PROJECT facts

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

Carbon Sequestration

04/2008

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

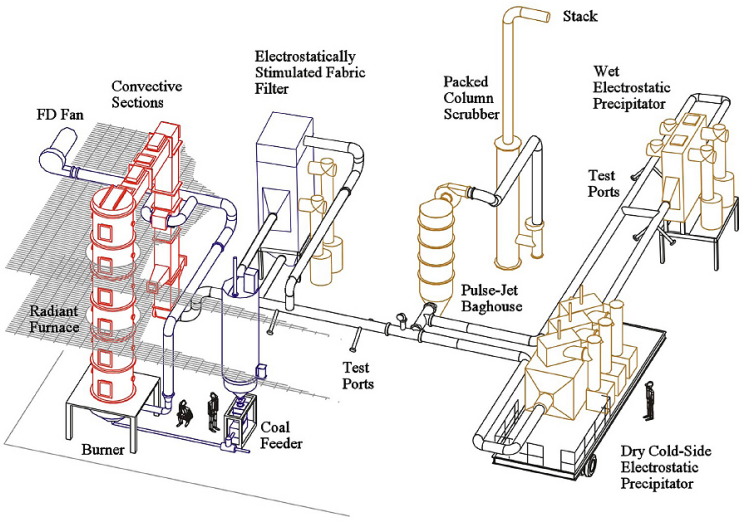
Background

Concern continues to mount over greenhouse gas emissions and their role in global climate change; and, if we are to continue burning coal, our most abundant fossil fuel, it is necessary to develop coal combustion technologies that can limit carbon dioxide (CO_2) emissions to the atmosphere. Oxycombustion is an emerging technology that has the potential to allow for control of CO_2 emissions at a lower cost than a conventional air-fired pulverized-coal (PC) power plant.

Description

Oxycombustion involves replacing air with pure oxygen in a PC boiler. The use of oxygen results in a lower volume of flue gas with a much higher concentration of CO_2 (greater than 60 percent by volume). 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.

However, the advantages of oxycombustion are offset, to some extent, by the cost of providing high-purity oxygen (95 to 99 percent assumed in most current designs). In addition, combusting coal in pure oxygen results in temperatures that are too high for existing boiler and turbine materials; therefore, part of the CO_2-rich flue gas



Schematic of the Southern Research/Southern Company Combustion Research Facility

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PERFORMANCE PERIOD

09/27/2005 to 09/26/2008

COST

Total Project Value
$1,079,654

DOE/Non-DOE Share
$863,723 / $215,931

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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 oxycombustion systems.

Primary Project Goal

The primary project goal is to thoroughly investigate, develop, optimize, and model oxycombustion and CO_2 recycle to assess its feasibility for retrofit to existing PC-fired power plants.

Objectives

- Modify the pilot-scale Combustion Research Facility (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 oxycombustion 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 oxycombustion 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. Retrofitting oxycombustion 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 is complete.
- The oxygen pad site has been determined.
- Oxygen mixing and control systems have been developed.

Planned Activities

- Construction of the flue gas recycle loop is expected to begin in FY 2008.
- Conduct flue gas recycle, oxycombustion experiments on various coals in the CRF facility.
- Adjust the existing CRF computational fluid dynamics model to incorporate flue gas recycle and oxygen-firing.