the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Jupiter Oxy-combustion and Integrated Pollutant Removal for the Existing Coal Fired Power Generation Fleet

Background

The mission of the U.S. Department of Energy/National Energy Technology Laboratory (DOE/NETL) Existing Plants, Emissions & Capture (EPEC) Research & Development (R&D) Program is to develop innovative environmental control technologies to enable full use of the nation's vast coal reserves, while at the same time allowing the current fleet of coal-fired power plants to comply with existing and emerging environmental regulations. The EPEC R&D Program portfolio of carbon dioxide (CO_2) emissions control technologies and CO_2 compression 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 coal-fired 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 prior to CO_2 storage.

Project Description

Jupiter Oxygen Corporation (Jupiter) will design, construct, and operate a 15 megawatt thermal (MWth)—5 megawatt electric (MWe) equivalent—pilot test facility in Hammond, IN, to demonstrate both Jupiter's high flame temperature oxy-combustion technology and NETL's Integrated Pollution Removal (IPR™) technology. This facility will test a 40 MMBtu/hr (million British thermal units per hour) oxy-coal burner that replicates the actual burner size needed for a 20 MWe retrofit in an operating utility coal boiler. Jupiter's oxy-combustion technology operates with a high-temperature flame and minimal flue gas recycle for improved heat transfer and boiler efficiency. A slipstream of the flue gas from the oxy-combustion test facility will be used to operate a bench-scale prototype of the IPR unit, which is designed to remove essentially all conventional emissions such as particulates, sulfur oxides (SO_x), nitrogen oxides (NO_x), and mercury, while also capturing CO_2 in a form that is suitable for transport and geologic sequestration.

These combined technologies can be retrofit to existing power plants as well as incorporated into the designs for new plants to facilitate fully carbon-capture-ready power plants that are completely compliant with NO_x, SO_x, mercury, and particulate regulatory requirements. Capture of greater than 95 percent of CO_2 and greater than 99 percent

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PERFORMANCE PERIOD

Start Date	End Date
10/01/2006	09/30/2012

COST

Total Project Value
$8,159,185

DOE/Non-DOE Share
$6,519,516 / $1,639,669

AWARD NUMBER

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U.S. DEPARTMENT OF ENERGY

of NO_x, SO_x, and particulates, as well as greater than 90 percent of mercury, is feasible. Data collected on boiler efficiency, heat transfer, flame and burner characteristics, materials performance, and flue gas characteristics will be used by Jupiter to refine their approach and by NETL to supplement their development of future computer modeling tools for oxy-combustion systems. This innovative approach in the field of carbon capture study will significantly add to the current knowledge base. The size of the test facility and burner capacities will accelerate technology development so that large-scale demonstrations, and ultimately commercialization, can be realized for both new and retrofit power plants in the near future.

Hammond, Indiana 15 MWth Test Facility

Primary Project Goal

The primary project goal is to test a full-size oxy-coal burner in a pilot-scale boiler facility in order to acquire reliable operating data on Jupiter's high flame temperature oxy-combustion technology and NETL's IPR technology to produce sequestration-ready CO_2.

Objectives

The project objectives are to design, construct, and operate a 5 MWe pilot-scale burner test facility and a 20 kWe IPR bench-scale unit; test fire the 40 MMBtu/hr oxy-coal burner and evaluate the resulting flame stability, heat transfer, fouling/slagging characteristics, and flue gas emissions in an atmosphere representative of a commercially installed oxy-coal combustion system; and utilize a slipstream from the burner test facility to treat 100 to 140 lb/hr flue gas to quantify the IPR process variables.

Planned Activities

- Perform parametric studies and operate the facility at steady-state optimum oxy-coal combustion conditions for three weeks of continuous 24-hour-per-day operation.
- Demonstrate that the single oxy-coal burner, firing at its design rate of 40 MMBtu/hr, maintains a stable flame and NO_x levels no higher than 0.15 lbs/MMBtu prior to the IPR.
- Demonstrate that the combination of oxy-coal combustion and the IPR process can produce CO_2 that meets the specifications for deep saline aquifer sequestration and/or enhanced oil recovery.
- Evaluate the retrofit impact of oxy-coal combustion and the IPR process on the balance-of-plant issues, including flame stability, steam generation, unburned carbon levels, tube wastage, slagging and fouling, recycle duct and boiler corrosion, pollutant emissions, and discharge streams, including by-products and parasitic energy requirements.
- Generate the necessary technical data—including equipment requirements for the boiler island, flue gas purification, and CO_2 compression—required as inputs into a systems analysis to demonstrate that the technologies are viable for technical and economic scale-up, either in combination or individually with generic counterparts.

Accomplishments

- Developed preliminary test plan.
- Completed installation of oxy-combustion and IPR equipment at the Hammond pilot plant.
- Operated the 5 MWe-equivalent oxy-coal combustion test facility and ancillary systems, including the IPR unit.
- Performed a series of oxy-coal burner development tests, which resulted in a modified first-generation burner.
- Performed parametric studies with the modified first-generation oxy-coal burner, which led to development of a second-generation burner, currently in fabrication.

Benefits

The operation of this testing facility will provide developmental engineering and design data for the research retrofit of future coal-fired power plants to advance the creation of a virtually zero emissions power plant for NO_x, SO_x, particulates, and mercury, as well as one that is capture-ready for CO_2 sequestration. This work will result in the development of both equipment and process specifications for scale-up of the two technologies.