

Hydrogen Recycling System Evaluation and Data Collection

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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



Reduction Furnace



LED Fabs



The Opportunity

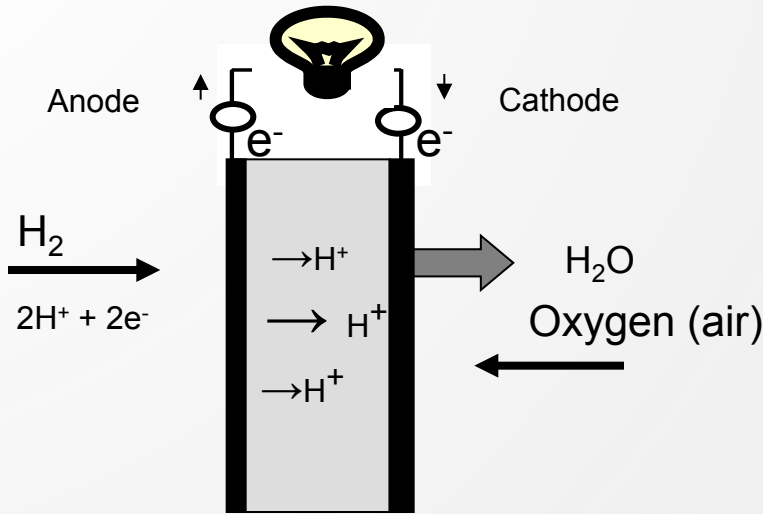


Industrial operations flare or vent hydrogen rich furnace exhaust gas into the atmosphere today



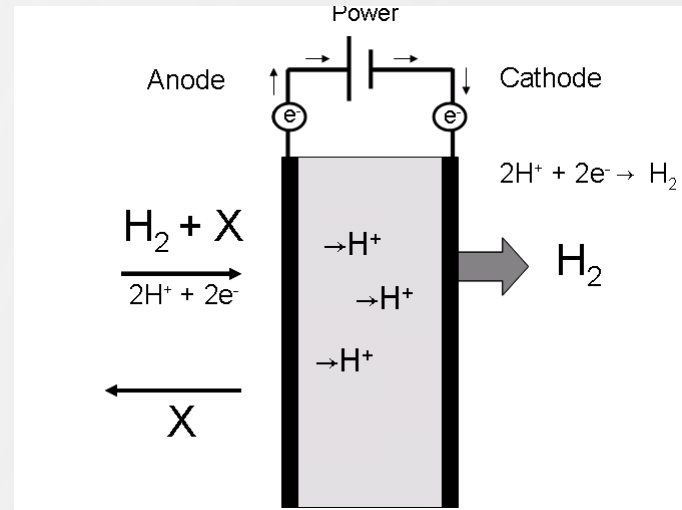
H2Pump Core Technology

Utilizing modified fuel cell technology for hydrogen recovery and recycling



Fuel Cell

Chemical energy converted directly to electricity



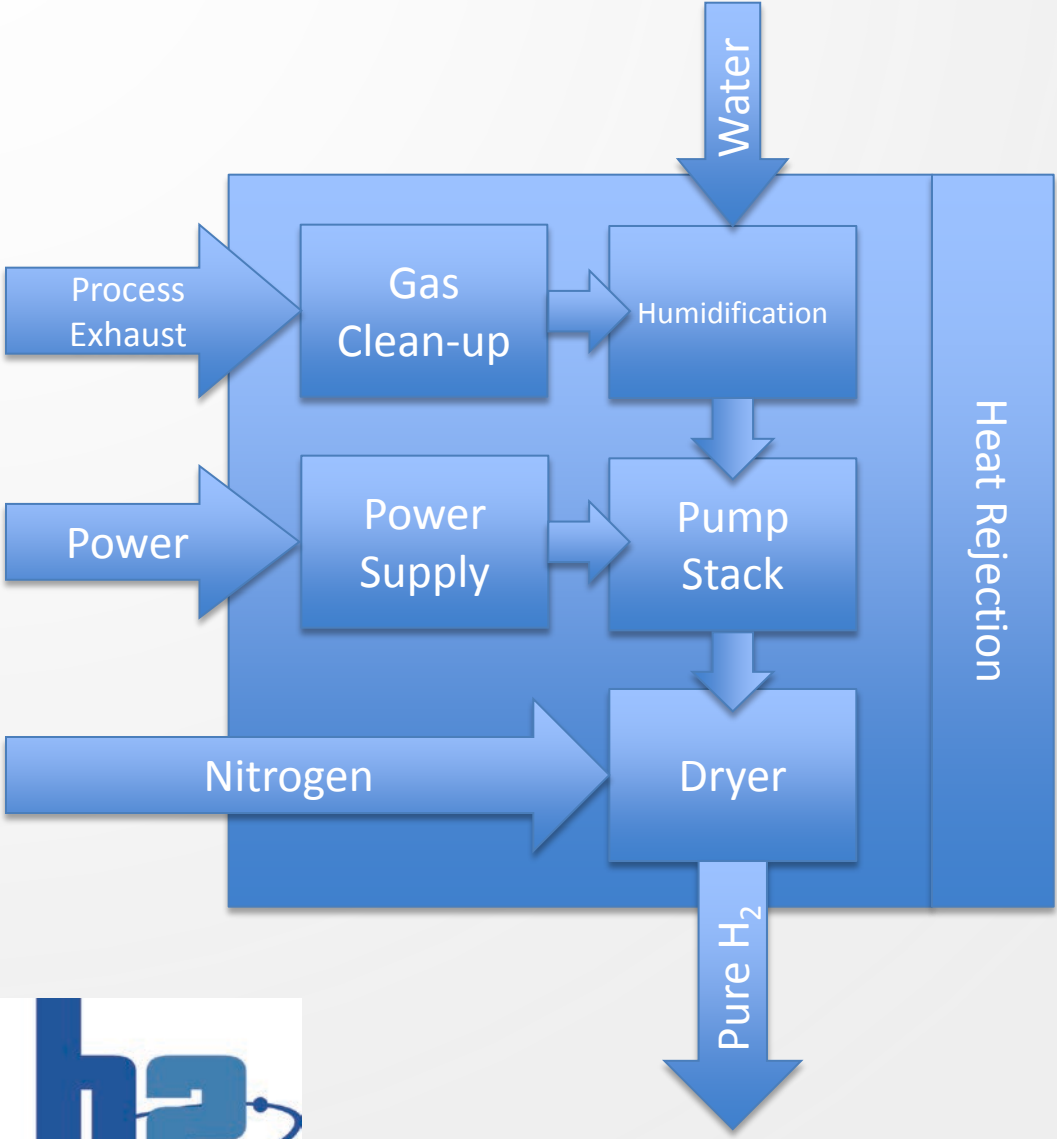
Hydrogen Recycling

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



HRS-100™



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

Budget

- Total project funding \$1.06M
 - DOE share: \$499K
 - Contractor share: \$567K
- Funding for FY13: \$966K
 - DOE share: \$453K
 - Contractor share: \$514K



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

Partners

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

Relevance

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

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



Plan & Approach

%
Complete

Phase 1

Task 1.0: Data Collection and Reporting Tool	30%
Task 2.0: System #1 at Ulbrich	90%
Task 3.0: System #2 at Ulbrich	
Task 4.0: System #3 at Pall Corporation	100%
Task 5.0: System #4 & #5 at Rome Strip Steel	100%
Go/ No Go Decision	

Phase 2

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**

System Build
& Test
Site Prep

**Build by Contract Manufacturer
Debug, Leak Check, Test and Qualification at H2Pump
Site Electrical, Internet, Nitrogen, Water and Exhaust**

Installation &
Commissioning

**Ship system
Locate and Hook-up
Training and continuous operation**

Data
Collection &
Monitoring

**12- 18 months
NREL detailed analysis
Identification of improvements**

Operation,
Maintenance

**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

h2 PUMP

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H2 Pump System Information Center

Fleet Status Screen

Serial Number	Customer	Location	Install Date	Runtime Hour	Kg Pumped	Power (KW)	Recycle Rate (Kg/day)
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3
HRS 100-101	Customer A	Anytown 1	23/01/2013	4500	14.625	50.41	66.3

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Update



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

