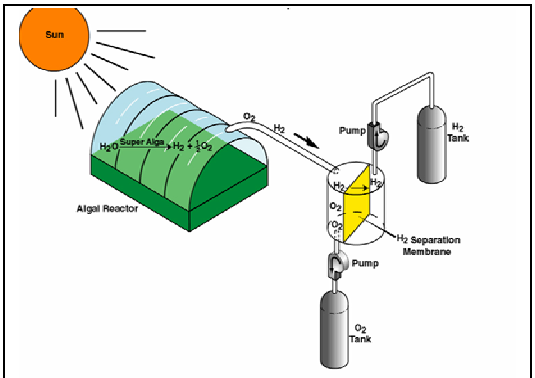
Hydrogen, Fuel Cells & Infrastructure Technologies Research

Through collaborative research and development, Oak Ridge National Laboratory (ORNL) is working to deliver technology breakthroughs that will increase energy effficiency and reduce the environmental impact on the transportation sector, ultimately providing science and technology to enable a U.S. transportation system that does not depend on foreign sources for fuel. ORNL is developing materials and processes for fuel cell systems and for the practical generation, storage, and delivery of hydrogen as an energy carrier.

Hydrogen Production & Delivery

Research projects currently under way at ORNL include:

- Combined Hydrogen and Electricity Energy Delivery (i.e., the "Super Grid" concept)
- Development of Efficient and Robust Algal H_2 Production Systems
- Inorganic Membranes for Hydrogen Separation
- Pyrochlore/Perovskite Ion Transport Membranes
- Hydrogen Permeability and Integrity of Hydrogen Transfer Pipelines
- Durable Semiconducting Oxide Anodes for the Photo-Assisted Dissociation of Water and the Production of Hydrogen
- Development of a Prototype Hydrogen Transition Model



Vision of H_2 production from designer alga

Hydrogen Storage

Researchers at ORNL are studying structural monitoring systems for high-pressure H_2 storage tanks. The objective of this project is to integrate smart structure capabilities into the high-efficiency, high-pressure composite tanks developed by Quantum Technologies Worldwide (QTWW). Compressed storage is an attractive near and possibly medium-term solution for efficient storage of hydrogen. Compressed hydrogen storage tanks would benefit from the integration of "smart structure" technologies to attain some of the FreedomCAR requirements, most notably the cost and weight reduction requirements that will demonstrate the economic viability of high-pressure tank systems. In the present project, ORNL is collaborating with QTWW to develop a strain monitoring system for their "TriShield" high-pressure tanks. Other non-destructive evaluation methods for tank health monitoring are being considered as well, including a composite damage detection technique using fluorescence imaging pioneered at ORNL.

ORNL is also developing advanced concepts for hydrogen storage including:

- Chemical Hydrides
- Metal Hydrides
- Carbon Materials
- Nonstandard Storage Methods

Education & Cross Cutting Analysis

Researchers at ORNL are supporting the Hydrogen Fuel Cells & Infrastructure Technologies (HFC&IT) Education Program by: (1) establishing a quantitative baseline of public understanding of hydrogen issues, (2) enhancing the HFC&IT website, (3) validating and maintaining a database of university programs and research on hydrogen fuel cells and the hydrogen economy, and (4) providing support for curriculum development and outreach activities.

Safety Codes & Standards

Researchers at ORNL are looking at fiber optic sensors for hydrogen detection. It will be essential that a reliable, robust, and low-cost means of detecting and locating hydrogen leaks be developed to assure rapid detection to protect equipment, the public, and the environment. In addition, researchers are developing a hydrogen pipeline-leak detection system that monitor tens of miles of piping from a central location. The sensors will be resistant to contaminants, accurate and reliable at low concentrations of hydrogen, and capable of being inexpensively manufactured and integrated into high pressure tanks of their lines.

Fuel Cell R&D

The National Transportation Research Center has just begun operation of a UTC phosphoric acid fuel cell to provide heating, cooling, and electricity to the building. It is currently supplying up to half of the building's power supply. Hydrogen is generated from an on-site natural gas steam reformer and a SEMCO desiccant wheel recovers energy (heating or cooling) and controls humidity from exhaust air. Other fuel cell research projects currently under way at ORNL include:

70% efficient graphite foam fuel cell heat exchanger

- Microstructure Characterization of PEM Fuel Cells
- Cost-Effective Metallic Bipolar Plates Through Innovative Control of Surface Chemistry
- Compact Carbon Foam Radiation for Fuel Cell Power Systems
- Development of a Robust Fiber-Optic Temperature Sensor for Fuel Cell Monitoring
- Selective Catalytic Oxidation of Hydrogen Sulfide
- High-Temperature PEM Membrane Development

Success Story

ORNL has developed a low-cost slurry-molding process for producing carbon composite bipolar plates for PEM fuel cells that received the 2002 "Excellence in Technology Transfer Award" from the Southeast Region of the Federal Laboratory Consortium. The Award was given for the successful transfer of the technology to Porvair Fuel Cell Technology, Inc. The manufacturing process involves the production of a carbon-fiber plate perform, into which flow fields are embossed rather than machined. Chemical vapor infiltration is used to coat the plate with a layer of carbon, making it hermetic and highly conductive. Porvair has licensed the technology and is scaling up production to the pilot plant level.

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