the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Development and Demonstration of Waste Heat Integration with Solvent Process for More Efficient CO_2 Removal from Coal-Fired Flue Gas

Background

The mission of the U.S. Department of Energy/National Energy Technology Laboratory (DOE/NETL) Existing Plants, Emissions, & Capture (EPEC) Research & Development (R&D) Program is to develop innovative environmental control technologies to enable full use of the nation's vast coal reserves, while at the same time allowing the current fleet of coal-fired power plants to comply with existing and emerging environmental regulations. The EPEC R&D Program portfolio of carbon dioxide (CO_2) emissions control technologies and CO_2 compression is focused on advancing technological options for the existing fleet of coal-fired power plants in the event of carbon constraints.

Pulverized coal (PC) plants burn coal in air to produce steam and comprise 99 percent of all coal-fired power plants in the United States. Carbon dioxide is exhausted in the flue gas at atmospheric pressure and a concentration of 10–15 percent by volume. Post-combustion separation and capture of CO_2 is a challenging application due to the low pressure and dilute concentration of CO_2 in the waste stream, which affects removal processes, and the parasitic energy cost associated with the capture, recovery, and compression of CO_2. The high energy cost could be effectively mitigated with a heat integration system that utilizes low-quality waste heat inherently available in power generation.

Project Description

Southern Company Services, Mitsubishi Heavy Industries America (MHIA), and URS Group have teamed to develop viable heat integration methods for the capture of CO_2 produced from PC combustion plants, improving upon the current state-of-the-art for solvent-based capture processes. An advanced level of heat integration between the power plant and the CO_2 capture facility will be demonstrated by incorporating a waste heat recovery technology into an existing amine-based CO_2 capture process. The project will incorporate MHIA's High Efficiency System (HES) heat recovery and integration technology into a currently operating 25 megawatt (MW) pilot plant demonstration of the Kansai Mitsubishi Carbon Dioxide Recovery (KM-CDR™) CO_2 capture process at Southern Company's Plant Barry. The KM-CDR demonstration is separately funded by an industry consortium unaffiliated with this project. The 25 MW HES technology will be designed, installed, and operated for 12 months to evaluate the resulting energy performance improvements. The KM-CDR process is designed for 90 percent CO_2 capture and is based on an advanced amine with several advantages over monoethanolamine (MEA), resulting in reduced steam demand for regeneration, lower corrosivity, and better stability to flue gas constituents such as oxygen.

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PROJECT DURATION

Start Date	End Date
10/01/2011	06/30/2015

COST

Total Project Value
$18,268,880

DOE/Non-DOE Share
$14,130,193/$4,138,687

AWARD NUMBER

DE-FE0007525

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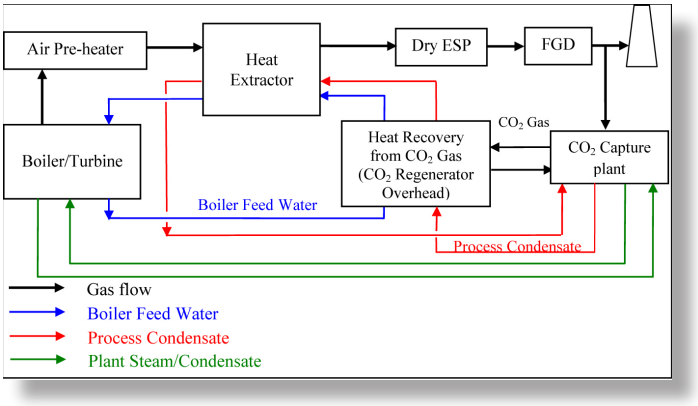
The HES incorporates a low temperature flue gas cooler to extract waste heat from flue gas exiting the power plant's air preheater and makes that heat available for use in both the power and CO_2 recovery plants. In a typical coal-fired power plant, the addition of a chemical solvent process for CO_2 capture requires the extraction of a relatively large volume of low pressure (LP) steam from the power plant's steam cycle, which decreases the power generation of the plant. The HES heat integration technology will use waste heat streams to provide needed process stream heating, reducing the amount of LP steam extracted for the solvent regeneration system. The recovered heat will also be used to heat boiler feed water, further reducing the extraction steam demands on the LP turbine and increasing the LP steam available for power generation. The HES has been successfully demonstrated at several low-sulfur, coal-fired power plants outside of the United States, though not with CO_2 capture. This project will examine the HES performance with high-sulfur flue gas, and as integrated with a CO_2 recovery system. A preliminary techno-economic analysis has indicated that HES with advanced heat integration can reduce the total energy impact of CO_2 capture by 26 percent, a considerable step toward meeting the DOE goal for the cost of electricity (COE).

The project will also demonstrate that the HES provides ancillary benefits to the host plant, such as reduced water use in the flue gas desulfurization system due to lower flue gas temperatures, better electrostatic precipitator (ESP) performance due to lower ash resistivity, and better sulfur trioxide capture in the ESP by lowering the flue gas below the acid dew point. These benefits to the host plant will, in turn, provide an additional benefit to the CO_2 capture process by reducing the impurity levels in the feed to the CO_2 capture process island, thus reducing the solvent consumption due to those impurities.

Primary Project Goal

The project goal is to design, install, and operate a 25 MW pilot-scale HES in conjunction with the KM-CDR pilot process at Southern Company's Plant Barry for 12 months. The project intends to demonstrate improved heat integration between the power plant and solvent-based CO_2 recovery processes, and show significant progress toward meeting DOE's goals of greater than 90 percent CO_2 capture with an increase in the COE of less than 35 percent.



Outline of HES Heat Extractor.

Objectives

The project objectives are to (1) quantify energy efficiency improvements to the CO_2 capture process when integrated with the HES and the host power plant; (2) identify and resolve operational and control problems from the integration of the HES and KM-CDR; (3) quantify the ancillary benefits of the HES technology to solvent-based CO_2 technologies such as reduced water consumption and better overall process performance; and (4) identify and resolve operational issues associated with the use of the HES on a high-sulfur flue gas.

Planned Activities

- Complete the Front-End Engineering Design for the HES.
- Develop a definitive cost estimate to confirm the project budget.
- Obtain the necessary permits to construct and operate the HES demonstration.
- Complete the detailed engineering, procurement, and construction of the HES.
- Prior to the start of operation, assess the baseline energy performance of the CCS plant.
- Operate the heat integration system for 12 months.
- Monitor operations and maintain equipment to ensure operating conditions are met.
- Assess improvements in energy performance of the integrated CO_2 capture system/host site.
- Identify and resolve any operational or equipment problems.
- Complete a final techno-economic analysis based on the results obtained.

Accomplishments

- Kick-off meeting conducted in October 2011.

Benefits

The integration of HES technology with the CO_2 capture process has a significant advantage associated with the energy efficiency of CO_2 recovery and provides several other benefits to the CO_2 recovery process and the balance of plant processes. Incorporating demonstration of the HES at an existing carbon capture pilot plant allows for the evaluation of improvements in the energy performance of the integrated pulverized coal plant and CO_2 capture process. The advanced energy integration concept has potential to lower the overall cost of CO_2 capture and demonstrate substantial progress toward meeting the cost and performance goals set by DOE.