the ENERGY lab

PROJECT FACTS

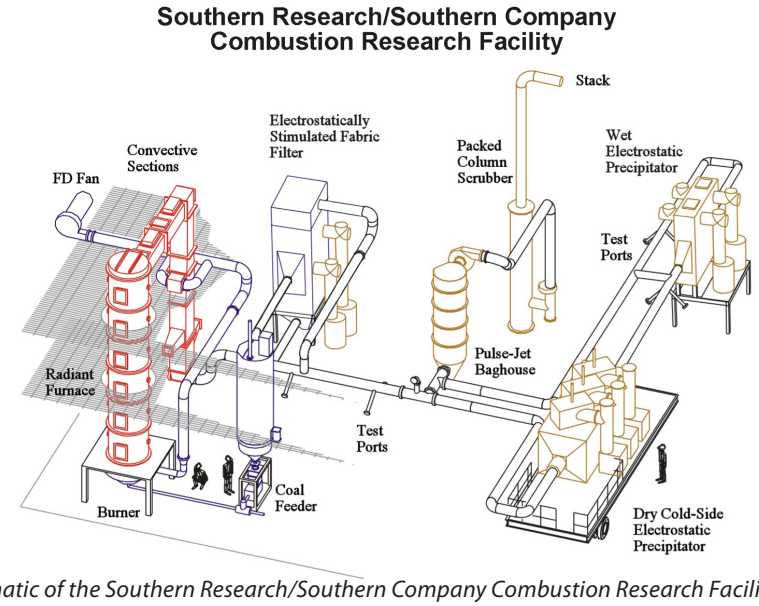
Existing Plants, Emissions & Capture

Oxygen-Fired CO_2 Recycle for Application to Direct CO_2 Capture from Coal-Fired Power Plants

Background

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

Oxy-combustion is a promising near-term technology for CO_2 capture and sequestration from pulverized coal (PC) power plants. Oxy-combustion uses oxygen, with a purity of 95 to 99 percent, to combust coal and produce a highly-concentrated CO_2 stream. The CO_2 is separated from water vapor by condensing the water through cooling and compression. Further treatment of the flue gas may be needed to remove pollutants and non-condensed gases (such as nitrogen) prior to CO_2 storage.



Schematic of the Southern Research/Southern Company Combustion Research Facility

CONTACTS

Jared P. Ciferno
Technology Manager
Existing Plants, Emissions & Capture
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-5862
jared.ciferno@netl.doe.gov

Timothy Fout
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-1341
timothy.fout@netl.doe.gov

Thomas Gale
Principal Investigator
Southern Research Institute
2000 Ninth Avenue South
Birmingham, AL 35205
205-581-2102
gale@sri.org

PERFORMANCE PERIOD

Start Date	End Date
09/27/2005	06/30/2010

COST

Total Project Value
$1,217,723

DOE/Non-DOE Share
$863,723 / $354,000

PARTNERS

Southern Research Institute
Linde Gas
MAXON Corporation
Reaction Engineering International
DTE Energy
Doosan Babcock
CORR Systems

Description

The cost of carbon capture in an oxy-combustion power plant should be lower than for a conventional air-fired PC plant as a result of the decreased flue gas volume and increased concentration of CO_2. However, the advantages of oxy-combustion are offset, to some extent, by the cost of providing high-purity oxygen. Additionally, the combustion of coal in pure oxygen could result in temperatures that are too high for existing boiler and turbine materials; therefore, part of the CO_2-rich flue gas must be recycled to the boiler to reduce the temperature in retrofit applications. Through this project, Southern Research Institute will explore the feasibility of retrofitting existing PC plants with oxy-combustion systems.

Primary Project Goal

The primary project goal is to thoroughly investigate, develop, optimize, and model oxy-combustion with CO_2 recycle to assess its feasibility for retrofit to existing PC-fired power plants. Oxygen-fired CO_2-recycle combustion will be extensively investigated in the semi-industrial-scale Combustion Research Facility (CRF), at Southern Research Institute, to develop a fundamental understanding of the effects of retrofitting this technology to existing air-blown coal-fired boilers, with a minimum capital expenditure. Specifically, it is intended that existing boilers, materials, and coal-feeding systems will be used.

Objectives

- Modify the pilot-scale CRF to allow oxygen-fired and CO_2-recycle operations.
- Collect data on furnace temperatures, unburned carbon, gas composition, and flow rates into and out of the furnace.
- Evaluate the effect of various parameters, including firing configuration, oxygen purity, CO_2 recycle rate, oxygen concentration, and coal type.
- Design, manufacture, and install an oxy-combustion burner specifically for the CRF.

Benefits

A number of studies have shown that recovering CO_2 from the flue gas at a PC-fired boiler will significantly increase the cost of electricity (COE). The main reasons are that the volume of gas is very large and the concentration of CO_2 is low, typically less than 15 percent. Commercially available absorption processes, such as amine-based systems, require large vessels and consume considerable parasitic power. Development of oxy-combustion will minimize the volume of flue gas produced and increase the CO_2 concentration, thereby significantly reducing CO_2 capture cost relative to commercially available CO_2 absorption processes. Retro-fitting oxy-combustion at existing PC power plants also will enable CO_2 capture goals to be met at a lower capital investment than would be required to construct new facilities.

Accomplishments

- The design of facility modifications and additions was completed.
- Oxygen mixing and control systems have been developed.
- Design of the flue gas recycle system, the control system, and the system integration was completed.
- Installation of heat transfer area to reduce moisture in the recycled flue gas was initiated.
- A cooling tower for the heat exchanger and scrubber cooler was put in place.

Planned Activities

- Conduct flue gas recycle, oxy-combustion experiments on various coals in the CRF facility.
- Adjust the existing CRF computational fluid dynamics model to incorporate flue gas recycle and oxygen-firing.