the ENERGY lab

PROJECT FACTS

Fuels

Engineering Design of Advanced Hydrogen-Carbon Dioxide Palladium and Palladium/Alloy Composite Membrane Separations and Process Intensification

Background

Technologies for pre-combustion carbon dioxide (CO_2) capture and economical hydrogen (H_2) production will contribute to the development of a stable and sustainable U.S. energy sector. The integrated gasification combined cycle (IGCC) process can be used to co-produce synthesis gas (syngas), electricity, hydrogen, fuels, and chemicals from coal and coal/biomass-mixtures in an environmentally responsible manner. The production of H_2 via the water-gas shift (WGS) reaction is a key part of this process. Hydrogen of various levels of purity can be produced from the IGCC process. The application of H_2 separation technology can facilitate the production of high-purity H_2 from IGCC as well as allowing for process intensification—combining H_2 generation, conversion enhancement, and separation in one unit. In addition, CO_2 produced from a WGS membrane reactor is under high pressure, suitable for sequestration or use in an enhanced oil recovery process.

The National Energy Technology Laboratory (NETL) is partnering with Worcester Polytechnic Institute (WPI) to develop a new form of composite membrane separation and process intensification for WGS reactors. This project is a follow-up effort to Composite Palladium and Palladium-Alloy Porous Stainless Steel Membranes for Hydrogen Production and Process Intensification, an earlier NETL-sponsored investigation by WPI, to further advance the novel technology.

Project Description

The project team will develop an integrated, cost-effective H_2 production and separation process that employs WPI palladium (Pd) and Pd-alloy membranes for use in WGS reactors. WPI will perform research and development leading to the demonstration of this process by constructing a system to produce a minimum of two pounds per day of H_2 at the pre-engineering/pilot scale. The team will develop strategies that effectively separate H_2 from coal (or coal-biomass)-derived syngas, meeting Department of Energy (DOE) 2015 performance targets for flux, selectivity, cost, and chemical and mechanical robustness.

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PARTNERS

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PROJECT DURATION

Start Date
10/1/2010

End Date
6/30/2012

COST

Total Project Value
$2,506,594

Goals and Objectives

The primary objective of this project is to carry out a comprehensive engineering design for advanced hydrogen-carbon dioxide (H_2-CO_2) Pd and Pd-alloy composite membrane separations with process intensification technologies that reduce the number of unit operations required for H_2 production from syngas derived from coal or coal-biomass.

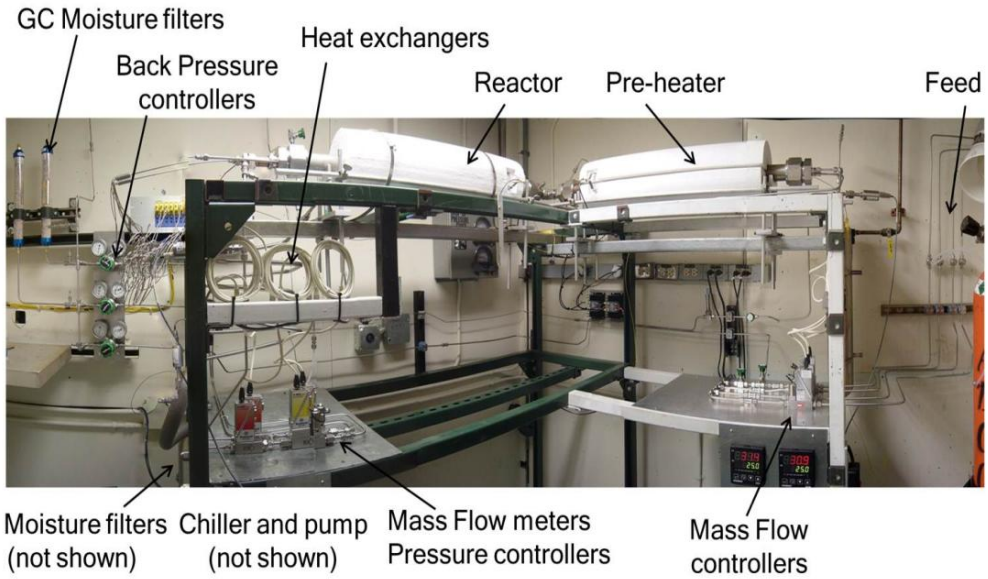
Pre-engineering/pilot scale membranes with membrane area (~ 780 cm2; 1" OD, 10" Long) sufficient to produce > 2 lb H_2 per day

Accomplishments

The research team has initiated synthesis of the pilot-scale membrane tube. The team has developed and is refining the process and instrumentation design (P&ID). The team submitted membrane coupon samples for testing in an actual gasifier stream in Wilsonville, AL. The coupons were tested for over 1,000 hours in a high-H_2S environment. The team submitted a second series of coupons to be tested in a low-H_2S stream for over 1,000 hours. Based upon characterization results of the coupon samples, a testing unit has been designed, fabricated and installed at the Wilsonville facility to test the membranes' ability to produce a minimum of two pounds H_2 per day under actual gasifier streams.

Benefit

This process intensification framework will lower the cost of fossil energy production by reducing the production of pure H_2 from syngas to a single unit operation consisting of a composite Pd or Pd-alloy water-gas shift membrane reactor, which could be integrated downstream in a H_2-producing, IGCC system. This work will help decrease our nation's dependence on imported fuels for the production of energy, fuels, chemicals, and H_2.



Setup for testing pre-engineering/pilot scale membranes