the ENERGY lab

PROJECT FACTS

Advanced Combustion Systems

Oxy-fired Pressurized Fluidized Bed Combustor Development and Scale-up for New and Retrofit Coal-fired Power Plants

Background

The Advanced Combustion Systems (ACS) Program of the U.S. Department of Energy/ National Energy Technology Laboratory (DOE/NETL) is aiming to develop advanced oxy-combustion systems that have the potential to improve the efficiency and environmental impact of coal-based power generation systems. Currently available carbon dioxide (CO_2) capture and storage technologies significantly reduce the efficiency of the power cycle. The ACS Program is focused on developing advanced oxy-combustion systems capable of achieving power plant efficiencies approaching those of air-fired systems without CO_2 capture. Additionally, the program looks to accomplish this while maintaining near zero emissions of other flue gas pollutants.

Oxy-combustion systems use high purity oxygen to combust coal and produce a highly concentrated CO_2 stream that can be more easily separated out of the flue gas. First generation oxy-combustion systems utilize oxygen from a cryogenic air separation unit integrated with a boiler system that represents current state-of-the-art air-fired boiler design. These first generation oxy-combustion systems have demonstrated technology viability; however, further research is needed to develop advanced oxy-combustion systems that meet the DOE carbon capture goals.

Oxy-combustion system performance can be improved either by lowering the cost of oxygen supplied to the system or by increasing the overall system efficiency. NETL targets both of these possible improvements through sponsored cost-shared research into pressurized oxy-combustion and chemical looping combustion (CLC). Through the two-phase Advanced Oxy-combustion Technology Development and Scale-up for New and Existing Coal-fired Power Plants Funding Opportunity Announcement, eight projects were recently chosen to begin Phase I. Under the 12 month Phase I effort, validation of the proposed pressurized oxy-combustion or CLC process will be accomplished through engineering system and economic analyses. Phase I projects will be eligible to apply for Phase II awards to develop and test the novel process components at the laboratory or bench scale.

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PARTNERS

Linde, LLC
Electric Power Research Institute
Pennsylvania State University
Jamestown Board of Public Utilities

PERFORMANCE PERIOD

Start Date	End Date
10/01/2012	09/30/2013

COST

Total Project Value
$1,267,070

DOE/Non-DOE Share
$1,000,000/$267,070

AWARD NUMBER

DE-FE0009448

U.S. DEPARTMENT OF ENERGY

Project Description

Pratt & Whitney Rocketdyne (PWR), together with Linde, LLC, Electric Power Research Institute, Pennsylvania State University, and Jamestown Board of Public Utilities, will validate a novel process for pressurized oxy-combustion in a fluidized bed reactor following NETL's engineering system and economic analysis guidelines. The innovative Oxygen-fired Pressurized Fluidized Bed Combustor (Oxy-PFBC) technology enables the production of electricity from coal with zero emissions, while the captured CO_2 can be stored in suitable geologic repositories. This technology has the potential to achieve 33 percent overall plant efficiency and 98 percent CO_2 capture with only a 30 percent increase in the cost of electricity (COE) when compared to a supercritical steam, pulverized coal plant without CO_2 capture.

The economic advantages of the Oxy-PFBC include higher efficiency that reduces fuel consumption and operating cost; higher pressure and efficiency that result in smaller equipment and lower capital cost; and bulk SO_2 removal by limestone and minimal NO_x formation that reduces emission control equipment costs. In Phase I, the proposed Oxy-PFBC design will be refined and the system matured to further reduce the COE while maintaining high efficiency. Technology gaps will be identified and mitigation plans developed to close these gaps.

Primary Project Goal

The primary project goal is to validate the Oxy-PFBC technology's ability to exceed the DOE/NETL carbon capture goal of achieving greater than 90 percent CO_2 removal with no more than a 35 percent increase in COE.

Objectives

The Phase I objectives are to confirm the technical performance and economic potential of the Oxy-PFBC system using standardized NETL guidelines and to identify technology gaps that need to be resolved to scale up the technology for field testing.

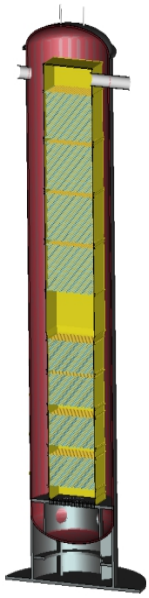

Diagram of an oxygen-fired pressurized fluidized bed combustor

Planned Activities

- Development of a design basis document that describes the approach to perform the system study, including definition of the cases to be studied and the assumptions to be made for process and economic performance analyses. Two cases are included in the baseline: a 550 megawatt electric (MWe) new supercritical steam plant and a plant retrofit at a minimum of 275 MWe.
- Perform systems and process engineering to determine process performance. System performance analyses will be completed using the Aspen Plus® process simulator for cases identified in the design basis document.
- Perform systems and process engineering to determine the process economics. An economic performance analysis will be completed following NETL requirements.
- Identify technology gaps by completing an analysis of the current state of development of all major/critical process components for the Oxy-Fired PFBC system.
- For each technology gap, identify the research required to fully develop the technology to commercialization.

Accomplishments

- Project awarded in September 2012.

Benefits

The Oxy-PFBC technology has the potential to exceed the DOE/NETL objectives of developing advanced oxy-combustion CO_2 capture technologies for new-build and retrofit commercial coal-fired plants capable of 90 percent carbon capture, near zero air emissions, zero liquid discharge, and reduced water consumption with less than 35 percent increase in COE over air-fired power plants without carbon capture.