VII.3 Hydrogen Recycling System Evaluation and Data Collection

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Contract Number: DE-EE0006091

Project Start Date: January 2013
Project End Date: June 2014

Overall Objectives

The objective of this project is to demonstrate the product readiness and to quantify the benefits and customer value proposition of H2Pump's Hydrogen Recycling System (HRS-100™) by installing and analyzing the operation of multiple prototype 100-kg per day systems in real world customer locations. The data gathered will be used to measure reliability, demonstrate the value proposition to customers, and validate our business model. H2Pump will install, track and report multiple field demonstration systems in industrial heat treating and semi-conductor applications. The customer demonstrations will be used to develop case studies and showcase the benefits of the technology to drive market adoption. The objectives of the project are to:

- Validate commercial assumptions around the Hydrogen Recycling Agreement including customer assumptions and system performance.
- Build case studies of the HRS-100™ in customer operations that can be used as credible demonstrations quantifying the operating cost savings, emissions reduction and production efficiency improvement.
- Expand the Beta test fleet into additional customer environments to accelerate learning, problem identification, resolution and reduce the risk of product launch
- Provide data to the National Renewable Energy Laboratory (NREL) for in-depth analysis of system performance characteristics and identify areas for improved data gathering and performance causal analysis. All of the data acquired by the systems will be made available for NREL. The minimum data includes stack voltage and current, system power, and hydrogen flow rate. Data frequency can be no less than a one minute interval. Maintenance and repair logs should also be provided to NREL, specifying time, maintenance item, or reason for repair. NREL will also be provided with all gas analysis to help determine whether certain gases result in higher degradation.
- Prepare and test commercial infrastructure elements such as installation, commissioning, reporting, operation, and maintenance.

Fiscal Year (FY) 2013 Objectives

- Create and deploy a database tool for retrieval of data logs to monitor and analyze system performance.
- Install and commission four of the eight systems in the first quarter of 2013 and provide data to NREL to perform degradation calculations.
- Execute Go/No-Go review.
- Install and commission the four remaining systems in the second half of 2013 and provide data to NREL to perform degradation calculations.

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan:

(D) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data

(G) Hydrogen from Renewable Resources

FY 2013 Accomplishments

- Installed and commissioned an HRS-100™ system at Ulbrich Stainless Steel in Wallingford, CT.
- Installed and commissioned an HRS-100™ system at Pall Corporation in Cortland, NY.
- Installed and debugged two HRS-100™ systems at Rome Strip Steel in Rome, NY in conjunction with a gas treatment system for oil removal and CO reduction.
- Implemented method for data retrieval, sharing and analysis with NREL while database development is underway.

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INTRODUCTION

Hydrogen is used in numerous industrial applications including metallurgical and semiconductor processing. Hydrogen intensive metal heat treating applications include stainless steel annealing, brazing, and metal production from ore. Each industrial application uses hydrogen for different purposes; however, in general, hydrogen is used to create an oxygen-free reducing atmosphere and is not consumed by the industrial process. H2Pump has developed a unique hydrogen recycling solution capable of reclaiming nearly 100 kg per day from such industrial processes.

Figure 1 shows how the HRS integrates with a typical industrial furnace or semi-conductor manufacturing tool. The HRS receives the furnace or tool exhaust which is normally flared or exhausted to atmosphere. The HRS requires certain utilities including electricity, water, and nitrogen. The heart of the HRS system is the electrochemical pump stack. The electrochemical process involves the extraction of hydrogen from a gas stream containing hydrogen followed by the formation of "new" hydrogen. This transformational approach is accomplished without mechanical compression. The new hydrogen is returned to the original process.

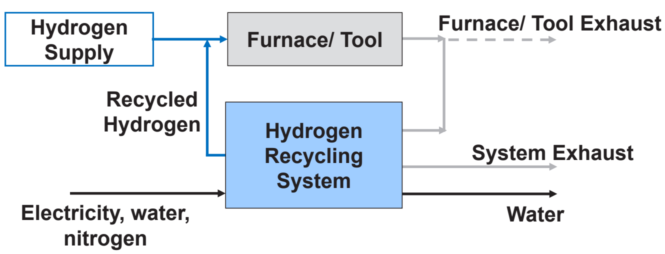

FIGURE 1. Integration of a Hydrogen Recycling System with an Industrial Process

The HRS-100™ system design is represented in Figure 2. The main subsystems and components include incoming gas clean-up, humidification, the pump stack, power supply, heat rejection and the dryer. Most heat treating processes require very low dew point in the hydrogen supply. To ensure adequate quality of the recycled product, H2Pump measures the dew point of the product before returning the hydrogen to the customer's process.

APPROACH

H2Pump is fortunate to have the support of the New York State Energy Research and Development Authority (NYSERDA) as a cost-sharing partner in this project. The NYSERDA award funds 50% of the system material cost, the installation cost, and the ongoing operation and maintenance costs of the demonstration. The DOE award shares the costs of the systems, the database development, and analysis performed by NREL.

A total of eight systems are planned to be installed and monitored during the project. For each site H2Pump follows the steps shown in Figure 3. The first step is establishing the site requirements and installation plan. Activities to uncover site specific issues, including potential gas contaminates are undertaken early in the planning process. Mitigation plans are put in place for known contaminates and the systems are installed and commissioned. Following commissioning, the system will be monitored and the data logs will be given to NREL for analysis.

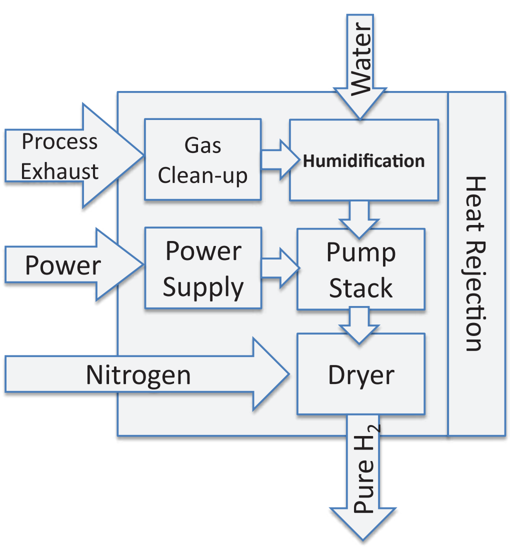

FIGURE 2. HRS-100™ Subsystems and Components

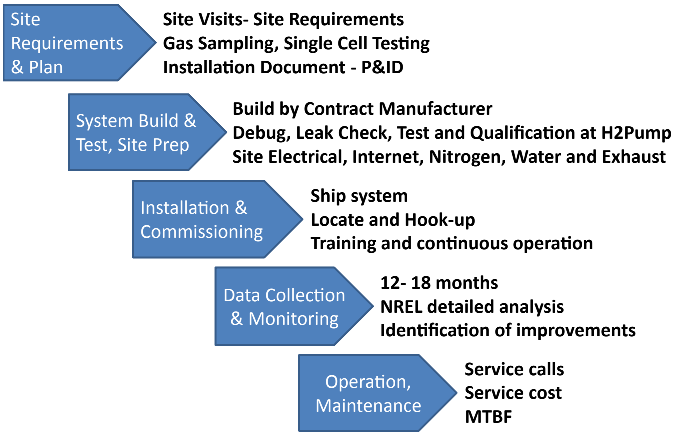

FIGURE 3. Program Approach

RESULTS

As of this report, the first four systems are installed, with only two fully commissioned and reporting only two months of operational data. The installed systems are shown in Figure 4. The final two systems should achieve continuous operation in the third quarter of 2013. Once more systems are reporting data H2Pump will be able to summarize the results and NREL will be able to report their analysis. This has delayed the Go/No-Go decision for a quarter.

CONCLUSIONS AND FUTURE DIRECTIONS

The site planning and commissioning steps are proving to be the most critical and time intensive part of the project. For the remaining four installations in the second part of the project, greater emphasis will be placed on understanding the site actual operational characteristics.

FY 2013 PUBLICATIONS/PRESENTATIONS

1. 2013 U.S. DOE Hydrogen and Fuel Cells Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting, May 13–17, 2013, Crystal City, Virginia.

FIGURE 4. Completed HRS-100™ Installs