NAS 8-2696-TM-00059

TECHNICAL MEMORANDUM

November 10, 1964

To: B. R. Nichols

From: P. D. Hess

Subject: Fuel Cell Module Development Plan - Activity 145 - 205

Distribution: J. L. Platner, D. P. Ghere, R. E. Lochen, J. R. Hurley, C. Martin, G. Johnson

---

1.0 FUNCTION

The Fuel Cell Module is the power subassembly that converts chemical energy to electrical energy. It consists of 33 two-cell sections and has the static moisture control subsystem as an integral part of the module. The requirements and components are described in Paragraph 3.1.1 of the Centerline Specification (NAS 8-2696-S-00024).

2.0 STATUS

Two fuel cell modules consisting of 35 two-cell sections have been constructed and tested as a breadboard system. The results of these tests have shown that a cell performance of 0.80 volts at 160 ASF or better can be expected for required life goals. The testing of these modules is continuing to verify life data.

3.0 DEVELOPMENT AREAS

The development areas of the fuel cell module will be limited to investigation of the following areas.

3.1 Gold plating of the oxygen plate will be investigated as an alternate to silver plating. The present oxygen plates, used in conjunction with the silver oxygen electrodes, have a layer of silver plated over the nickel-plated magnesium for additional corrosion protection. Problems with the silver plating have been observed in obtaining a good bond of the silver to the nickel plate and a silver plate of uniform thickness. In cell operation, the silver electrodes develop a bond to the silver plating and possibly cause a gas diffusion limitation to the electrode reactant sites. Also rebuilding or re-use of the oxygen plates is difficult and frequently requires replating. Porosity in the silver plating has also been noted which allows corrosion of the nickel substrate.

Initial testing of gold plating over the nickel-plated magnesium oxygen plates had produced good results in bonding, uniformity of thickness and produces a non-porous plate. A few cells have been constructed with gold-plated oxygen plates and the silver oxygen electrode could be readily removed without damage to the plating bond, indicating superior rebuild characteristics.

Additional testing should be accomplished to verify initial results.

3.2 Improved methods for manifolding reactant gases into individual cell plates should be investigated so as to minimize localized drying effects. The reactant gases are ported into the cells through 0.030" by 0.250" holes that have been cut by the EDM process. These EDM holes connect to a 0.062" by 0.093" transverse slot for distribution of the reactant gases over the face of the electrodes through the 0.030" by 0.060" grooves. A change in the abrupt transition from EDM hole to slot may result in a better gas distribution.

Tests should be designed to minimize these adverse effects. Designs for improved intercell reactant manifolding should attempt to use the water vapor and water transport membrane for humidification of reactant gases.

3.3 Methods of dry stacking fuel cell modules should be investigated as an improvement over wet stacking.

Wet stacking of fuel cell modules requires that calibrated amounts of KOH electrolyte be added into the cell membranes and water transport membranes. Additionally, wet stacking makes it difficult to handle saturated asbestos sheets.

Dry stacking could greatly increase the speed of assembly and possibly result in a more optimum electrolyte distribution in asbestos membranes. Tests should be designed to test the feasibility of dry stacking and to develop techniques for dry stacking.

3.4 Modules should be constructed with 20 mil asbestos and compared to the 30 mil asbestos built cells for improved capacity and/or efficiency, performance and life.

Decreased capacity and/or efficiency can be realized by reducing the internal ohmic resistance of individual cells. Reduced ohmic resistance is possible in cells built with 20 mil asbestos as compared to the standard 30 mil asbestos cell. Tests should be designed to evaluate possible performance advantages against the possible reduced reliability of the 20 mil system.

3.5 Additional testing, over that accomplished under Part II, should be conducted on Type 446 and 546 electrodes to allow comparison of these electrodes to the standard Clevite electrode. A statistically significant number of electrodes should be tested to verify equivalent performance and life.

3.6 Type HYSAC silver electrodes should be tested and compared to SINAC silver (15 g) for improved capacity and life. A statistically significant number of electrodes should be tested.

3.7 Technique for installing transistorized sensing elements internal to the cell should be investigated for possible improved temperature compensation of the vacuum controller.

4.0 TEST PLAN

Test specifications detailing the required testing and the required completion date for the testing should be generated as soon as possible.

P. D. Hess

P. D. Hess

nfm