the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Flue Gas Purification Utilizing SO_X/NO_X Reactions During Compression of CO_2 Derived from Oxyfuel Combustion

Background

Oxy-combustion in a pulverized coal-fired power station produces a raw carbon dioxide (CO_2) product containing contaminants such as water vapor, oxygen, nitrogen, and argon from impurities in the oxygen used and any air leakage into the system. Acid gases are also produced as combustion products, such as sulfur oxides (SO_x), hydrogen chloride, and nitrogen oxides (NO_x). These impurities must be removed before the CO_2 stream is introduced into a pipeline to prevent corrosion and comply with environmental regulations. Additionally, end use purity requirements, particularly for applications like enhanced oil recovery, may necessitate the removal of impurities.

Description

Air Products and Chemicals, Inc. will design and construct a 15-bar reactor system for the removal of sulfur and nitrogen oxides (SO_X/NO_X) from a CO_2-rich flue gas generated at Alstom Power Inc.'s pilot-scale, tangentially-fired (T-fired), oxy-coal combustion unit. Using this reactor system, a comprehensive experimental evaluation of the SO_X/NO_X reaction process will be conducted following well-established experimental, modeling, and engineering analysis techniques. This test system will be designed to receive a slip stream of ~0.35 thermal megawatts (MW_{th}) equivalent flow rate from a larger oxy-coal combustion unit. The project will use analytical techniques to characterize the reactor products and the level of CO_2 purification. The project will also assess the effect of different operating conditions, such as those approximating the intended application, including higher pollutant removal. The test data will be used to model reactor performance to determine the critical parameters.

Primary Project Goal

The goal of this project is to determine the feasibility of purifying CO_2 derived from flue gas that has been generated in a coal combustion unit operated in oxy-combustion mode.

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PARTNERS

Air Products and Chemicals, Inc.
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PERIOD OF PERFORMANCE

10/1/2008 to 9/30/2010

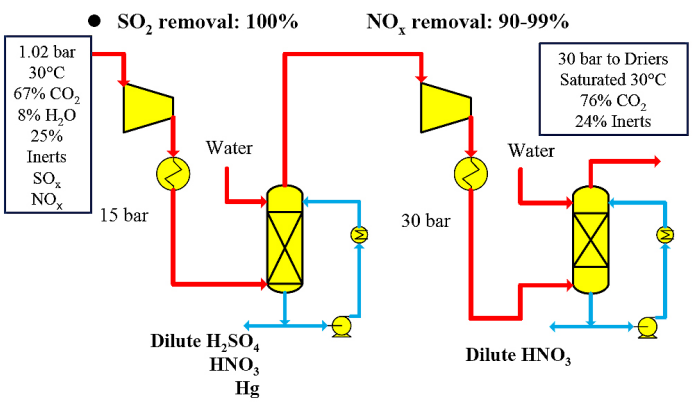
COST

Total Project Value
$1,254,995

DOE/Non-DOE Share
$918,244 / $336,751

Objectives

The project objectives are to: (1) design and construct a reactor system for the purification of CO_2 from oxy-coal combustion; (2) evaluate reactor performance and robustness; and (3) model reactor performance.



Air Products' CO_2 Compression and Purification System: Removal of Sulfur Dioxide, NO_x, and Mercury

Benefits

While some key components of the oxy-coal system (i.e., the air separation unit, CO_2 compressors, and certain aspects of the boiler) have been operated at scale for years, an engineering prototype of the entire system, from combustion to sequestration, needs to be demonstrated as an integrated unit. Air Products' compression/purification technology system offers a novel way to handle the compression and purification of a CO_2-rich stream. It consists of two parts within the CO_2 compression and purification steps: (1) 1 to 30 bar compression with SO_X/NO_X removal and (2) 30 to 110 bar compression with inert removal. This system allows for greater than 90 percent CO_2 capture at a reduced cost.

Planned Activities

Phase I:

- Design, build, and commission a 15-bar reactor system designed to cool an oxy-coal combustion flue gas slip stream (~0.35 MW_{th} flow rate equivalent), compress from 1 to 15 bar, and react within a 15-bar column the SO_X/NO_X present in the CO_2-rich flue gas.
- Perform a shakedown test of the reactor system and ship the unit to Alstom Power in Windsor, Connecticut.
- Prepare a test plan to illustrate the final design and capabilities of the reactor system, the results of the shakedown test, and the proposed operating conditions of the test matrix.
- Evaluate the reactor unit using oxy-coal derived flue gas generated onsite by Alstom Power.
- Conduct at least one multi-day run using an actual oxy-coal derived flue gas.
- Characterize liquid and gaseous reactor effluents using standard analytical techniques to assess any change in reactor performance.

Phase II:

- Evaluate the reactor unit using oxy-coal derived flue gas generated onsite by Alstom Power.
- Conduct at least two multi-day runs using an actual oxy-coal derived flue gas.
- Evaluate the performance of the reactor based on the reactor effluents for different reactor pressures and water recycle rates.
- Characterize liquid and gaseous reactor effluents using standard analytical techniques to assess any change in reactor performance.
- Develop an engineering model to describe the 15-bar purification reactor performance.
- Perform a sensitivity analysis to elucidate the parameters most critical to performance.