Hydrogen Recycling System Evaluation and Data Collection

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H2Pump LLC
May 16, 2013

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Overview

Limited Liability Corporation with headquarters in Latham, NY

• Founded in October of 2005
• Hydrogen reclamation and recycling solutions
• Recipient of R&D awards from the US Department of Energy, US Department of Defense and New York State Energy Research and Development Authority
• InterTech Group is a strategic partner and investor
• 18 employees
Commercial Hydrogen Market

Industrial Processes Using Hydrogen:

- Metals processing (steel, annealing, sintering, brazing)
- Semi-conductor & LED processing
- Ceramics processing
- Chemical by-product H2
- Float glass manufacturing
The Opportunity

Industrial operations flare or vent hydrogen rich furnace exhaust gas into the atmosphere today.
Utilizing modified fuel cell technology for hydrogen recovery and recycling

**Fuel Cell**
Chemical energy converted directly to electricity

**Hydrogen Recycling**
Electricity utilized to drive separation process

- Purify, pressurize and “pump” in a single step
- Reliable non-mechanical process
- Ambient pressure exhaust gas operation
- Up to 90% recovery of hydrogen
- Leverages existing fuel cell supply base
- Eliminates Oxygen associated failures modes
Overview

Timeline
• Project start date: 1/2/13
• Project end date: 6/30/14*
• Percent complete: 15%
* Project continuation and direction determined annually by DOE

Barriers
• TV 3.6D. Lack of Hydrogen Refueling Infrastructure Performance and Availability Data
  – Efficiency: 10 kWhr/kg
  – Availability: 80%
• TV 3.6G. Hydrogen from Renewable Resources

Budget
• Total project funding $1.06M
  – DOE share: $499K
  – Contractor share: $567K
• Funding for FY13: $966K
  – DOE share: $453K
  – Contractor share: $514K

Partners
• NYSERDA & NREL
• Site Hosts:
  – Ulbrich Stainless Steel
  – Pall Corporation
  – Rome Strip Steel
  – SUNY, Albany- College of Nanoscale Sciences and Engineering (CNSE)
Objective:

• To demonstrate the product readiness and quantify the benefits of H2Pump's Hydrogen Recycling System (HRS-100™) by installing and analyzing the operation of eight pre-commercial 100 kg per day systems in real world customer locations.

• H2Pump will install, track and report multiple field demonstration systems in industrial heat treating, LED Fabs and semi-conductor applications.

• The demonstrations will be used to develop case studies and showcase the benefits of the technology to drive market adoption.
## Relevance

<table>
<thead>
<tr>
<th>DoE Barrier</th>
<th>Metric</th>
<th>Target 2013-2014</th>
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<tbody>
<tr>
<td><strong>D. Lack of Performance and Availability Data</strong></td>
<td>System Efficiency</td>
<td></td>
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<tr>
<td></td>
<td>• Recycling rate (kg/day)</td>
<td>&gt; 80</td>
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<tr>
<td></td>
<td>• Electrical consumption (kWhr/kg)</td>
<td>&lt; 10</td>
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<tr>
<td></td>
<td>Availability %</td>
<td>&gt; 80%</td>
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<tr>
<td></td>
<td>Annual run time (24/7) - hours</td>
<td>&gt; 7,000</td>
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<td></td>
<td>Mean time between failure - hours</td>
<td>&gt; 1,200</td>
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<td><strong>G. Hydrogen from Renewable Resources</strong></td>
<td>Stack life time - hours</td>
<td>&gt; 14,000</td>
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<tr>
<td></td>
<td>Annual service cost</td>
<td>$15,000</td>
</tr>
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<td>Annual projected savings</td>
<td>$40,000</td>
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### Plan & Approach

| Task 1.0: Data Collection and Reporting Tool | 30% Complete |
| Task 2.0: System #1 at Ulbrich | 90% Complete |
| Task 3.0: System #2 at Ulbrich | 100% Complete |
| Task 4.0: System #3 at Pall Corporation | 100% Complete |
| Task 5.0: System #4 & #5 at Rome Strip Steel | 100% Complete |
| **Go/ No Go Decision** | |
| Task 6.0: System #6 at TBD | |
| Task 7.0: System #7 at CNSE- MOCVD | |
| Task 8.0: System #8 at CNSE- EUV | |
| Task 9.0: Program Management | |
| Task 10.0: Extended Runtime | |
Plan & Approach

Site Requirements & Plan
- Site Visits - Site Requirements
- Gas Sampling, Single Cell Testing
- Installation Document - P&ID
- Build by Contract Manufacturer
- Debug, Leak Check, Test and Qualification at H2Pump
- Site Electrical, Internet, Nitrogen, Water and Exhaust
- Ship system
- Locate and Hook-up
- Training and continuous operation
- 12-18 months
- NREL detailed analysis
- Identification of improvements
- Service calls
- Service cost
- MTBF
Accomplishments and Progress

Task 1.0: Create Data Collection, Monitoring and Reporting Tool and Database

✔ Create a Requirements Document
  • Fleet Status
  • Customer Screen
  • Database
  • Administration

✔ Select a supplier
  • Access to NREL
  • Stack degradation
  • Efficiency improvements
  • Sensor elimination
  • Optimization
Accomplishments and Progress

Site: Ulbrich Specialty Strip Mill- Wallingford, CT

Task 2.0 Ulbrich (System #1)
- Many types of SS foil
- Multiple continuous furnaces
- Varying Oil and CO
- Site Requirements and Plan
- System Build, Test, Site Prep
- Installation and Commissioning

Task 3.0 Ulbrich (System #2)
- Site Requirements and Plan
- System Build, Test
- Installation delayed pending #1
Accomplishments and Progress

Site: Pall Corporation- Cortland, NY

Task 4.0 Pall (System #3)
- Annealing of SS filters
- Two bell furnaces
- Cyclic operation

✓ Site Requirements and Plan
✓ System Build, Test, Site Prep
✓ Installation and Commissioning
Accomplishments and Progress

Site: Rome Strip Steel - Rome, NY

Task 5.0 Rome (System #4 & #5)

- Integrate 16 bell furnaces
- Varying operation
- High Oil content
- High CO content
- Dual HRS-100™ units

✓ Site Requirements and Plan
✓ System Build, Test, Site Prep
✓ Installation and Commissioning
Proposed Future Work

April 2013- Go/ No Go Decision Meeting, Database On-line

April 2013- Complete Site Plan and Install- CNSE- MOCVD

May 2013- Complete Site Plan and Install at CNSE- EUV

June 2013- Complete Site Plan and Install at Site TBD

Quarterly data reviews with NREL
Collaborations

NREL - Data Analysis

NYSERDA - NYS Demo Cost share

NYS Engineering Firms - Hesnor Engineering, Zeller Corporation, O’Brien and Gere and Edwards Vacuum

Site Hosts (Industry) - Ulbrich, Pall, Rome Strip Steel, CNSE
Summary

Four of eight installs completed in 1Q13

Database and reporting tool complete by April 2013

Remaining installs complete in 2Q13

Operation and maintenance thru 2013 and 2014