PROJECT facts

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

Sequestration

03/2006

GREENHOUSE GAS EMISSIONS CONTROL BY OXYGEN FIRING IN CIRCULATING FLUIDIZED BED BOILERS

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Background

The object of oxygen-fired combustion is to burn the fuel in enriched air or pure oxygen to produce a concentrated stream of CO_2. Oxygen fired combustion presents significant challenges, but also provides a high potential for technology breakthroughs and a step-change reduction in CO_2 separation and capture costs. Barriers and issues include: 1) oxygen from cryogenic air separation is expensive, and oxygen combustion consumes several times more oxygen than gasification; 2) combustion of fuels in pure oxygen occurs at temperatures too high for existing boiler or turbine materials, while CO_2 recycle to control temperature increases the parasitic power load.

Primary Project Goal

The overall project goal is to conduct economic evaluations of the recovery of carbon dioxide using a newly constructed circulating fluidized bed (CFB) combustor while burning coal, petroleum coke, or biomass fuel with a mixture of oxygen and recycled flue gas, instead of air.

Objectives

- The Phase I objective is to determine which of the new concepts in a CFB are technically feasible and have the potential of reducing the target cost of carbon avoided.
- Petroleum coke and coal samples will be combustion tested in a 4-inch Fluidized Bed Combustion reactor to determine their gaseous (NO_x, SO_2,CO) and unburned carbon emissions and ash agglomeration/sintering potentials during combustion in oxygen-rich environments.
- The Phase II objective is to generate a refined technical and economic evaluation of the most promising concept for reducing CO_2 mitigation costs (based on recommendations from Phase I), based on data from proof-of-concept testing of the most promising concept.

PARTNERS

Alstom Power Inc.

ABB Lummus Global, Inc.

Praxair, Inc.

Parsons Energy and Chemical Group

COST

Total Project Value
$2,730,471

DOE/Non-DOE Share
$2,730,471 / $546,095

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Accomplishments

Phase I has been completed. The performance analysis of the base case (Air-Fired) CFB has been conducted. Key results included plant-efficiency, equipment costs, cost of electricity, and CO_2 mitigation costs. Work was completed on design/performance analyses of:

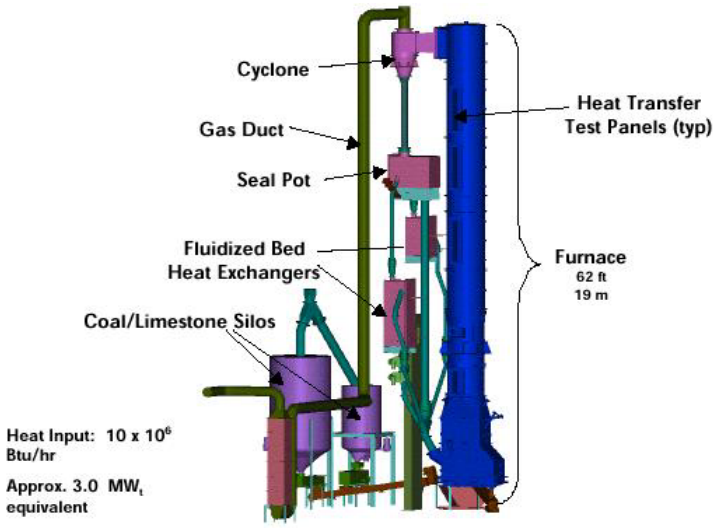
- Three advanced O_2-fired CFB concepts
- One high temperature carbonate regeneration process
- One chemical looping concept
- Two IGCC cases (one base case without CO_2 capture and one with a water-gas shift reactor to capture CO_2).

Phase II pilot testing has been completed. Two test runs were performed in March and June of 2004. Experiments were conducted using coal and petcoke. Oxygen levels examined include 21% (baseline) and various levels up to a local high of 70% oxygen. The rest of the stream was CO_2 to simulate a flue gas recycle. Key results include:

- Successful operation of the 2.9MW_{th} facility with bituminous coal and petcoke with no evidence of particle agglomeration or defluidization in the furnace
- Higher than normal sulfur emissions for bituminous coal than normal for the same limestone feed rate. Due to higher furnace temperature necessary to ensure calcination of limestone.
- Lower NO_x emissions under oxygen firing. Mainly due to reduction in prompt NO_x.
- Updated performance analyses based upon testing results.

Benefits

The results from this project will provide the power industry with concrete data concerning greenhouse gas emissions control by oxygen firing in circulating fluidized bed boilers. The comparison of the several different technologies will target the most economical gas clean-up configuration.



ALSTOM's Multi-Use Test Facility (MTF)

Project201.pmd