High-Performance, Durable, Palladium-Alloy Membrane for Hydrogen Separation and Purification

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This presentation does not contain any proprietary or confidential information
### Overview

#### Timeline
- April, 2005 start date
- April, 2008 end date
- 20% complete

#### Budget
- $4 million Total
  - $2.4M DOE share
  - $1.6M Contractor share
- $85k funding rec’d FY05
- $255k anticipated FY06

#### 2005 Targets
- Flux = 100scfh/ft² @20 psi & 400°C
- System Cost = $1500/ft²
- Durability = 8760 hrs (1 year)

#### Partners
- Chevron Texaco
- Colorado School of Mines
- ORNL
Project objectives

• Apply an effective thermal diffusion barrier on a porous stainless steel tube, over which a defect free, dense palladium alloy membrane is applied.

• Obtain performance values equal to relevant hydrogen production and cost targets.

• Optimize copper/palladium ratios and furnace cycles to form alloys for best overall performance.
Approach

• Apply membranes by multiple methods, upon porous metal substrates with various diffusion barriers, and measure performance.

• Improve the surface roughness of the porous substrate/diffusion barrier composite

• Improve the permeance of the support tube without loss of collapse resistance
Technical Accomplishments/ Progress/Results

Permeance of composite
- Version #1 = 8-18 scfh/ft² @400°C/20 psi
- Version #2 = 45-118 scfh/ft² @400°C/20 psi
- Version #3 = 55-81 scfh/ft² @400°C/20 psi

Surface roughness
- Improved version #2 from Ra=73 u in to Ra=23 u in

Base tube permeance
- Improved version #3 by more than 50% while achieving sufficient collapse resistance

Separation factor
- Achieved 2005 target of 99.9% w/ single gas testing
Technical Accomplishments/ Progress/Results

Meeting 2005 permeance targets

Hydrogen Flux @ 400 °C Vs. Time for Pd Membrane, CSM-Pall-69, on Pall AccuSep Support

Hydrogen Flux (scfh/ft²) vs. Time (hrs)

- H₂ Flux at 40 psi
- H₂ Flux at 20 psi

70 min air purge
Future Work

• Continue making thinner membranes on smoother, more permeable substrates to achieve 2010 target performance.
• Evaluate methods to produce palladium copper alloys and evaluate vs. pure palladium.
• Chevron-Richmond will begin system testing using synthetic reformate streams.
• Evaluate 2 different methods to apply fittings to the composite tubes.
Planned Cross section of composite structure

- Palladium alloy membrane
- Diffusion barrier (Red)
- Porous Stainless Steel
Porous metal

Diffusion barrier

Palladium membrane