PROJECT facts

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

Gasification Technologies and Hydrogen & Syngas

5/2006

DEVELOPMENT OF MIXED-CONDUCTING DENSE CERAMIC MEMBRANES FOR HYDROGEN SEPARATION

CONTACTS

Gary J. Stiegel
Gasification Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236
412-386-4499
gary.stiegel@netl.doe.gov

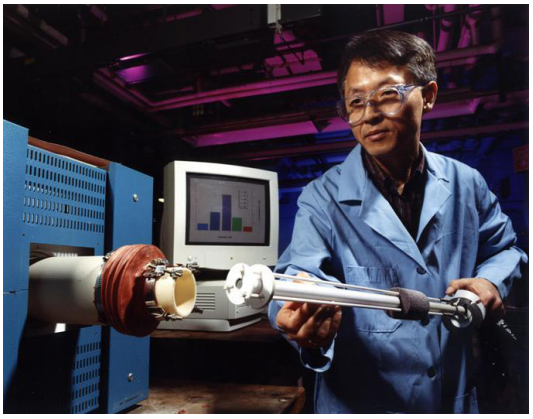
John Winslow
Hydrogen & Syngas Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236
412-386-6072
john.winslow@netl.doe.gov

Richard J. Dunst
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236
412-386-6694
richard.dunst@netl.doe.gov

Description

The development of cost-effective membrane-based reactor and separation technologies is of considerable interest for advanced coal-based power and fuel production technology applications. Specifically, the development of mixed conducting dense ceramic membranes is critical to transitioning to hydrogen-based energy. In the long term, hydrogen is anticipated to be the fuel of choice for both power and transportation industries. For a hydrogen-based energy structure, fossil-fuel based technologies will be required to generate hydrogen for various uses including energy production and value-added commercial products. A cost-effective hydrogen separation technology is integral to successful fossil-based hydrogen production technologies. Thin, dense ceramic membranes fabricated from mixed protonic and electronic conductors may provide a simple, efficient means for separating hydrogen from fossil-based gas streams.

Dense ceramic membranes will be developed to separate hydrogen in a non-galvanic mode from hydrogen-containing gaseous mixtures such as products from coal gasification, natural gas partial oxidation, and water gas shift reaction. These membranes will consist of either dual-phase ceramic/metal composites or monolithic mixed protonic and electronic conductors. The work involves identifying and evaluating materials with suitable hydrogen permeability and the development of methods for fabricating thin, dense membranes. Chemical, mechanical, and thermal stabilities of these materials will be studied.



A researcher preparing the membrane for a test.

CONTACTS (cont.)

U. Balachandran
Principal Investigator
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
630-252-4250
balu@anl.gov

PARTNER

Argonne National Laboratory

COST

Total Project Value
$4,040,000

DOE/Non-DOE Share
$4,040,000 / $0

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Primary Project Goal

The primary goal of this project is to develop thin and dense ceramic membranes fabricated from mixed protonic and electronic conductors to provide a simple and cost-effective means for separating hydrogen from coal gasification and other partial-oxidation-product streams.

Accomplishments

- Tested ceramic membranes sealed to metallic tubing under high pressure to evaluate the integrity of the seals.
- Evaluated mechanical properties of the membranes before and after exposure to hydrogen-containing gas mixtures.
- Fabricated and sealed thin membranes to tubes or other appropriate fixtures for testing and test hydrogen flux.
- Selected a membrane composition and initiated tests for membrane efficiency in separating hydrogen from simulated coal gas streams.
- A hydrogen-selective membrane developed as part of this project was selected by an independent judging panel and the editors of R&D Magazine as one of the 100 most technologically significant products introduced into the marketplace in 2004.

Benefits

Cost-effective ceramic membrane technology will benefit hydrogen-based power production and transportation where pure hydrogen is needed to power solid oxide fuel cells. The use of a ceramic membrane to separate hydrogen from a shifted syngas stream will also produce a higher concentrated CO_2 steam which is beneficial for sequestration. Previous studies have shown that ceramic membrane technology has the potential to increase hydrogen production by 32 percent and increase carbon capture by 13 percent over conventional pressure swing adsorption technology.