Uninterrupted Power Source

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Objectives

To supply a fuel cell/battery power plant system which can supply immediate power (from l to 5 kW) to the grid in case of power failure

Technical Barriers

This project addresses the following technical barrier from the Fuel Cells section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year R,D&D Plan:

- D. Fuel Cell Power System Benchmarking

Approach

- Design a 1- to 5-kW fuel cell/battery power plant system
- Test at in-house and in outside laboratories
- Analyze the results of the tests and finalize the design

Accomplishments

- Since the inception of this project, testing of a 300-watt Apollo alkaline fuel cell coupled with a lead cobalt battery has been carried out.
- In December, 2002, a 2.2-kW alkaline fuel cell and lead-acid battery were tested at Hydrolec Incorporated of Jacksonville, Florida, one of Apollo's customers.
- From January to June, 2002, a 2.5-kW alkaline fuel cell was tested by Apollo at a fuel cell manufacturing plant in Cologne, Germany.
- Preparations are being made in September, 2003, to test a 2-kW alkaline fuel cell and lead cobalt battery at the Florida Atlantic University.
- An ammonia cracker was developed and tested at the Technical University of Graz in Austria under the direction of Dr. Karl Kordesch. This provides an excellent method of delivering hydrogen to the fuel cell.
- The ammonia cracker has been in continuous operation at Apollo's laboratory in Fort Lauderdale, Florida.
- A larger and more advanced version of the ammonia cracker was developed and tested at the Apollo Fuel Cell Laboratory in Austria and has been sent to Fort Lauderdale, Florida, for further testing and evaluation. Plans are to test it at the Florida Atlantic University.

- Production of a special battery for the Apollo Power Plant system has been subcontracted to Millennium Battery Company, a manufacturer of batteries in Miami, Florida.
- A study of power plant-to-grid switches has been made.
- A study of hydrogen sensors has been made.

Future Directions

- A 2-kW Apollo Power Plant has been built and will be installed at the Florida Atlantic University in Boca Raton, Florida, for demonstration to interested parties.
- A 5-kW Apollo Power Plant will be built, using experience gained from the 2-kW unit, to be delivered to DOE.

Introduction

Many companies are developing fuel cells which can be used to supply instant power to the grid in case of grid failure. In the low temperature fuel cell field (70-80°C), development has proceeded on two types of fuel cells: the alkaline fuel cell (AFC), which has been used by the National Aeronautics & Space Administration (NASA) since the Apollo Moon Mission of the 1960s, and the proton exchange membrane (PEM) fuel cell. The AFC has the highest cell voltage and efficiency of any fuel cell but was considered too expensive for commercial applications. However, it has been shown that the AFC can be produced at a much lower cost than its competitor for earth applications, and it has been demonstrated that the AFC is less complicated, not requiring humidification and air compressors. Also, it has been shown that the AFC can be advantageously shut down during periods when its energy is not needed, while the PEM fuel cell can never be routinely shut down. To take advantage of this shut-down feature, Apollo Energy Systems has developed a system wherein a battery can be paralleled with the AFC and can do most of the work while the AFC is dormant. This prolongs the life of the AFC and results in lower overall cost since the fuel cell (which operates only intermittently) is more expensive than the battery (which is in continuous operation). It has also been found that the AFC can operate on far less noble metal catalyst than the PEM fuel cell, resulting in a lower manufacturing cost.

Therefore, Apollo Energy Systems has embarked on a program of AFC development coupled with battery development and plans to produce Apollo Power Plants for residential, commercial and industrial applications and Apollo Electric Propulsion Systems for application in land, water and air vehicles.

Approach

Several prototype Apollo Power Plants of different electrical sizes will be tested and evaluated so as to create a performance base for sizing the final prototype fuel cell and battery combination (see Figure 1). Tests will be carried out at Apollo's laboratory in Fort Lauderdale, Florida, at the laboratory of one of Apollo's customers, at a fuel cell facility in Germany, at a local university (Florida Atlantic University of Boca Raton, Florida), and finally at Apollo's pilot plant in Florida which is planned to be constructed in the last quarter of 2003.

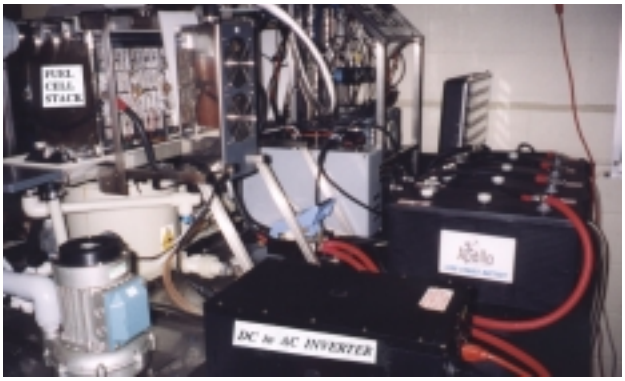

Figure 1. 2 kW Apollo Power Plant with Alkaline Fuel Cell stack, Lead Cobalt Battery and DC to AC Inverter

Results

- A 300-watt Apollo Power Plant has been built and is under constant test in Apollo's laboratory in Ft. Lauderdale, Florida. Results to date are positive.
- A 2-kW Apollo Power Plant has been built and will be installed at the Florida Atlantic University in Boca Raton, Florida.

Conclusions

- The basic concept of combining an AFC with a lead cobalt battery has been shown to be technically viable.
- As a result of this work, Apollo believes that Apollo Power Plants for stationary use and Apollo Electric Propulsion Systems for use in vehicles, boats and aircraft can be produced and effectively utilized, at reasonable prices.

FY 2003 Publications/Presentations

Six papers published in the Handbook of Fuel Cells - Fundamentals, Technology and Applications (ISBN: 0-471-49926-9), by John Wiley & Sons, Ltd., Chichester, UK, 2003:

1. Hydrogen/Oxygen (Air) Fuel Cells with Alkaline Electrolytes, M. Cifrain and K. Kordesch, Volume 2, Part 4, pp 267-280
2. Stack Materials and Design, K. Kordesch and V. Hacker, Volume 4, Part 4, pp 765-773
3. Ammonia Crackers, V. Hacker and K. Kordesch, Volume 3, Part 2, pp 121-127
4. A Comparison Between the Alkaline Fuel Cell (AFC) and the Polymer Electrolyte Membrane (PEM) Fuel Cell, K. Kordesch and M. Cifrain, Volume 4, Part 4, pp 789-793
5. Alkaline Methanol/Air Power Devices, G. A. Koscher and K. Kordesch, Volume 4, Part 9, pp 1125-1129
6. Automotive Development, V. Hacker and K. Kordesch, Volume 4, Part 11, pp l217-1223

Abstracts of four papers to be presented at Fuel Cell Conferences in 2003

1. Electronic Abstract, Ammonia as Hydrogen Source for an Alkaline Fuel Cell-Battery Hybrid System, K. Kordesch, V. Hacker, G. Faleschini, G., Koscher, M. Cifrain, *Fuel Cell Seminar, Miami Beach, Florida, November 3-6, 2003*
2. Flowing Electrolyte Direct Methanol Fuel Cells, D. James, X. Deng, K. Kordesch, *Fuel Cell Seminar, Miami Beach, Florida, November 3-6, 2003*
3. Alkaline Fuel Cells (An Overview) - Tutorial on Fuel Cells, K. Kordesch and M. Cifrain, *204th Meeting of the Electrochemical Society, Orlando, Florida, October 12-17, 2003*
4. Can Refillable Alkaline Methanol-Air Systems Replace Metal-Air Cells?, K. Kordesch and G. Koscher, *23rd Power Sources Symposium, September 22-24, Amsterdam, Holland*

Special Recognitions & Awards/Patents Issued

1. 2 Patent Applications have been filed on Alkaline Fuel Cells, Karl Kordesch, M. Cifrain
2. 1 Patent Application has been filed on an Ammonia Cracker, Gottfried Faleschini, Viktor Hacker, Karl Kordesch
3. 3 Patent Applications have been filed on Tri-Polar Lead-Cobalt Batteries, Robert Aronsson