic	5 ppb*
CO_2	>90 percent removed**

*At pressure ≥ 600 pounds per square inch; temperature ≥ 400° Fahrenheit

** With <10 percent contribution to increase in Cost of Electricity

Accomplishments

A pre-FEED, or process design package, has been developed for the high-temperature syngas cleanup units utilizing the experimental information available from bench-scale testing and the Eastman pilot plant test with real coal-derived syngas. The design basis for the Front End Engineering Design (FEED) package was finalized and the FEED design has been completed.

A Final Environmental Assessment (EA) document has been issued for this project in compliance with DOE's National Environmental Policy Act (NEPA) implementation procedures. In conjunction with this Final EA document, DOE has issued a Finding of No Significant Impact (FONSI) for this project.

Benefits

A DOE-funded and an independent system study predict that the RTI high-temperature syngas cleanup process for an IGCC plant will increase overall IGCC thermal efficiency by two to three percentage points and reduce the cost of electricity by six percent. Integrating this technology with activated MDEA solvent technology for CO_2 separation has the potential to minimize the impact of carbon capture on consumer electricity costs and accelerate CCS deployment. By using domestic coal resources, this system also has the potential to reduce the cost of producing chemicals, transportation fuels, and substitute natural gas, thereby enhancing America's energy security and economic prosperity.

NETL

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