VIII.10 International Partnership for Hydrogen and Fuel Cells in the Economy—Regulations, Codes and Standards Working Group

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Fiscal Year (FY) 2013 Objectives

- Complete Phase I of the Type IV tank hydraulic test measurement multi-national round robin (RR)
- Advance the Type IV tank pneumatic test measurement multi-national RR
- Initiate new RR activities on fuel quality effects on fuel cell stacks
- Initiate a focus on safety for our meetings and the International Partnership for Hydrogen and Fuel Cells in the Economy Steering Committee (IPHE SC) website

Technical Barriers

This project addresses the following technical barriers from the Codes and Standards section of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan section 3.7.5:

(A) Safety Data and Information: Limited Access and Availability

(F) Enabling National and International Markets Requires Consistent Regulations, Codes, and Standards

(G) Insufficient Technical Data to Revise Standards

(H) Insufficient Synchronization of National Codes Standards (by extension International Standards)

(K) No Consistent Codification Plan and Process for Synchronization of R&D and Code Development

Contribution to Achievement of DOE Codes and Standards Milestones

This project will contribute to achieving the following DOE milestones from the Safety Codes and Standards sections of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan (Section 3.7.7)

- 2.1 Publish a system for classifying accident types. (2Q, 2012)
  - Safety data base portal, incident highlights during Regulations Codes and Standards Working Group (RCSWG) meetings
- 2.2 Publish a draft international hydrogen fuel specification standard. (4Q, 2012)
  - Initiated a task force to investigate a fuel quality on stack behavior RR
- 2.9 Publish technical basis for optimized design methodologies of hydrogen containment vessels to account appropriately for hydrogen attack. (Q4, 2014)
  - Hydraulic and pneumatic Type IV tank testing measurement RR
- 3.1 Develop, validate, and harmonize test measurement protocols. (4Q, 2014)
  - Hydraulic and pneumatic Type IV tank testing measurement RR
- 3.2 Publish hydrogen quality testing protocols. (4Q, 2015)
  - Initiated a task force to investigate fuel quality effects on stack performance
- 4.2 Develop supporting research programs (round robins) to provide data and technologies. (2Q, 2012)
  - Tank measurement and fuel quality RR
- 5.1 Update safety bibliography and incidents databases. (4Q, 2011 – 2020)
  - IPHE safety Web portal to international data bases

FY 2013 Accomplishments

- Hydraulic testing successfully completed on the first of two 35-MPa tanks by the U.S.
  - Successfully performed analysis of the combined results, drafted improvements to the measurement protocol. Execution of the improved measurement protocol on the second 35-MPa tank is in progress by both participants as of the writing of this document.
- Hydraulic testing successfully completed on both 35-MPa tanks by China.
- Held two RCSWG face-to-face meetings which accomplished the following:

  - Advanced the tank measurement RR
  - Launched a RR on fuel quality for stack behavior
  - Made a safety discussion a standing agenda item
  - Launched a IPHE RCSWG presence on the IPHE SC website
  - Launched a RCSWG activity to produce an incidents/safety portal to international databases
- Provided two reports to the IPHE SC at the Fall and Spring SC Face-to-Face

INTRODUCTION

The IPHE was established in 2003 as an international intergovernmental organization to accelerate the use of hydrogen and fuel cells in the economy. It provides a mechanism for partners to organize, coordinate and implement effective, efficient, and focused international research, development, demonstration, and commercial utilization activities. The following countries are members of IPHE:

- Australia
- Germany
- New Zealand
- Brazil
- Iceland
- Norway
- Canada
- India
- Norway
- China
- Italy
- Republic of South Africa
- European Commission
- Japan
- United Kingdom
- France
- Republic of Korea
- United States

At the May 2010 IPHE SC meeting in Essen Germany the IPHE SC endorsed the importance of the RCSWG in taking a leading role in harmonizing RCS, from an IPHE top-down perspective. The IPHE/RCSWG is now one of two standing working groups for the IPHE; the other is the Education working group. The RCSWG's role is to create and conduct a forum where potentially contentious and controversial issues of RCS are identified and handled. The RCSWG can recommend a consensus solution and promote resolution of these contentious issues. The RCSWG also conducts pre-normative work to globally harmonize the execution of testing relevant to RCS.

BACKGROUND

The RCSWG has currently one RR in progress on measurement protocol for testing Type IV tanks. Additional activities are planned for the future. The RCSWG chose to pursue the tank testing issue first. There have been issues raised about the lack of uniformity in test measurement protocol related to Type IV composite overwrap pressure vessels. The RCSWG response was to launch a RR to define a harmonized test measurement protocol. Successful completion of this RR will result in the creation of a harmonized test measurement protocol suitable for use by testing facilities around the world. This protocol will ensure uniformity of testing procedures and subsequently uniformity in the results of these tests, regardless of where they are being performed. Also, the protocol will be suitable for smaller testing facilities as opposed to multi-million dollar research facilities.

APPROACH

A representative cycle stress test protocol was developed drawing from the three draft standards and regulations (SAE International J2579, the Global Technical Regulation, and the European Integrated Hydrogen Project Rev 12B). Our representative cycle stress tests will be or were applied both hydraulically and pneumatically. The testing will occur at several different RCSWG members' facilities around the world. The currently identified RCSWG participating countries in this RR are Brazil, China, the European Union (EU), France, and the U.S. Brazil has been active in helping to draft the protocol. China, France, and the U.S. are active in the hydraulic testing, the EU, France, and the U.S. are active in the pneumatic testing phase. Hexagon Lincoln has supplied four 35-MPa tanks for the hydraulic testing; Commissariat à l'Energie Atomique, France, is supplying six 70-MPa tanks for both the hydraulic and pneumatic phases of this project.

RESULTS

RCSWG has successfully completed the first test campaign on 35-MPa Type IV tanks, in China and the U.S. (see Figures 1 and 2). A total of four different test configurations were executed. Results from this first test campaign were analyzed and used to improve the test measurement protocol.

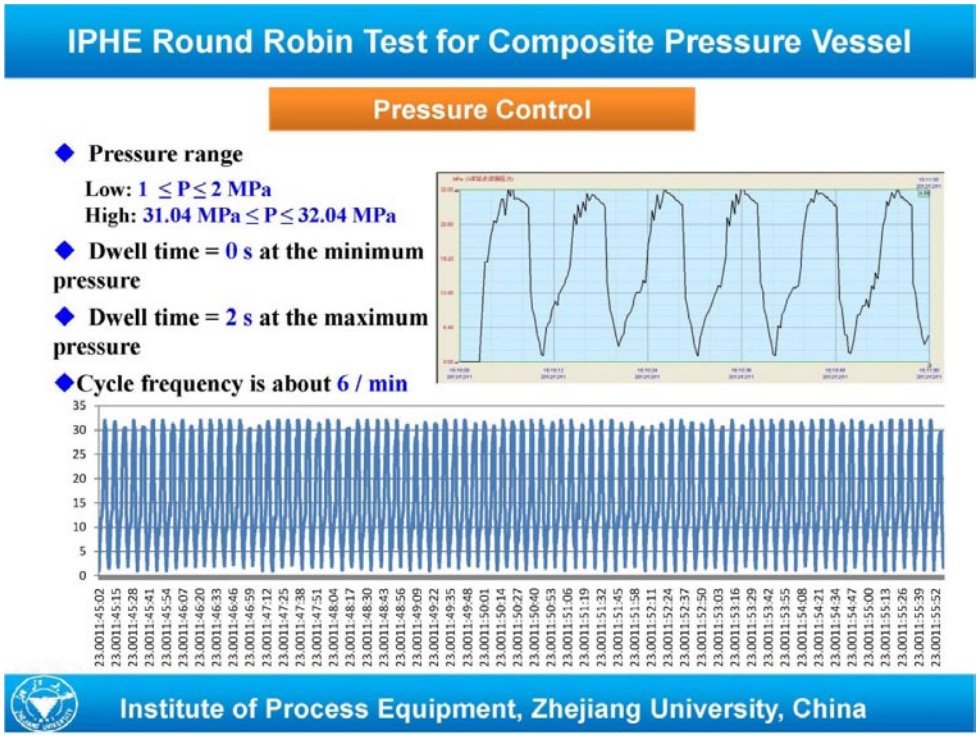

FIGURE 1. Test results from the Institute of Process Equipment, Zhejiang University, China. The figure shows tank pressure (ordinate) for a 100 cycles (abscissa) (bottom plot) and an expanded pressure vs. cycle for six cycles (top plot).

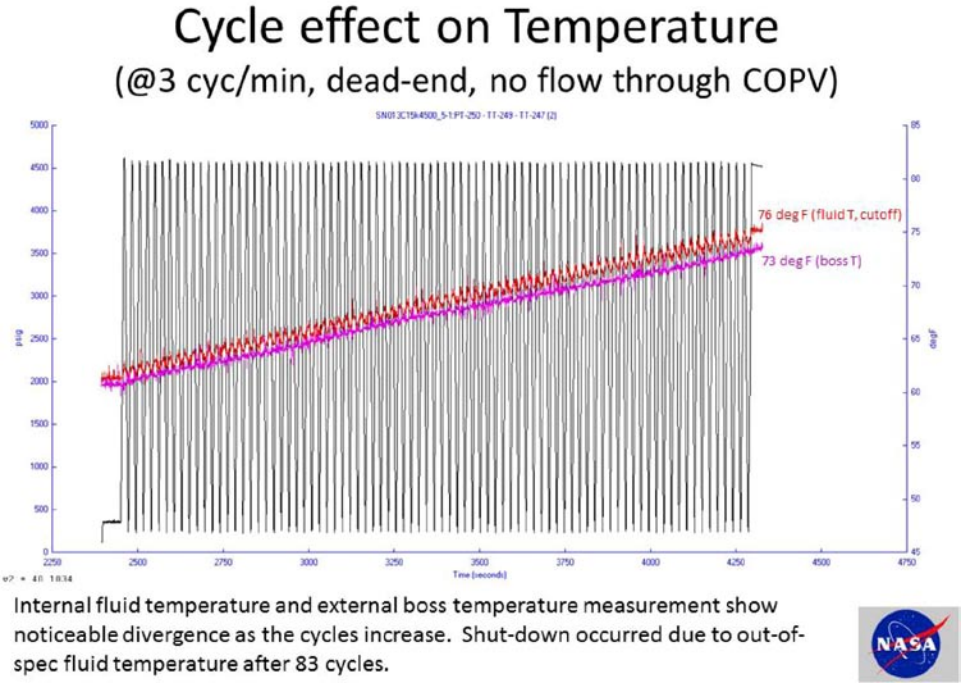

FIGURE 2. This figure shows the rise in temperature (ordinate) of the working fluid inside the tank at for the end-boss for a dead-ended configuration as a function of cycle number (abscissa). Note: the temperature deviation between the boss temperature (lower plot) and the in-tank fluid temperature (upper plot), and note that deviation grows with the number of cycles.

CONCLUSIONS AND FUTURE DIRECTIONS

This current phase of the RR on tank measurement protocol has been a success in that we have developed a test measurement protocol that, when applied, will ensure uniformity in results independent of the facility. We have also successfully demonstrated that when the modified test measurement protocol is used, the test campaign can be executed and maintained with in the cycle test specifications.

We have recently initiated the pneumatic phase of this RR and anticipate similar results from this effort. We have also initiated a RR focused on fuel quality effects on stack performance. Five member countries have been identified to comprise a task force to define this new RR. This RR has received official endorsement from the IPHE SC. We will officially launch at our Fall 2013 face-to-face meeting.

An additional benefit of the tank measurement RR will be the creation of two research laboratories which will have the capability to address the measurement of hydrogen dispensing suitable for metrology needs, as specified in International Organization of Legal Metrology R139 in the EU and National Institute of Standards and Technology Handbook 44 in the U.S. We will consider an activity addressing the pre-normative issues related to metering at the conclusion of the pneumatic phase of the Type IV tank RR.