PROJECT facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Sequestration

03/2006

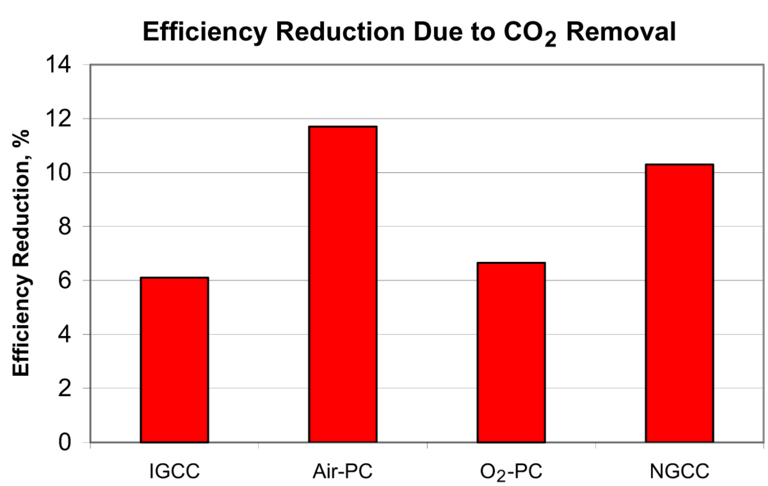
Conceptual Design of Oxygen-Based PC Boiler

Background

Because of growing concern that a link exists between global climatic change and emission of greenhouse gases, such as CO_2, it is prudent to develop new coal combustion technologies to meet future emissions standards, should it become necessary to limit CO_2 emissions to the atmosphere. New technology is needed to ensure that the U.S. can continue to generate power from its abundant domestic coal resources. This project will design an optimized combustion furnace to produce a low-cost, high-efficiency power plant that supports the U.S. Department of Energy's (DOE) goal of developing advanced combustion systems that have the potential to control CO_2 through an integrated power system that produces a concentrated CO_2 stream for subsequent use or sequestration. Specifically, this work will evaluate the technical viability and economic competitiveness of an oxygen-enriched, pulverized coal (PC) fired boiler system with CO_2 sequestration. When oxygen is used in place of air as the combustion medium, the flue gas has a high concentration of CO_2, making recovery of CO_2 for sequestration much more economic.

Primary Project Goal

The primary goal of this project is to develop a conceptual PC-fired powerplant, using oxygen as the combustion medium to facilitate the capture of CO_2 for subsequent sequestration.



CONTACTS

Sean Plasynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236
412-386-4867
sean.plasynski@netl.doe.gov

Timothy Fout
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-1341
timothy.fout@netl.doe.gov

Andrew Seltzer
Foster Wheeler Development Corporation
12 Peachtree Hill Road
Livingston, NJ 07039
973-535-2542
andrew_seltzer@fwc.com

PARTNER

Foster Wheeler Development Corporation

COST

Total Project Value

$406,482

DOE/Non-DOE Share

$325,186 / $81,296

ADDRESS

National Energy Technology Laboratory

1450 Queen Avenue SW
Albany, OR 97321-2198
541-967-5892

2175 University Avenue South
Suite 201
Fairbanks, AK 99709
907-452-2559

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

One West Third Street, Suite 1400
Tulsa, OK 74103-3519
918-699-2000

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Objectives

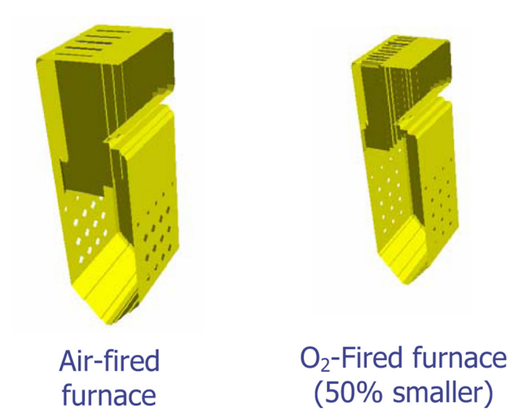
- Conduct a literature review to evaluate previous work in this area.
- Develop process modeling simulations for a conceptual design for an oxygen-enriched, PC-fired boiler with CO_2 capture.
- Develop a conceptual power plant design.
- Estimate costs for this conceptual power plant.
- Predict power plant performance and emissions and compare the overall cost of electricity of the conceptual power plant to a conventional PC-fired power plant (460 MW_e subcritical, natural circulation boiler firing high-volatile bituminous coal to produce 2,400 psig steam at 1,050 ºF and reheat steam at 1,050 ºF).

Accomplishments

All project objectives have been achieved. The entire cycle has been modeled in Aspen-Plus, including mills, air heater, furnace, heat recovery banks, feed water heaters, and steam turbines. Parametric runs have been made to evaluate the effect of operating variables on furnace performance. These studies have led to several conclusions. A higher flame temperature results in a more compact furnace and less gas recycle (limited by maximum furnace wall temperature) and to a higher cycle efficiency due to greater boiler efficiency. Estimates indicate that the parasitic power requirement for CO_2 capture is considerably lower than for a conventional plant and is comparable to that for an integrated gasification combined cycle (IGCC) system. Similarly, efficiency loss due to CO_2 capture is lower than for a conventional plant and comparable to an IGCC system.

Benefits

This project resulted in a conceptual design of a process that is competitive with IGCC in terms of cost of electricity and CO_2 mitigation cost when carbon dioxide is being captured. The best case is under higher capacity factors (around 85%). A substantially reduced furnace size leads to cost benefits, and a simple plant design means high reliability. The new plant uses proven steam plant technology. New air separation techniques could significantly improve economics.



Spatial comparison of an air-fired furnace versus an oxygen-fired furnace.