the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

# OTM-Based Oxy-Combustion for $CO_2$ Capture from Coal Power Plants

## Background

Oxy-combustion, or burning fuel in oxygen to generate flue gas consisting of primarily carbon dioxide ($CO_2$) and water ($H_2O$), is established as a credible means to facilitate $CO_2$ capture from coal power plants. The economics of conventional oxy-combustion 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 oxy-combustion 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 a novel oxygen transport membrane (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.

The basic principle behind the OTM oxy-combustion 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.

## Description

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 oxy-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 oxy-combustion can be fabricated to survive and maintain reliability in a fuel environment. During 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.

The objectives of this project are to develop an optimum process configuration for integrating OTMs in a power generation process, and to advance and prepare OTM technology for pilot-scale field testing.

## CONTACTS


**Jared P. Ciferno**
Technology Manager
Existing Plants, Emissions & Capture
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-5862
jared.ciferno@netl.doe.gov

**Timothy Fout**
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-1341
timothy.fout@netl.doe.gov

**Maxwell Christie**
Principal Investigator
Praxair, Inc.
175 East Park Dr.
P.O. Box 44
Tonawanda, NY 14151-0044
716-879-7739
max_christie@praxair.com


## PERFORMANCE PERIOD

**Start Date**
04/01/2007

**End Date**
06/30/2010

## COST

**Total Project Value**
$9,520,466

**DOE/Non-DOE Share**
$5,638,544 / $3,332,163

## PARTNERS

Praxair, Inc.
University of Utah
ENrG Inc.


NATIONAL ENERGY TECHNOLOGY LABORATORY

Albany, OR • Fairbanks, AK • Morgantown, WV • Pittsburgh, PA • Houston, TX

**Website: www.netl.doe.gov**

**Customer Service: 1-800-553-7681**

U.S. DEPARTMENT OF ENERGY

## 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

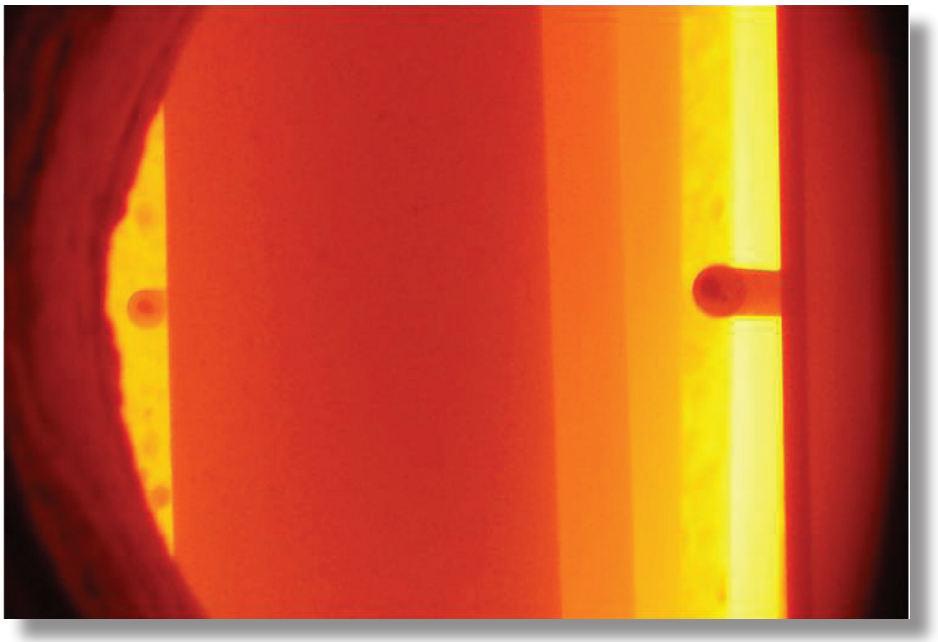
An OTM-based coal-fired power process will help attain the Existing Plants, Emissions, & Capture program goals by providing a highly concentrated, sequestration-ready stream of $CO_2$ without costly separation and cryogenic oxygen production.

## 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, IN.
- Evaluate OTM performance improvements in single and multi-tube OTM reactors at Praxair research facilities in Tonawanda, NY.

## Accomplishments

- Demonstrated stable OTM performance with sulfur impurities in simulated coal-derived fuel gas.
- Developed pilot plant specifications for OTM flux and fuel utilization.
- Demonstrated OTM combustion at target specification.
- Continued OTM performance improvement through characterization and manufacture of OTM tubes, and preparations for scale-up.
- Demonstrated significant progress toward achieving flux and performance targets for the OTM materials.
- Completed construction of the OTM multi-tube reactor at the University of Utah. Testing is currently underway.



*OTM tubes during combustion testing in multi-tube reactor.*