PROJECT facts

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

Carbon Sequestration

08/2007

OTM-BASED OXYCOMBUSTION FOR CO_2 CAPTURE FROM COAL POWER PLANTS

CONTACTS

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Background

Oxycombustion, or burning fuel in oxygen to generate flue gas consisting of primarily CO_2 and H_2O, is established as a credible means to facilitate CO_2 capture from coal power plants. The economics of conventional oxycombustion processes are currently limited by the parasitic power that is required for cryogenic oxygen production in conventional air separation units (ASU). A further limitation of oxycombustion is the requirement that a portion of the CO_2 in the exhaust must be cooled and recycled in order to maintain the temperature in the combustion chamber within practical limits. Praxair has developed novel OTM technology that has the potential to solve both of these issues. OTMs can be integrated such that there is minimal need for air compression and the parasitic power consumption required for oxygen production is reduced by 70-80% as compared to cryogenic ASU.

Under a prior agreement with the DOE, Praxair determined that the cost of CO_2 avoided from advanced boilers that use the integration of air separation from OTMs and oxyfuel combustion is competitive with other CO_2 capture processes when applied to large power plants. This work also demonstrated that durable oxygen transport membranes for oxyfuel combustion can be fabricated to survive and maintain reliability in a fuel environment. During the prior testing Praxair observed a zero percent failure rate for the OTM membranes being tested. However, the highly durable materials selected for the OTM reactors will require substantial development in order to improve oxygen flux through the OTM system, while maintaining durability, and reducing manufacturing costs.

Description

The basic principle behind the OTM oxycombustion system is the use of chemical potential for the oxygen separation driving force instead of pressure. In conceptual designs, the OTM is integrated directly with the boiler. The combustion reaction on the fuel side of the membrane creates a very low oxygen partial pressure compared to the air side of the membrane. This chemical potential difference drives oxygen through the membrane without the need for additional air compression.

PARTNERS

Praxair, Inc.
University of Utah

COST

Total Project Value
$8,358,445

DOE/Non-DOE Share
$5,432,989 / $2,925,456

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Objectives

Phase I Objectives:

- Increase oxygen flux of OTMs to commercial targets while maintaining the current levels of strength and reliability.
- Develop and down-select an optimum process integration cycle for OTM coal- based power system with CO_2 capture.
- Test the effects of coal and flue gas impurities on the performance of OTMs.

Phase II Objectives:

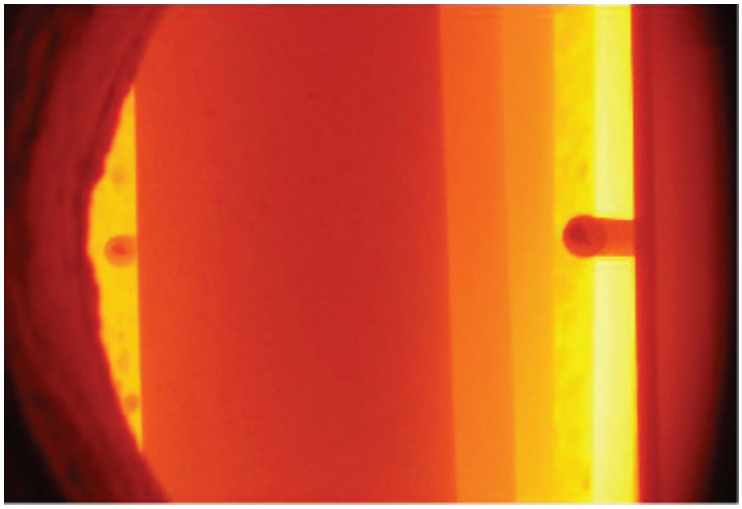
- Demonstrate ability to produce OTM tubes with appropriate dimensions and manufacturing yield required to proceed with pilot demonstration.
- Deliver preliminary engineering design for OTM pilot plant system.

Benefits

An OTM-based coal fired power process will help attain the Carbon Sequestration program goals by providing a highly concentrated, sequestration-ready stream of CO_2 without costly separation and cryogenic oxygen production.

Planned Activities

- Design, construct, and operate bench-scale OTM-coal reactor at the University of Utah for the evaluation of OTM performance in a coal-based power system.
- Conduct OTM manufacturing process development at Praxair OTM pilot manufacturing facility in Indianapolis, IA.
- Evaluate OTM performance improvements in single and multi-tube OTM reactors at Praxair research facilities in Tonawanda, NY.



OTM tubes during combustion testing in multi-tube reactor.