XI.9 Novel, Low-Cost Solid Membrane Water Electrolyzer (Phase II Project)

John A. Kosek
Giner, Inc.
89 Rumford Ave
Newton, MA 02466
Phone: (781) 529-0505; Fax: (781) 893-6470; E-mail: jkosek@ginerinc.com

DOE Technology Development Manager: Matt Kauffman
Phone: (202) 586-5824; Fax: (202) 586-9811; E-mail: Matthew.Kauffman@ee.doe.gov

DOE Project Officer: Alec Bulawka
Phone: (202) 586-5633; Fax: 202-586-8148; E-mail: Alec.Bulawka@hq.doe.gov

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Objectives

- To refine select solid membrane alkaline electrolyzer (SMAE) stack components.
- To scale-up the SMAE stack in both active area and number of cells.
- To design a complete SMAE system.
- To demonstrate operation of a SMAE stack operating on solar power.
- To conduct an economic analysis, projecting the cost of the complete SMAE system.

Technical Barriers

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

- J. Costs
- R. System Efficiency
- T. Renewable Integration

Approach

The goal of this DOE small business innovation research (SBIR) project is the development of a SMAE which is capable of high current density and high differential pressure operation. This improvement in operating conditions is obtained at a small cost increase (per cell) over that of the state-of-the-art low-pressure alkaline electrolyzer which is considerably lower than for acid (proton exchange membrane [PEM]) electrolytes. The ability to run at substantially higher current densities will enable the stack to be built with far fewer cells (hydrogen production rate is directly proportional to current density for a given cell size), and will therefore cost significantly less than standard alkaline electrolyzers. The main component of the alkaline electrolyzer cell, being developed under this DOE SBIR project, is a membrane electrode assembly (MEA) in which the membrane is a novel alkaline membrane. The membrane is sandwiched between two electrodes made with electrocatalyst and supports which are stable in alkaline solutions. The electrodes of the cell can be based on noble metals (as in an acid electrolyzer) but they can also use less expensive base metals, typically nickel or noble metal doped nickel.

The MEA or active component of the electrolyzer is compressed between bipolar plates of similar design as the ones used in state-of-the-art PEM electrolyzers except that they are made of nickel or of an alkaline resistant nickel alloy, carbon or even stainless steel. The electrolyzer is made of a stack of these cells connected in series by means of bipolar plates. When fully developed, the SMAE to be developed in this SBIR project will receive its power from a photovoltaic source, resulting in a low-cost, *green* H_2 production system.

Accomplishments

- The feasibility of operating a differential pressure water electrolysis stack containing a novel alkaline membrane was demonstrated. Select cells were able to be operated at current densities out to 1,000 mA/cm^2 at differential pressures of up to 2.06 MPa.
- Single cell operation with a thin alkaline membrane demonstrated the ability to operate the cell at greater than 85% voltage efficiency at current densities above 400 mA/cm^2.
- A three cell stack was successfully fabricated and operated at atmospheric pressure. The stack had an overall voltage efficiency of 87% at 400 mA/cm^2.
- The feasibility of using nickel based hardware in the electrolyzer was demonstrated.
- Projected the cost for high pressure hydrogen production (100,000 SCFD hydrogen) at 29% below the DOE targets for 2005.