Integrated Short Contact Time Hydrogen Generator DOE Project Review Meeting

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Project ID # PD10

Overview

Timeline

Project start date: 01/01/2005
Project end date: 12/31/2007
Percent complete: 8%

Budget

Total project funding

- > DOE share: $2.6M
- > Contractor share: $1.4M

Funding received in FY04: $0.00
Funding for FY05: TBD

Barriers

- Technical Barriers Addressed:
  - A. Cost of Fuel Processor
  - C. Operation and Maintenance (O&M)
  - D. Feedstock Issues
- Technical Targets (2010):
  - Total Energy Efficiency (%LHV) > 75%
  - Total H_2 Cost < $1.50/gge H2

Partners

- University of Minnesota
- Argonne National Lab

H_2 Production Technology Objectives

Develop a compact H_2 generator that delivers H_2 at a cost of \$1.50/kg (based on DOE H_2A model) with >75% (LHV) efficiency

Year 1:

- Complete system analysis & develop conceptual design
- Demonstrate SCPO feasibility with energy & economic analysis
- Identify base-case catalysts & generate initial lab-scale results

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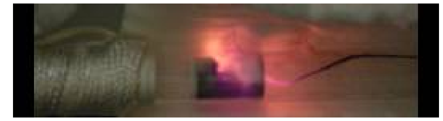
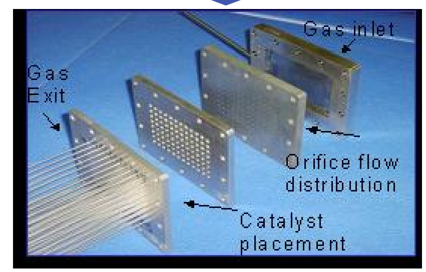
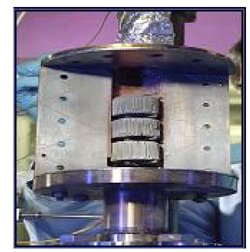
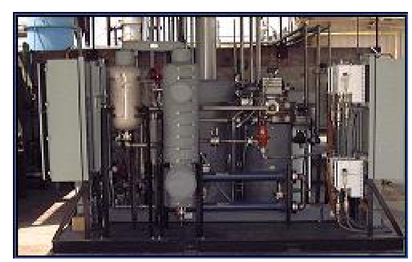
GE Research Approach

- Catalyst development
  - –Short contact time catalyst
    - •CPO (GE/UoM)
    - •SMR (GE/ANL)
    - •Shift catalyst (GE)
  - –High throughput screening & bench scale experiments (GE)
- System development
  - –Design compact H_2 generator by staging catalysts (GE)
  - –Demonstrate concept feasibility on a pilot scale system (GE)

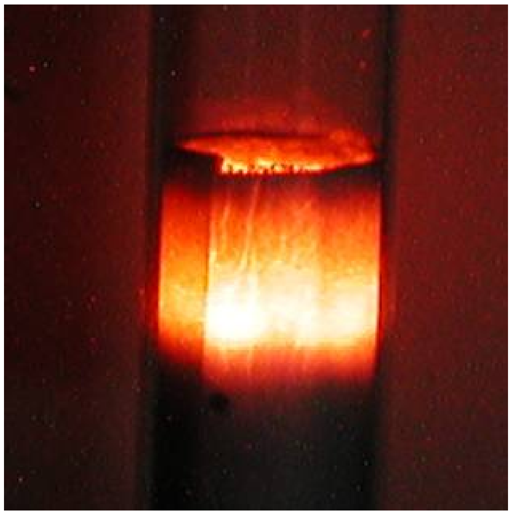


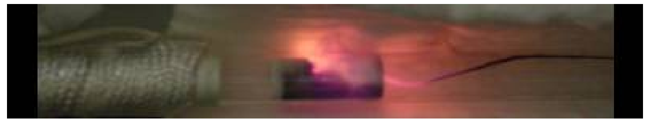


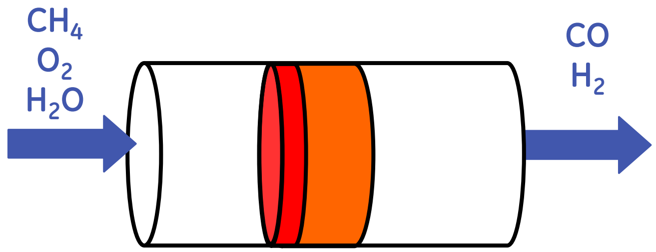




Why staged catalytic partial oxidation? (SCPO)

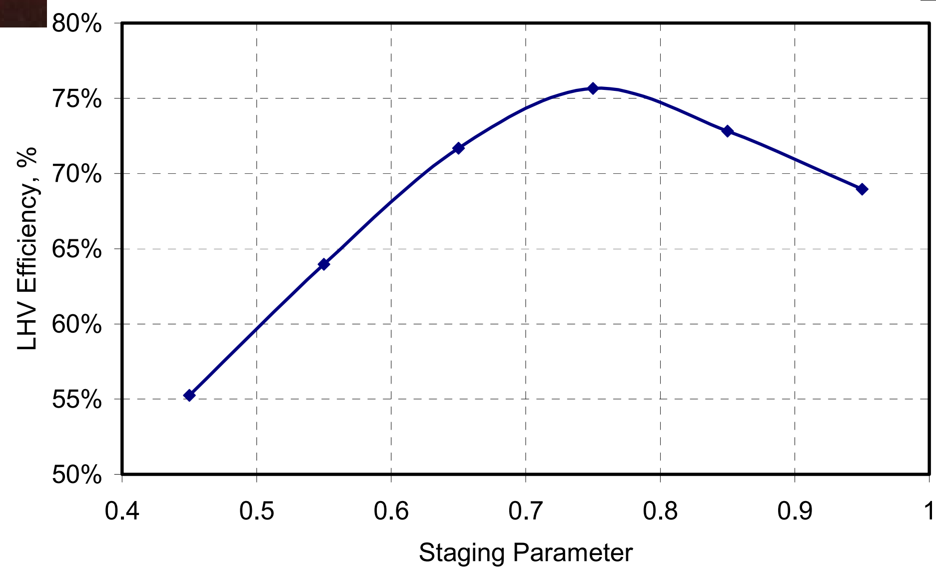


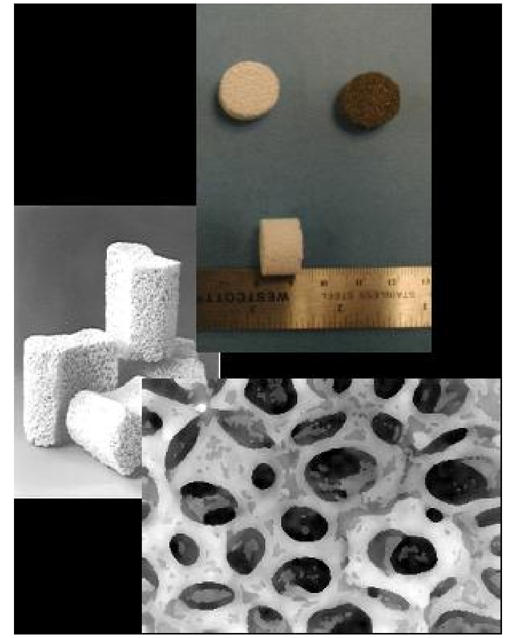




CPO: (Exothermic)
$CH_4 + \frac{1}{2} O_2 = CO + \mathbf{2}H_2$

SMR: (Endothermic)
$CH_4 + H_2O = CO + \mathbf{3}H_2$





Catalyst Support

Leverage GE HTS Capabilities

- Rapid screening of catalyst-reactant pairs
- Miniaturization to reduce test time/cost
- Large screening area = large design space explored
- Adjacent technology: NOx emissions reduction
  - –Expertise in high T catalysis development
  - –Demonstrated HTS hardware & data capabilities

High-throughput screening (HTS) reactor

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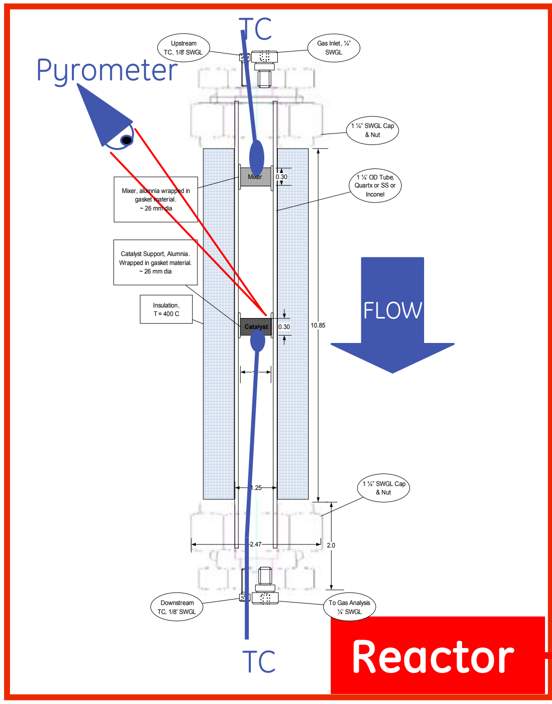
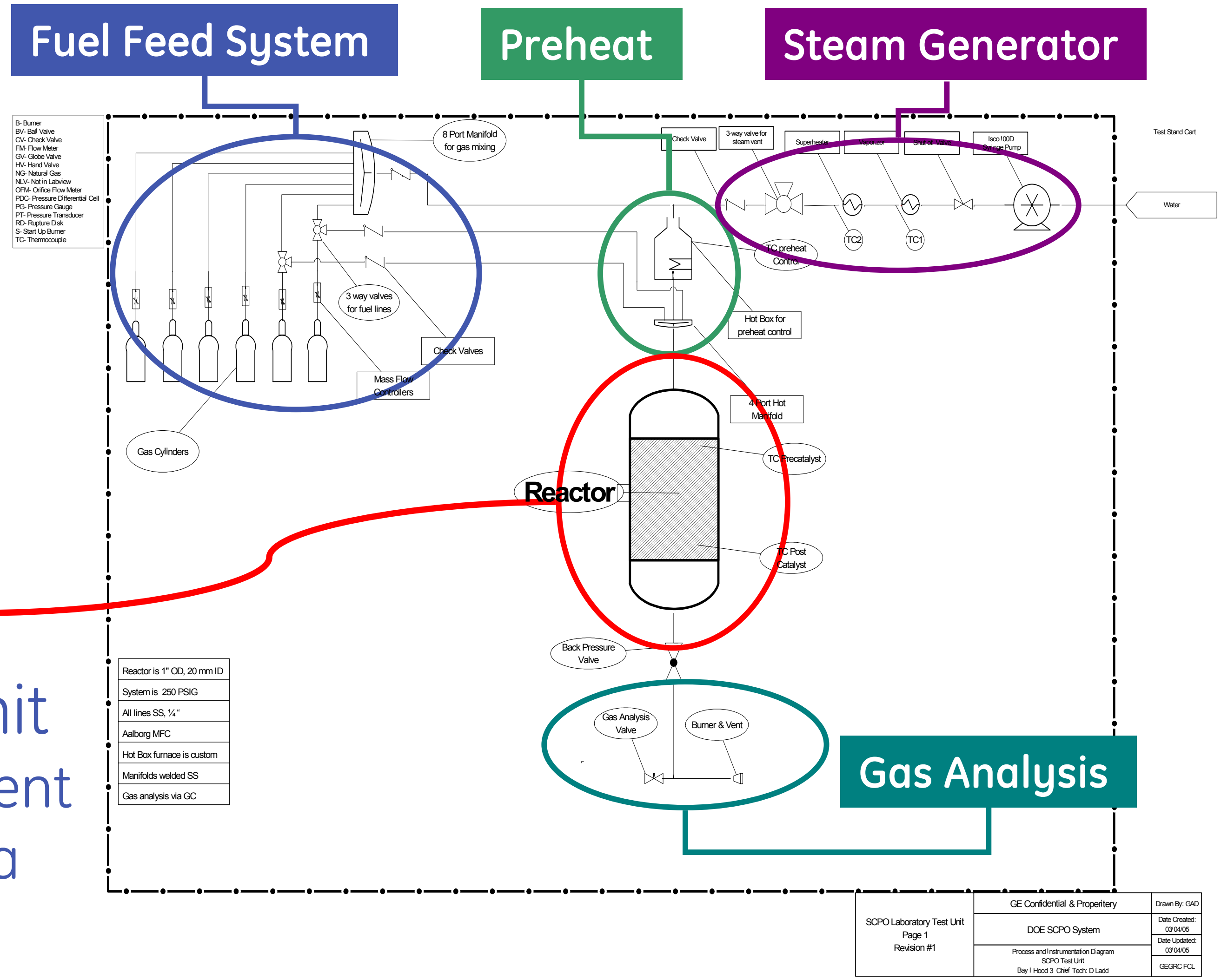
Leverage GE Reformer Design Experience





SCPO lab-scale unit

—catalyst development

—system design data

Quantify Performance/Cost Trade-offs

Minimize "cost of hydrogen"

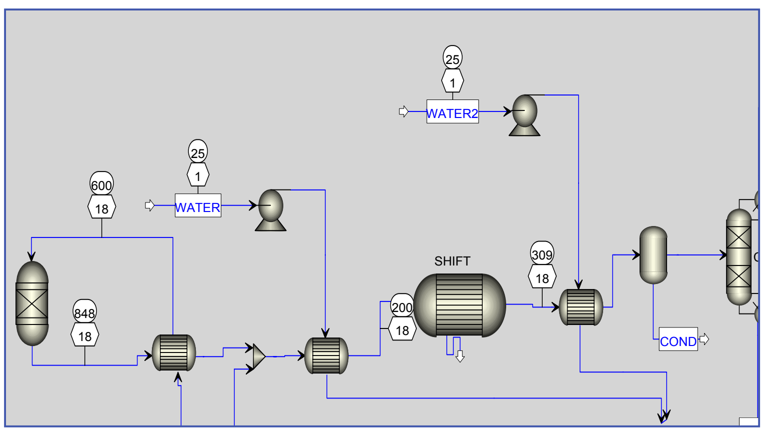
High Efficiency
- High fuel conversion
- Low steam/C
- Low O_2/C
- High PSA recovery
- Low vent temperature
- Minimum losses
- Utilization of waste heat

Low Capital Cost
- Compact (high space velocity)
- Energy Integration

Safe Operation

High Reliability

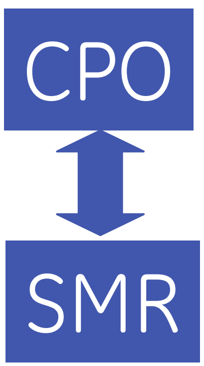
Process Model & Flow-Match



DOE H_2A Model

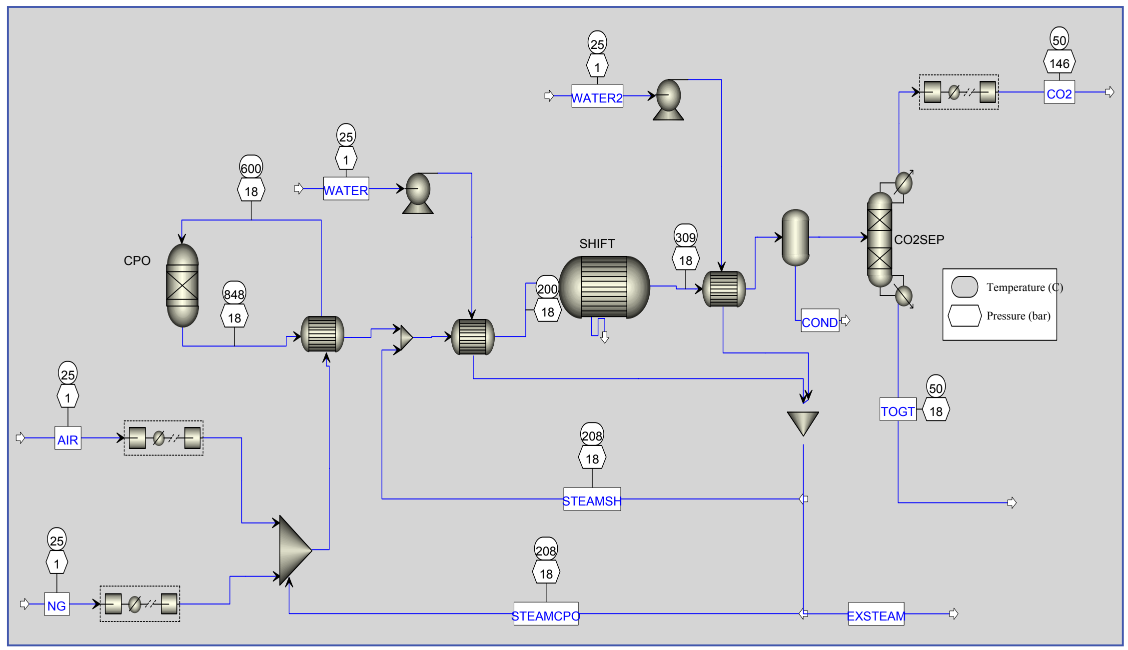
Analyze System Concepts

Catalyst staging
& Heat exchange
Scenarios



Staging

Scenario analysis process modelling
(example)



Aspen Plus

Assess "cost of hydrogen": DOE H2A

Model output

Hydrogen cost for 10 year life of refueling station

Key inputs

- Detailed installed capital costs
- Process operating efficiencies
- Feedstock costs
- O&M

Enables

Comparison across alternative reforming technologies

GE Path Forward

Reminder of Year 1

- Complete system analysis, & develop conceptual design for a compact H_2 generator
- Demonstrate SCPO feasibility through energy & economic analysis
- Identify base-case catalysts and demonstrate preliminary lab-scale results

Year 2

- Go/No-Go decision based on energy & economic analysis
- Catalyst optimization
- Design of pilot-scale H_2 generator

Year 3

- Demonstrate catalyst durability
- Demonstration of the H_2 generator feasibility through operation of pilot-scale unit .

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Supplemental Slides

The following three slides are for the purposes of the reviewers only – they are not to be presented as part of your oral or poster presentation. They will be included in the hardcopies of your presentation that might be made for review purposes.

Publications and Presentations

No publications so far.

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Hydrogen Safety

The most significant hydrogen hazard associated with this project is:

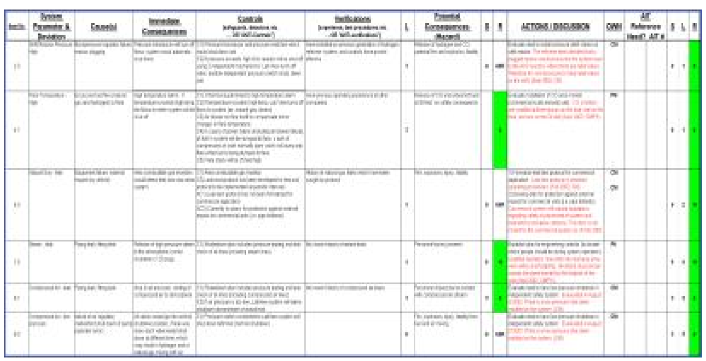
The most significant risk associated with SCPO reformer will be the mixing of fuel (natural gas, syngas) and air at elevated temperatures under abnormal conditions such as leak or control system failure.

Hydrogen Safety

Our approach to deal with this hazard is:

The preliminary approach to minimizing this risk is to design the entire reformer skid to meet standards of NEMA and ASME. GE performs a three step safety review; preliminary hazard assessment (PHA), hazardous operation review (HazOp) and accident scenario review (ASR).

Sample HazOp



Sample ASR