VII.I.5 Component Benchmarking: *Establishing a Standardized Single Cell Testing Procedure through Industry Participation, Consensus and Experimentation*

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Start Date: FY 2002
Projected End Date: Project continuation and direction determined annually by DOE

Objectives

- Collaborate with industry, universities and other government agencies involved with the United States Fuel Cell Council (USFCC)
- Establish a standardized test procedure for single cell polymer electrolyte membrane (PEM) fuel cells
- Conduct round-robin tests using the "standardized test protocol"
- Identify and correct issues regarding the procedure
- Expand the protocol to include longevity and durability testing

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- A. Durability
- B. Cost
- C. Electrode Performance

Approach

- Conduct frequent meetings with the USFCC (2 conference calls/month)
- Propose steps in the test procedure
- Agree upon a well-defined test procedure for single cell tests
- Validate each potential test site for testing protocol
- Conduct blind-tests using the protocol at different test-sites
- Compare and analyze results

Accomplishments

- Held regular productive meetings with members of the USFCC

- Established a preliminary standardized test procedure for single cell PEM fuel cells
- Completed first round of testing
- Carried out the first round robin series of tests
- Modified the test protocol based on initial test results
- Presented findings at national meetings

Future Directions

- Utilize lessons learned to further improve the existing protocol
- Define a calibration procedure for test stations running these types of measurements
- Expand the testing protocol to include longevity and durability testing
- Participate in the 2nd round robin

Introduction

The work described herein is the result of collaborative efforts of members of the USFCC, Materials and Components Working Group, Single Cell Task Force, which includes industry-leading companies, universities, government laboratories and individuals to address important fuel cell related issues. PEM fuel cell test results have been reported and published for many years. However, the lack of universally-accepted testing procedures, conditions and data format increases the difficulty in comparing and analyzing results between different testing facilities. The goal of the task force is to provide the PEM Fuel Cell industry with a standard fuel cell testing protocol outlining a consistent, repeatable method for running a single cell test and generating a polarization curve. We expect that the results of this study will allow us to establish testing protocols that will be widely accepted as accurate and will facilitate the commercialization of fuel cells [1,2].

Approach

The Single Cell Testing Protocol has been developed in order that laboratories can publish testing results for a new material or component in a consistent, verifiable manner. A single cell PEM fuel cell was used to generate the initial baseline. The intent is for laboratories to run the Single Cell Test Protocol first, with the standard cell, verifying their in-house capabilities and baseline, and then with new materials. As new components are compared against the baseline, the published data can be used as a new baseline [1,2].

The protocol consists of several stages: cell assembly, gross leak testing, electrochemical H_2 crossover measurement, initial break-in, conditioning, and polarization curve [1]. Cell assembly, pressure testing, and initial break-in were performed at the initial test facility, and are described in detail elsewhere [4]. The polarization curves were generated at all of the test sites: LANL, Teledyne Energy Systems, Inc., Greenlight Power Technologies, and Electrochem. After the fuel cells were tested at the above mentioned sites they were then returned to the original test site for one final test.

Results

At the initial test site, LANL, a complete test, from assembly to full break-in, lasted approximately 53 hours. Data were recorded for each stage of the protocol but it is the polarization curves that are of primary interest. A series of constant current polarization curves were measured using 46 cm^2 fuel cells operated with 1.2 and 2.0 stoichiometric flows for the hydrogen and air, respectively. Other cell conditions such as; current settings, gas flow rates and testing sequence are listed in detail in the protocol [4]. The fuel cells were set for 20 minutes at the desired current, and then the average voltage for the last 5 minutes was recorded. The results shown in Figures 1 and 2 are for fuel cells operated at 60 ^oC while being exposed to fully-humidified gases and ambient back pressure at the different test sites. In the subsequent measurements (Figures 3 and 4) the conditions were set at 80^oC with 25 psig of back pressure.

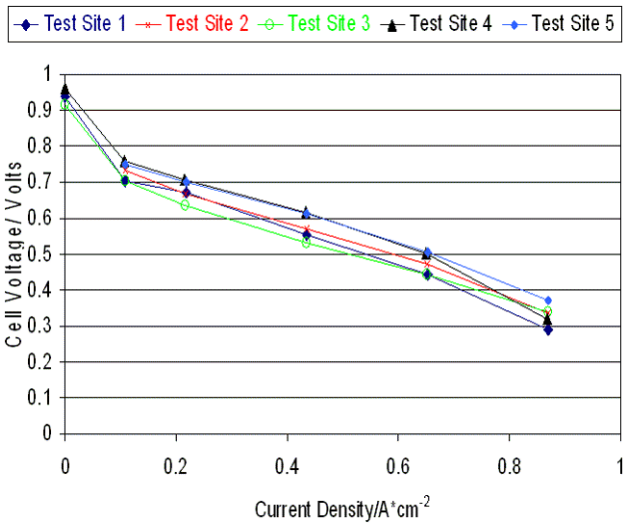

Figure 1. Family of V-I Curves Generated at the Different Test Sites for Fuel Cell Number 1 Operating at 60 °C and Ambient Pressure at Sea

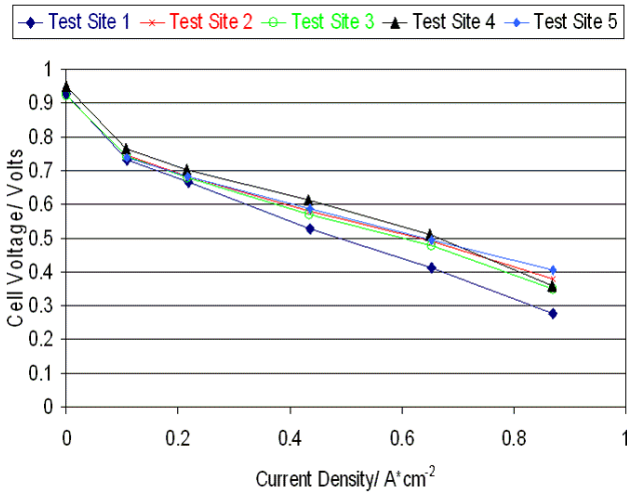

Figure 2. Family of V-I Curves Generated at the Different Test Sites for Fuel Cell Number 2 Operating at 60 °C and Ambient Pressure at Sea Level

Conclusions

- Fuel cell break-in requires longer times at lower temperatures and pressures [2,3,4]
- Variations in the test results led to discussions that helped identify and correct issues regarding testing equipment and calibration techniques used at the different sites [2,3,4]

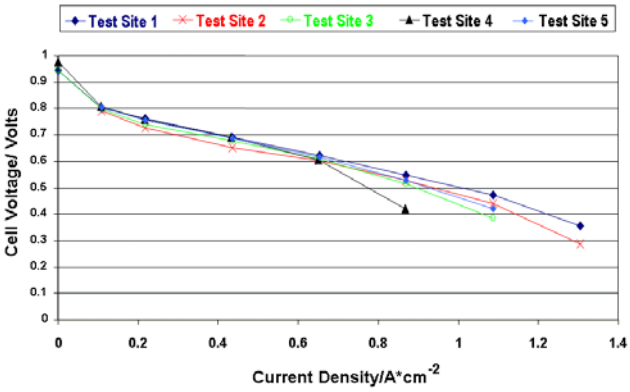

Figure 3. Family of V-I Curves Generated at the Different Test Sites for Fuel Cell Number 1 Operating at 80 °C and 25 psig at Sea Level

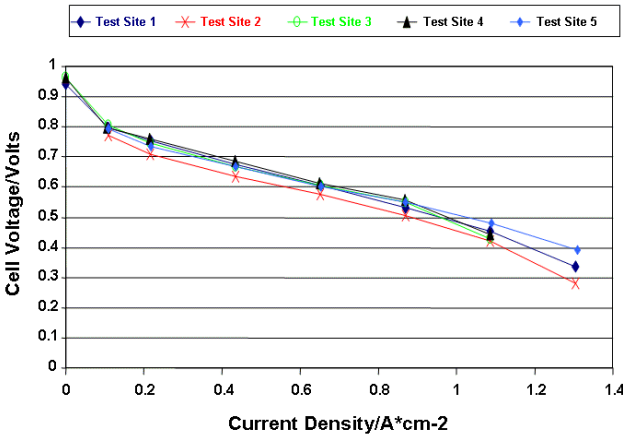

Figure 4. Family of V-I Curves Generated at the Different Test Sites for Fuel Cell Number 2 Operating at 80 °C and 25 psig at Sea Level

- Statistical analysis showed performance increased from site-to-site for low temperature and pressure tests, while remaining statistically constant at the elevated temperature and pressure tests [3]

Special Recognitions & Awards/Patents Issued

1. Invited presentation at the 207th ECS meeting in Quebec City, Canada (May 2005)

FY 2005 Publications/Presentations

1. David Lane (W.L. Gore and Associates), Eric Teather (DuPont Fuel Cells), Tommy Rockward (Los Alamos National Laboratory - LANL), Francisco Uribe (LANL), Dawn McNeil, (Teledyne Energy Systems), Ross Bailey (Greenlight Power Technologies), Michael Pien (ElectroChem, Inc.), "Establishing a Standardized Single Cell Testing Procedure through Industry Participation, Consensus and Experimentation," 2004 FC Seminar Abstracts, San Antonio, TX (Nov. 2004), p. 303

   Presented at the 2004 Fuel Cell Seminar in San Antonio, TX

References

1. Rockward, T., Lane, D., Teather, E., Uribe, F., McNeil, D., Bailey, R., Pien, M. "Establishing a Standardized Single Cell Testing Procedure through Industry Participation, Consensus and Experimentation," 2004 FC Seminar Abstracts San Antonio, TX (Nov. 2004), p. 303.
2. McNeil, D., Lane, D., Teather, E., Rockward, T., Uribe, F., Bailey, R., Pien, M. 207th ECS Meeting, Quebec City, Canada (May 2005), Abstract No. 785.
3. Monthly USFCC Materials and Components Task Force conference calls.
4. Single Cell Test Protocol, USFCC Document No. 05-014 (www.usfcc.com).