TECHNICAL ASSESSMENT AND ANALYSIS OF HYDROGEN R&D PROJECTS

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Abstract

Energetics performs independent site-visit-based assessments of projects associated with the DOE hydrogen program. A report on the results of these assessments is provided to the Peer Review Panel to augment the information that they obtain from the Principle Investigators prior to and during the Peer Review itself. In addition, a more general, abbreviated version of the site-visit reports are made available as information to the public.

During the period May 1999-April 2000, Energetics performed a total of five site visits on Hydrogen R&D projects. While the details of these visits as presented in writing to the Review Panel are competition-sensitive, this paper contains some more generic general comments about these site visits.

Energetics also completed an analysis of a process that was devised by PowerBall Technologies, LLC, which involves the use of plastic-encapsulated sodium hydride pellets as an on-board hydrogen storage system. The most recent work involved the analysis of a process modification to the recycling step as proposed by PowerBall. The modification dealt with the addition of oxygen to the recycling process in order to increase the exothermicity of the reaction.

Introduction

Part of the role that Energetics plays in the DOE Hydrogen Program is to provide independent technical assessments of ongoing hydrogen R&D projects. In addition, Energetics performs analyses on hydrogen-related processes and systems. During the period May 1999–April 2000, Energetics visited five laboratories in order to perform assessments on hydrogen production and storage R&D projects. This paper discusses these assessments. In addition, Energetics has analyzed an alternative regeneration scheme for a hydrolysis-based metal hydride storage system. This subject is discussed in the paper entitled "Analysis of the Sodium Hydride-based Hydrogen Storage System being developed by PowerBall Technologies, LLC" which follows the present report.

Technical Assessment of R&D Projects

Background/Approach

Over the past four years, Energetics has performed site visits at the laboratories of nineteen projects that have been part of the DOE Hydrogen Program. This work adds a new dimension to the review process: it provides the reviewers with in-depth information that they cannot get from once-a-year 20 minute presentations. It also provides for more continuity in the interfacing between the Program and the projects, helping to establish ongoing dialogs with the Principle Investigators (PI).

Once a project is chosen for technical assessment, a literature review is performed on the subject. This includes a review of the last two or three years of Annual Operating Plan submittals, monthly reports, the Annual Review paper, reviewers' consensus comments from the past few years, publications in journals, and journal publications on the same or similar topics by other researchers. The PI is then contacted, and an on-site visit is arranged. A set of topic questions or discussion points is then drawn up and sent to the PI about two weeks prior to the visit. These questions form the basis for a major part of the discussion during the site visit.

During the site visit a tour is requested, preferably with a demonstration of the experimental process(es) as well as a presentation by the PI on the project and its current status. The visit then concludes with discussions based on the topic questions as well as on any other issues that may result from the tour, demonstration, and PI presentation. The on-site visit may last from a half-day to over a full day.

Following the site visit, two reports are written. The first is a detailed report that discusses the project and its strengths and weaknesses in a thorough manner. This report is provided to the Peer Review Team as part of their information package prior to the Peer Review Meeting. A copy is also provided to the Hydrogen Program Manager. The second report is a condensed narrative that discusses the technology but provides no critique. This second report is made available to the public.

Assessments Performed

Prior to May 1999 (the start date of this Annual Report), Energetics had performed a total of fourteen site-visit technical assessments of hydrogen R&D projects. These assessments are identified in Table 1. During the period of this current report (May 1999 – April 2000) a total of five additional technical assessments were completed. These are shown in Table 2.

Table 1. Technical Assessments Performed Prior to May 1999

Project	Performing Laboratory	Date of Visit
Enzymatic Conversion: Biomass-Derived Glucose to Hydrogen	Oak Ridge National Laboratory	Feb. 1996
Hydrogen from Catalytic Cracking of Natural Gas	Florida Solar Energy Center	Feb. 1996
Hydrogen Manufacture by Plasma Reforming	Massachusetts Institute of Technology	April 1996
Photovoltaic Hydrogen Production	U of Miami	May 1996
Hydrogen Storage in Carbon Nanofibers	Northeastern U	Dec. 1996
Carbon Nanotubes for Hydrogen Storage	National Renewable Energy Laboratory	June 1997
Storage and Purification of Hydrogen Using Ni-coated Mg	Arthur D. Little, Inc.	June 1998
Hydrogen Transmission and Storage with a Metal Hydride Organic Slurry	Thermo Power, Inc.	June 1998
Thermal Management Technology for Hydrogen Storage	Oak Ridge National Laboratory & Materials and Environmental Research, Inc.	August 1998
Improved Metal Hydride Technology	Energy Conversion Devices, Inc.	August 1998
Hydride Development for Hydrogen Storage	Sandia National Laboratories (CA)	Sept. 1998
Biomass to Hydrogen via Fast Pyrolysis and Catalytic Steam Reforming	National Renewable Energy Laboratory	Dec. 1998
Hydrogen Separation Membrane Development	Savannah River Technology Center	March 1999
Hydrogen Production by Photosynthetic Water Splitting	Oak Ridge National Laboratory	March 1999

Table 2. Technical Assessments Performed May 1999 – April 2000

Project	Performing Laboratory	Date of Visit
Bioreactor Project	University of Hawaii	July 1999
Insulated Pressure Vessels for Cryogenic Hydrogen Storage	Lawrence Livermore National Laboratory	September 1999
PEM Fuel Cell Stacks for Power Generation	Los Alamos National Laboratory	January 2000
Hydrogen from Biomass in Supercritical Water	University of Hawaii	March 2000
Hydrogen Storage Tank Liners	Lawrence Livermore National Laboratory	March 2000

Results/Conclusions

The outcome of the individual technical assessments cannot be reported in this document due to the competition-sensitive nature of much of the results. However, several broad conclusions can be reported here:

- Projects in general appear technically sound.
- The majority of these five projects appeared to be going down the correct technical pathway.
- Good progress is being made in the areas of hydrogen storage tanks and fuel cells.
- Safe, inexpensive on-board storage is probably the single most important need if hydrogen is to be the fuel of choice for fuel cell vehicles. In the nearer term, at least, hydrogen will need to be stored as either a compressed gas or a liquid.
- Constant reminders that these are supposed to be HYDROGEN projects is still important. We have found over the years that for several reasons (multiple funding sources is one major one) some projects tend to lose their hydrogen focus. This can manifest itself as, for instance, research on alternative on-board fuel choices, extensive emphasis on byproducts of a hydrogen production system, or focus on basic research that does not improve hydrogen production efficiency.
- Too much "territorialism" exists.
- More tie-in of the PIs with other phases of the overall Program is needed. Surprisingly, we found that many PIs are not very well attuned to what is going on in other parts of the Program including research in other areas, overall Program technical direction, or the interaction of the Program with other areas of DOE.