PROJECT facts

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

Combustion Technologies

2/2006

ADVANCED, LOW/ZERO EMISSION BOILER DESIGN AND OPERATION

Background

Over the past years, environmental concerns regarding pollutants have grown dramatically. Current annual greenhouse gas (GHG) emissions are 12% higher than they were in 1992. In addition, carbon dioxide (CO_2) emissions are projected to increase by an additional 34% over the next 20 years. About one third of carbon emissions in the United States come from power plants, and coal-fired power plants are the largest single point emitters of greenhouse gases. Coal is our most abundant fossil fuel source with an estimated supply for the next 250 years, and as the demand for energy increases, coal will continue to be the prime source for electricity generation. Therefore, deployment of new and retrofit technologies to capture and sequester CO_2 in the power generation industry to meet future environmental regulations while using an abundant and low-cost fuel source is the preferred choice for electricity production.

Oxy-combustion Technology

The traditional pollutant-control method for coal-fired units involves a post-combustion flue gas treatment system comprising many treatment devices for each regulated pollutant. This approach is very expensive and designed to control one specific pollutant, requiring additional devices and expense each time a new pollutant is identified.

The oxy-combustion technology development initiative provides alternatives: (1) To develop a retrofit technology applicable to existing boilers, a portion of the flue-gas is recycled thus replacing the combustion air with CO_2 and O_2 mixtures and keeping the boiler characteristics and dimensions the same as the air-fired base-case; and (2) For new plants, the volume of flue gas recirculation would be set to a minimum value enabling a more compact boiler design and resulting in significant reductions in boiler costs (see Figures 1 and 2).

O_2-CO_2 combustion replaces the nitrogen of the air by CO_2 and maintains a temperature compatible with the operating temperature limits of today's materials, and is also compatible with today's boiler and burner designs.

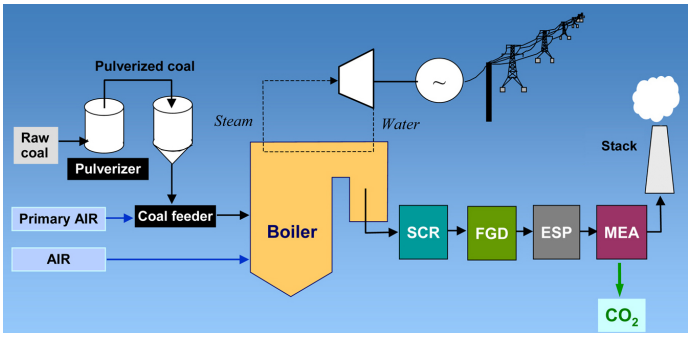

Figure 1: Boiler Schematic with Flue Gas Post-Treatment—Existing Air-fired Operation

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PARTNERS

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PROJECT DURATION

9/30/02 – 12/31/04

COST

Total Project Value
$1,035,287

DOE/Non-DOE Share
$785,287 / $250,000

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

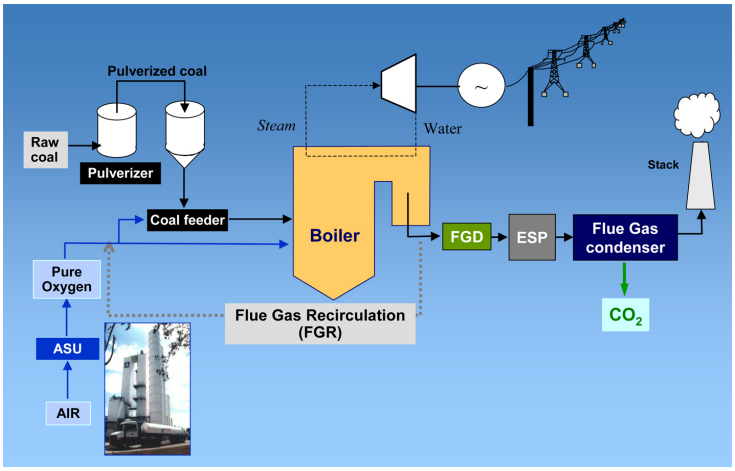

Figure 2: Boiler Schematic with Flue Gas Post-Treatment—Oxygen-fired Operation using Flue-gas Recirculation

Project Goals

The primary goal is to evaluate and optimize a multi-pollutant control approach that produces a CO_2-rich flue gas stream for subsequent use or sequestration. Results and information from these evaluations would then be used for retrofit applications or in a preliminary design of a new-generation, oxy-fired with flue gas recycle, coal-based boiler.

Project Objectives

- Demonstrate the feasibility of the oxycombustion technology with flue gas recirculation on Babcock & Wilcox's 1.5MWth coal-fired pilot boiler;
- Measure its performances in terms of emissions and boiler efficiency while selecting the right oxygen injection and flue gas recycle strategies; and
- Perform an economics analysis, comparing carbon capture via O_2-CO_2-fired power plants with alternate technologies.
- Perform engineering study to investigate the technical and financial requirements for converting a 25MWe existing air-fired pulverized-coal boiler into an Oxy-coal fired system.
- Perform process simulations and cost estimates on new 550MWe net PC power plants, equipped with a super and ultra super critical units.

Accomplishments

- The oxycombustion technology with flue gas recycling has been successfully demonstrated;
- NO_x emissions from oxycombustion were significantly lower (70%) than the air-fired case;
- The CO_2 content in flue gas of 15% in air-fired conditions has been increased to 80% in O_2-fired conditions;
- The flue gas volume exiting the boiler has been reduced by 70%, making any necessary flue gas treatments easier;
- The oxycombustion technology has electricity costs that are about 20% lower than conventional technology with CO_2-capture by amine scrubber; and
- Preliminary process economic calculations indicate that the cost of CO_2 avoided using oxycombustion technology is significantly lower than if amines are used for CO_2 capture in air-fired unit.