

Low Cost Hydrogen for Next Generation Vehicles

Grant Information

Grant No: DM0422223

SBIR Phase II

Topic: AM

Award date: 7/15/04

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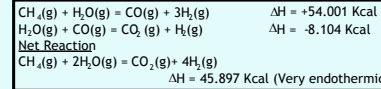
Introduction

- Fuel cell systems are being developed for cars and stationary applications
 - Of most interest is the Polymer Electrolyte Membrane (PEM) fuel cell.
- The PEM is a low temperature fuel cell
 - PEM's can start at room temperature,
 - Works best with high purity, bottled hydrogen (H₂)
 - H₂ is the "FreedomFUEL" for the "FreedomCAR"
 - Needed is a Filling Station to provide H₂ to the fleet of FreedomCARs.



Current Hydrogen Production

- The lowest cost source of hydrogen is steam reforming of natural gas (CH₄)



- Steam reforming plants use large Direct-fired chamber containing multiple rows of expensive high nickel alloy tubes to provide the heat for the endothermic reforming reaction

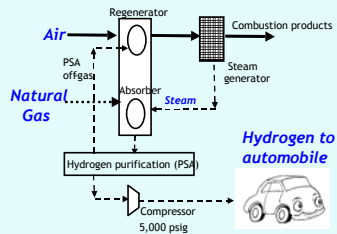


Steam reforming plant

Project Goals

- Overall goal:** Reduce the cost of hydrogen at small scale filling stations for cars and at large scale plants.
- Approach:** Minimize the capital cost and improve efficiency of steam reforming of natural gas to hydrogen.
- The key is to use a proven, regenerable, low cost carbon dioxide sorbent.
- The sorbent provides the heat for reforming and shifts the equilibrium of the reforming and shift reactions.

Low Cost Hydrogen System



- Significant cost saving because the large, expensive direct fired chamber is replaced with two low cost carbon steel (absorber and regenerator) beds.

Potential Applications

- Hydrogen production is one of the fastest growing business areas of the chemical industry.
- U.S. demand is growing more than 5% per year from a base of \$2 billion per year in merchant sales.
- Hydrogen powered vehicles and other applications of fuel cells will increase the demand by an order of magnitude.
- Because of the high cost to transport hydrogen, low capital cost technology is needed to make hydrogen economically at small scale filling stations for vehicles.

Hydrogen Cost Targets

- Reduction in hydrogen costs is critical to success of fuel cell based vehicles.
- Produce H₂ at \$10.50/MMBTU at filling stations. (Gasoline is \$14.75/MMBTU.)
- Produce H₂ at \$4.09/MMBTU at large plants. (Current large scale H₂ prices are \$5.54/MMBTU with natural gas at \$3.15/MMBTU.)
- The development of this technology will provide the essential low cost hydrogen distribution system necessary for the next generation fuel cell based vehicles.

Commercialization Activities

- TDA is teamed with Air Products the world's largest supplier of hydrogen.
- During Phase II Air Products is contributing its staff to assist with the engineering & cost analysis of the process.
- To facilitate commercialization, Norpro Saint-Gobain is manufacturing the sorbent by a standard industrial process during Phase II.

Technical Objectives

- Produce low cost carbon dioxide sorbent by commercial techniques.
- Demonstrate long cyclic lifetime and performance of sorbent.
- Design the small scale hydrogen generation system for a filling station based on the test data.

Commercialization Plans

- TDA will license the technology
- Air Products currently produces both large and small scale hydrogen systems
- With over \$1 billion dollars in hydrogen sales, annually Air Products, has the customers, technology and business rationale to scale up and introduce this technology.

Technical Results to Date

- TDA developed sorbent with high carbon dioxide loading and good attrition resistance
- Long cyclic lifetime demonstrated in small scale system
- Sorbent is being scaled up by Saint Gobain NorPro using commercial processes

For Additional Information

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