2004 DOE Hydrogen, Fuel Cells & Infrastructure Technologies

Program Review Presentation

Startech Hydrogen Production

STARTECH ENVIRONMENTAL CORP.

This presentation does not contain any proprietary or confidential information.

Objectives:

1. Field test integrated hydrogen production on a pilot scale using plasma gasification and ceramic membrane hydrogen separation.

2. Evaluate commercial viability and scalability through extended operation under representative conditions.

Budget

- $612,000 Total Current Funding.
- DOE Support = $490,000
- Contractor's Share = $122,000
- Award Expected July 2004.

Gasification Targets

3.1.2 Reduce Distributed Hydrogen Production Cost:

- Potential to meet or exceed distributed hydrogen production goal of $1.50 per kg H_2.
- Potential tipping fee income from waste feedstock eliminates feedstock cost and can pay for hydrogen production by itself.

3.1.5 This Program Advances work on the following Technical Tasks

- Task 1: Distributed Production Feedstock Options This test program will Utilize Scrap Plastic, Coal, and Surrogate Medical Waste as representative Gasification Feedstocks.
- Task 2: Low-Cost, Low Volume Distributed Production of Hydrogen from Natural Gas or Liquid Fuels.
- Task 3: Advanced Distributed Hydrogen production: The PCS integrated with StarCell Hydrogen Purification constitutes an Advanced Fuel Flexible Reformer Technology for distributed hydrogen production.
- Task 7: Gasifier Product Gas Clean-up: Will determine PCS gas polisher efficiency and suitability of synthesis gas for subsequent processes.
- Task 11: Applied Research on advanced hydrogen Purification

Gasification Barriers

B. Operation and Maintenance Costs:

- The plasma Converter is highly automated: Low Labor Cost.
- Designed to run continuously despite variations in feedstock: Minimal Downtime.
- Plasma Conversion is cost competitive from both a Capital and an O&M Standpoint.

C. Feedstock and Water Issues:

- PCS feedstock flexibility addresses many location-specific feedstock supply issues.
- Water use is clean and minimal.

D. Carbon Dioxide Emissions:

- Process lends itself to clean Carbon Sequestration technologies.

E. Control and Safety:

- Fully Automated System with Fail Safe systems interlocks
- Ambient pressure and continuous feed contribute to an inherently safe gasification system.

Ceramic Membrane Features

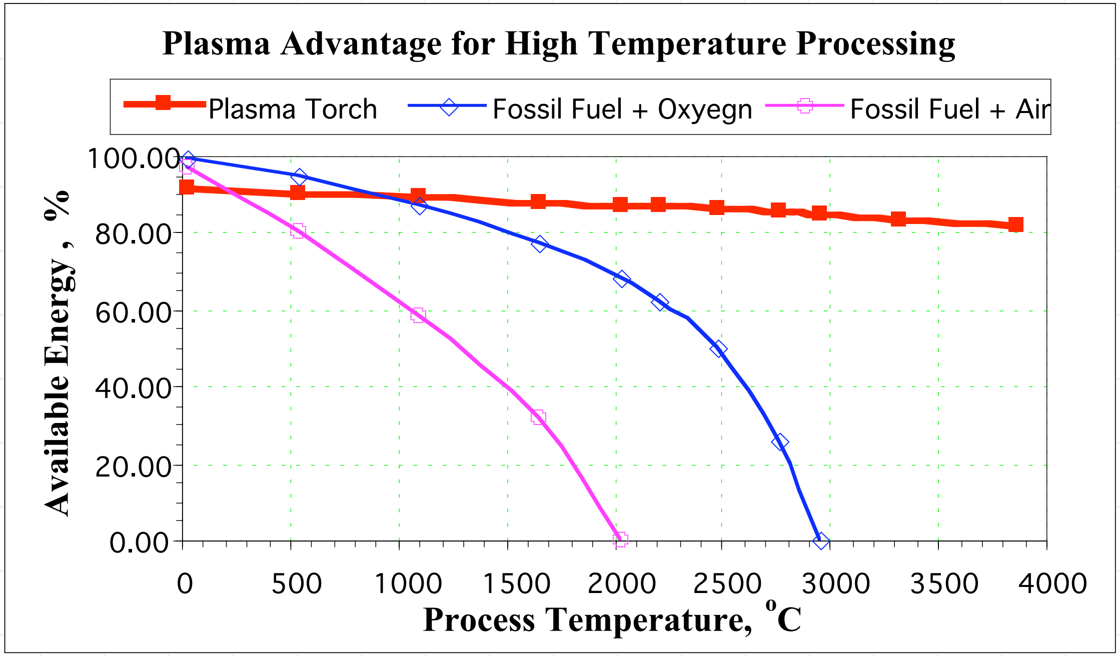
- Applied Research on Advanced H2 Separation
  - Utilize Systemized and Multistage Ceramic Membrane Technology for Hydrogen Purification.
  - Evaluate Ceramic Membrane performance with various operating conditions and over extended operation.
- Advantages of Ceramic Membranes
  - Excellent material temperature and chemical stability
  - Microporous material yields much higher throughputs versus nonporous polymeric membranes
  - Cost efficient gas separation can be achieved at low pressures, i.e. 50 to 100 psi

Technical Approach

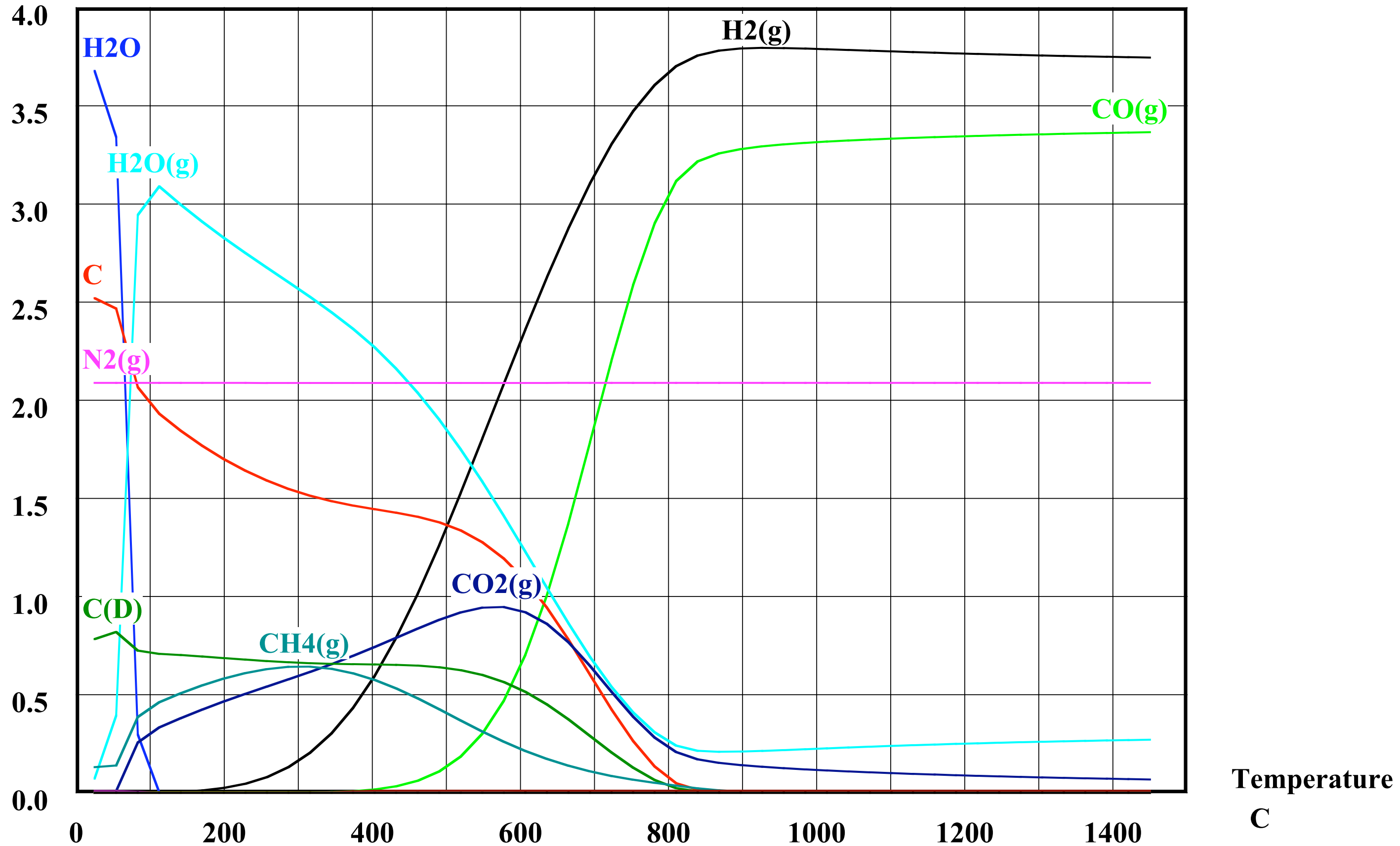
- Utilize StarCell Ceramic Membrane System to purify Hydrogen from a mixed Synthesis Gas.
- Utilize Plasma Converter Gasification System to generate Hydrogen Rich Synthesis Gas.
- Measure processing cost and quality of hydrogen production from several representative feedstocks.
- Characterize plasma gasification and membrane separation as an integrated hydrogen production system.
- Determine viability for StarCell scale-up and next phase development.

Why Plasma?

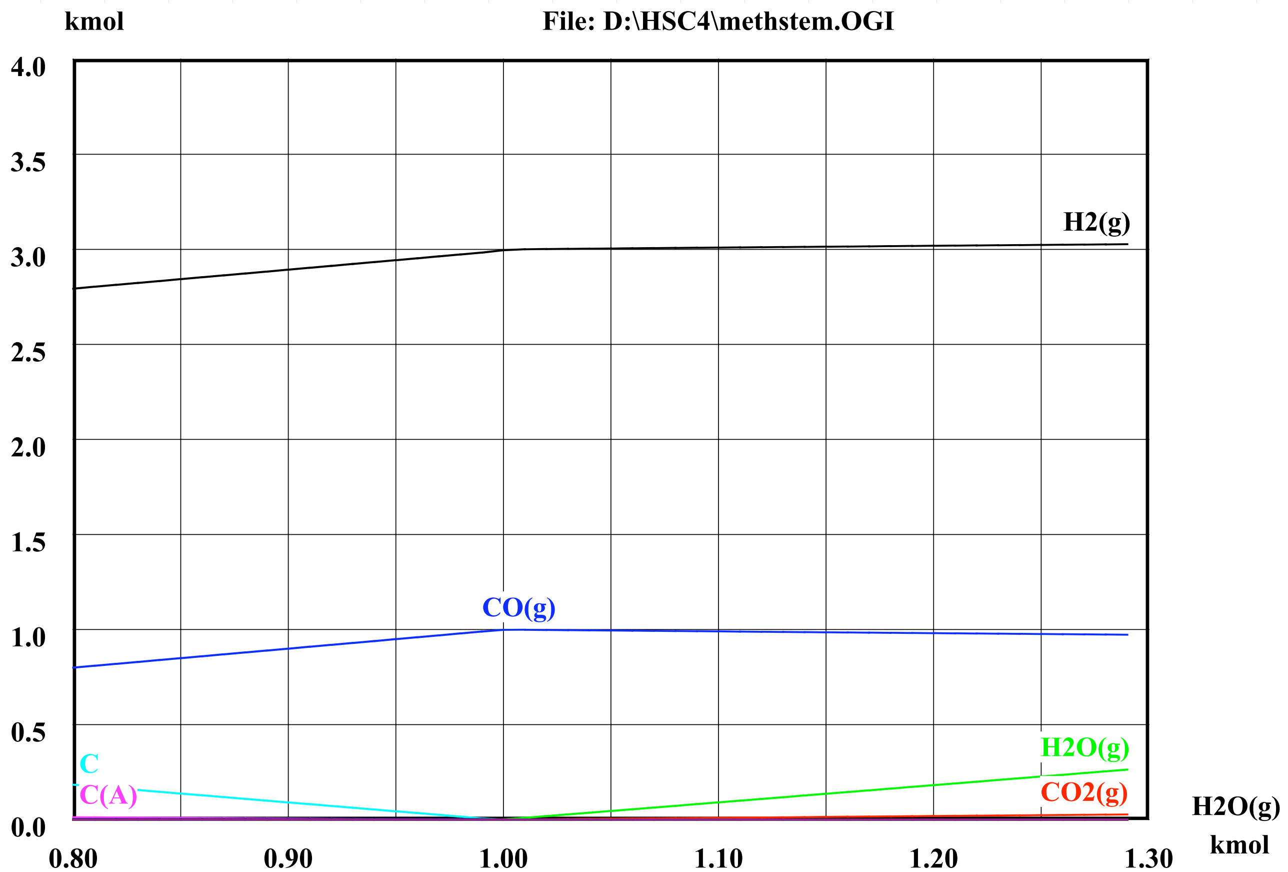
- Superior Environmental Performance
- "Massless Heat"
- High Temperatures
- Commercially Available Equipment
- Low Gas Volumes



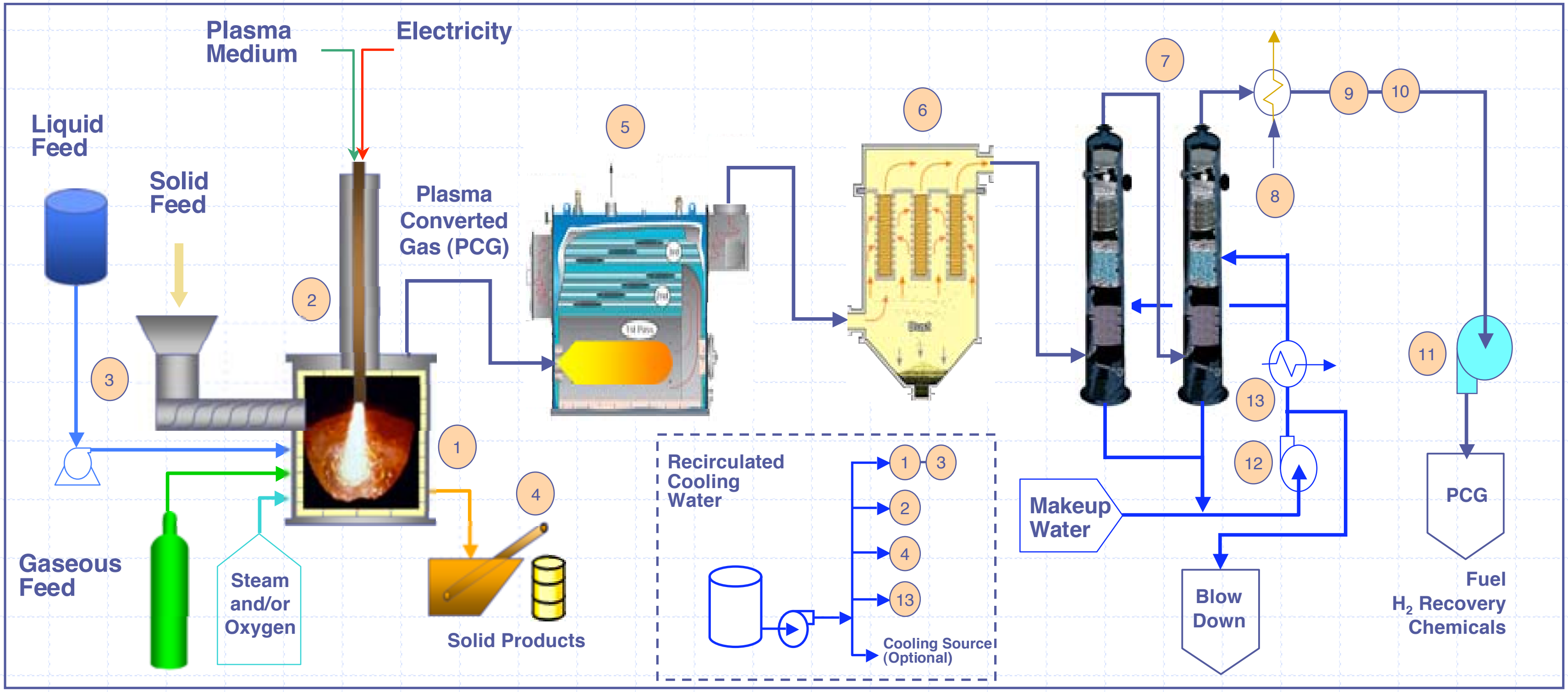
EOLE Gasification



Plasma Processing of Organic Materials

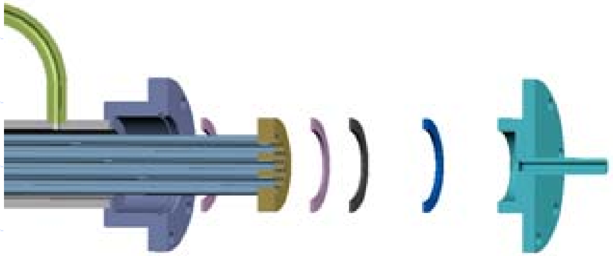


Plasma Converter System



StarCell: How It Works

- StarCell Modules are stainless steel housings with ceramic membrane tube bundles inside.
- Rated for up to 600ºF and operates at or below 100 psig.
- Mixed gas enters through the inlet port and hydrogen permeates through the membrane.
- Hydrogen exits through one exit port and the reject gas exits through another.

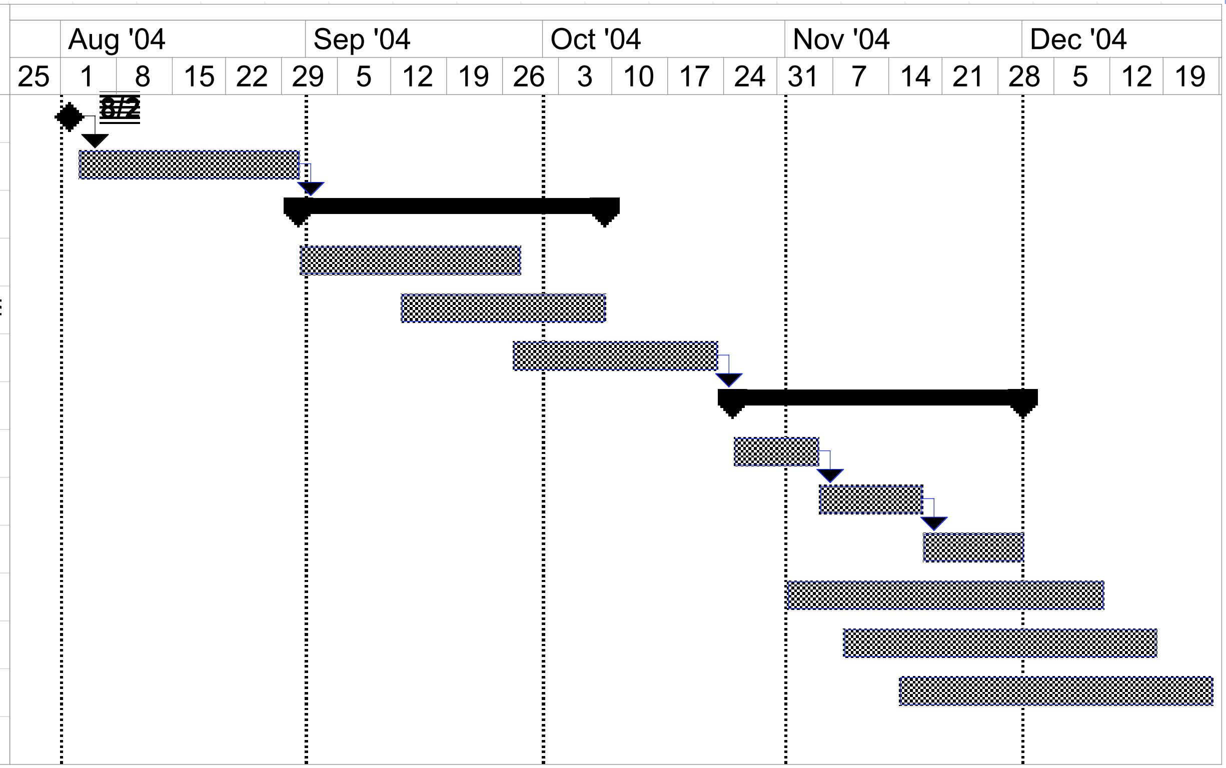


Project Safety

- Process Hazard Analysis and Design Review Principles Used
- Plasma Conversion is performed at slightly negative pressure vs. pressurized systems.
- High process temperature prevents accumulation of feedstock in the PCS.
- Gas is removed continuously from the system as it is generated.
- Control System has built in Fail-Safe controls.

Project Time Line

ID	Task Name
1	Contract Award
2	Program Plan
3	**System Mods**
4	Design Review Process
5	Process Hazard Analysis
6	Test Plan
7	**Perform Testing**
8	Med Waste
9	Coal
10	Scrap Plastic
11	Sample Analysis
12	Data Compilation
13	Final Test Report



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