ADVANCED WATER-COOLED PHOSPHORIC ACID**FUEL CELL DEVELOPMENT****TECHNICAL PROGRESS REPORT NO. 20****A QUARTERLY REPORT****for****OCTOBER, NOVEMBER, DECEMBER 1989****Contract DE-AC21-88MC24221****FCR-10836****Prepared for**

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PROGRAM HIGHLIGHTS

- Fabrication of repeat parts for the small area short stack is progressing. One hundred (100) electrode substrates and 150 ERP substrates were graphitized. In addition, 30 electrode substrates were run through each manufacturing step to verify the manufacturing process.
- The teflon content and compaction pressure of shop-made electrodes for the small area short stack was optimized based on results of single cell tests.
- A single cell with GSB-18P catalyst and 1 mg/cm² loading continues to perform very well. Performance is 0.66 volts per cell after 1200-hours of operation at 300 ASF.
- Three integral separator plate (ISP) configurations have been selected for verification in the upcoming short stack based on out-of-cell tests.
- Bubble pressures over 7 psid have been demonstrated in filler-bands applied with a production curtain and coating process.
- Five (5) full-size (small area) coolers were successfully molded, and development of encapsulation approaches for molded and commercial graphite coolers continued.

I. INTRODUCTION

The Advanced Water Cooled Phosphoric Acid Fuel Cell Development program is being conducted by International Fuel Cells Corporation (IFC) to improve the performance and minimize the cost of water cooled, electric utility phosphoric acid fuel cell stacks.

The program adapts the existing on-site Configuration B cell design to electric utility operating conditions and introduces additional new design features. Task 1 consists of the conceptual design of a full-scale electric utility cell stack that meets program objectives. Tasks 2 and 3 develop the materials and processes required to fabricate the components that meet the program objective. The design of the small area and three 10-ft² short stacks is conducted in Task 4. The conceptual design also is updated to incorporate the results of material and process developments, as well as results of stack tests conducted in Task 6. Fabrication and assembly of the short stacks is conducted in Task 5 and subsequent tests are conducted in Task 6. The Contractor expects to enter into a contract with The Electric Power Research Institute (EPRI) to assemble and endurance test the third 10-ft² short stack. The management and reporting functions of Task 7 provide DOE/METC with program visibility through required documentation and program reviews.

This report describes the cell design and development effort that is being conducted to demonstrate by subscale stack test, the technical achievements made toward the above program objectives.

II. STATUS

TASK I – CONCEPTUAL DESIGN

Objectives

The objective in this task is to define the conceptual design for a cell stack having a performance level of at least 175-W/ft² and a manufactured cost of less than \$400/kW. The stack must be capable of operating for a minimum of 40,000 hours at electric utility conditions.

Activity

This activity was completed. Conceptual design updates will be reported in Task 4 – Stack Design.

TASK 2 – COMPONENT DEVELOPMENT

Subtask 2.1 – Materials Development

Objectives

The objectives of this subtask are to provide an improved substrate, verify the stability of low cost substrate and electrolyte reservoir materials at pressurized cell operating conditions, and increase the thermal conductivity of the electrolyte reservoir.

Activity

Substrate precursor paper formed by Vendor C for IFC was heat treated and used to build 2 inch by 2 inch cells. Test results for these substrates show that cell performance met goals.

Thirty (30) substrates made by Vendor A and Vendor C were processed through each step of electrode processing. Overall attrition of Vendor C substrates was twice that of Vendor A substrates.

The thermal conductivity of the electrolyte reservoir plates which were heat treated in a one-step process was significantly higher than the specification:

	<u>Specification</u>	<u>One Step HT ERP</u>
Thermal Conductivity (Btu/HrFt°F)	> 8.0	11.6

Electrolyte reservoir plates formed with both carbon fiber and natural fiber and heat treated via the 2-step process have completed laboratory evaluation. The results are shown in Table 2.1-1.

Table 2.1-1. ERP Fiber Reinforcement Comparison		
Property	Carbon Fiber	Natural Fiber
Density (g/cc)	1.10	1.13
Compressive Yield Strength (psi)	499	468
Compressive Modulus (psi)	17,461	19,660
Flexural Strength (psi)	1265	1531
Electrical Resistance (mV/mil)	0.002	0.003
Thermal Conductivity(Btu/HrFt °F)	12.8	9.3
Corrosion Potential (mV)	1180	1160

Subtask 2.2 – Single Cell Testing

Objectives

The objectives of this subtask are to test subscale cells to evaluate improvements in cell components consisting of substrates, electrolyte reservoir plates, catalyst and matrix; verify performance and endurance of components fabricated for short stacks; optimize the hydrophobicity of catalyst layers made from the GSB-18 and GSB-18P catalysts for operation at power densities of 200 WSF or greater; evaluate a higher performing laboratory catalyst for this application, and define the permissible range of operating conditions.

Activity

(1) Improved Catalyst Layers

Cell tests of new improved catalyst layers have continued during this quarter. See Table 2.2-1. A test program which stresses the functional capabilities of both anodes and cathodes is being followed. This program is directed towards identifying both anode and cathode catalyst layers which have improved electrolyte management properties. The development of these new catalyst layers will allow higher cell efficiencies at power densities of 200 WSF or greater. Each cell test follows the identical program so that direct comparisons of performance can be made between electrodes with different hydrophobicities. Programs consist of break-in at 60-300 ASF; diagnostics and performance to 500 ASF; and shutdown and electrolyte conditioning (wet-up) cycles.

Table 2.2-1. Subscale Cells With Improved Catalyst Layers

Table 2.2-1. Subscale Cells With Improved Catalyst Layers			
<u>Cell #</u>	<u>Anode</u>	<u>Cathode</u>	<u>Test Purpose</u>
4360	0.26 mg HYCAN (I)	0.51 mg GSB-18 (I)	Evaluate improved electrode catalyst layers
4361	0.26 mg HYCAN (I)	0.50 mg GSB_18 (I)	
4362	0.26 mg HYCAN (S)	0.50 mg GSB-28 (S)	
4363	0.25 mg HYCAN (I)	0.50 mg GSB-28 (I)	
4380	0.25 mg HYCAN (I)	0.52 mg GSB-28 (I)	
4381	0.25 mg HYCAN (I)	0.52 mg GSB-18 (I)	
4382	0.24 mg HYCAN (I)	0.53 mg GSB-18 (I)	
4383	0.26 mg HYCAN (S)	0.51 mg GSB-18 (S)	
4405	0.27 mg HYCAN (I)	0.52 mg GSB-18 (I)	
4406	0.26 mg HYCAN (I)	0.51 mg GSB-18 (I)	
4407	0.25 mg HYCAN (S)	0.52 mg GSB-18 (S)	
4408	0.24mg HYCAN (S)	0.51 mg GSB-18 (S)	
4384	0.25 mg HYCAN (S)	0.50 mg GSB-18 (S)	Freeze test for anode stability
4385	0.26 mg HYCAN (I)	0.50 mg GSB-18 (S)	
Notes:			
(I) - improved catalyst layer with wettability control features			
(S) - standard catalyst layer			

This test program led to large performance losses in the cells. It is evident from the test data that the new anode structure is very stable since in every test the hydrogen gain did not increase appreciably through the testing sequence. The performance stability of the cathode structure was not as good. The oxygen gain did increase steadily during the test.

The performance comparison data for the best performing new catalyst layers are shown in Table 2.2-2. The improved cathode structures, evaluated in the builds listed, demonstrated better stability than the standard cathode on the basis of oxygen gain changes. This observation led to the 4th generation of cell tests. In this series of tests two cells were built with standard electrodes (4407 – higher than normal cathode hydrophobicity, 4408 – normal cathode hydrophobicity). Two cells were built with new improved electrodes (the cathode in 4405 is similar to that in 4382 and the cathode in 4406 more hydrophobic than that in 4405). The anodes (4405, 4406) were the new improved types used in all of the cells listed in Table 2.2-1. An initial set of hydrogen gains and oxygen gains were done on each cell (Table 2.2-3) and they were placed on endurance at 300 ASF. As shown in Figure 2.2-1, the performance stability of each of these cells is excellent.

At this time the cells with standard electrodes are performing slightly better, on an absolute level, than the cells with improved electrode structures. The cells will continue at 300 ASF until 1,000 hours when diagnostics will be performed. After the diagnostics are taken, the cells will start a program of shutdowns.

Another set of cells (4384, 4385) has been run over this reporting period to establish the stability of the new anode structures. All previous testing of the improved anodes indicated good stability; however, tests to establish improved anode stability generally require long test times. Therefore an accelerated test program was needed to evaluate the new structures in a reasonable time period. It has been determined from previous testing at IFC that putting cells through a shutdown cycle which solidifies the electrolyte can lead to significant decay of the anode. A test program with six “freeze” cycles was chosen and one cell with the standard HY-CAN anode (4384) was also evaluated at the same time as the new improved anode (4385). The cathodes in both of these cell tests are standard electrodes. Hydrogen gains for the two cells are plotted in Figure 2.2-2 before and after each of the five (5) “freeze” cycle. Through the first five (5) freeze cycles the improved anode is very stable and is also performing better on an absolute basis than the standard anode. The test program will be terminated after the sixth “freeze” cycle.

The results of the subscale cells tested during the past quarter indicate that the new improved electrodes allow better acid management within the cell package and, therefore, improved high current density performance. The anodes are very stable, and some of the new cathode structures have stability at least comparable to the standard cathodes. Continued cell testing should result in data which can document the performance advantages of the new improved structures.

**Table 2.2-2. Performance Comparison:
New Electrodes vs. Standard Electrodes**

Cell No.	Electrode Type (Anode and Cathode)	Performance H ₂ Gain pre/post mV at 300 ASF	Changes O ₂ Gain pre/post	Operating Condition
4383	Standard	23/21 21/19 19/22	100/110 110/119 119/131	3-shutdowns 1-wetup Acid Addition
4382	Improved	23/21 21/20 20/47	98/101 101/102 102/110	3-shutdowns 1-wetup Acid Addition
4362	Improved	21/20 21/20 20/26	96/98 101/105 105/102	3-shutdowns 1-wetup Acid Addition
4361	Improved	21/20 22/21 21/22	103/110 111/118 118/117	3-shutdowns 1-wetup Acid Addition

**Table 2.2-3. Initial Performance for 4th Generation Cell Tests
Diagnostic Data**

Cell No.	Load Time -hrs.	Performance at 300 ASF - mV		
		Cell Voltage	H ₂ Gain	O ₂ Gain
4405	324	627	20	92
4406	305	631	22	92
4407	303	633	25	86
4408	282	634	21	102

2) Electrode Optimization Trials

Nineteen (19) subscale cells were run during the quarter to provide information on the effects of TFE-content and compaction pressure on the performance of electrodes made by production methods. Cells from this series of tests which continue to run are listed in Table 2.2-4.

The anode and cathode catalysts which were used to make electrodes for all of the cells in Table 2.2-4. were qualified for use in the short stack. Cell 4387 was used for the qualification test. This cell, containing electrodes made in the laboratory continues on test. Its performance at 1506 hr. is 20 mV above E-line at 300 ASF and atmospheric conditions.

Table 2.2-4. Effect of % TFE and Compaction Pressure on the Performance of Shop-made Electrodes				
Build #	Relative TFE Content	Relative Compaction (pli)	Hours	Volts (at 300 ASF/415°F) 80:60μ
4390	1	4	1294	0.585
4399	1.29	2	1025	0.612
4401	1.14	2	1000	0.625
4402	1.14	2	995	0.616
4403	1	2	928	0.618
4404	1	2	924	0.626
4416	1.29	2	399	0.615
4417	1.29	2	395	0.614
4422	1.29	1	227	0.605
4423	1.29	3	226	0.610

GSB-18P Cathode Catalyst

Cell # 4394 containing a GSB-18P cathode has been on test for the past two months. The 18P catalyst is from a 500g batch prepared at IFC.

The cathode was fabricated in the laboratory; the loading is 1 mg Pt/cm². After 1200 hours on test at 14.7 psia/415°F the cell is giving 0.660V at 300 ASF, 80:60μ (ie. 200 WSF)

Its performance and stability are equivalent to that reported for "1 mg cells" under contract DEN3-364 - see FCR-8022, Technical Progress Report #12, June 1985 - May 1986.

TASK 3 - PROCESS DEVELOPMENT

Subtask 3.1 - Substrates

Objective

The objectives of this subtask are to develop the process technologies required to produce electrode substrates and electrolyte reservoir plates that meet the technical requirements and cost objectives established in the conceptual design.

Activity

One hundred full-size substrate precursors were given an experimental heat treatment which carbonized and graphitized them in one step. The heat treated sheets were wrinkled, presumably due to insufficient pressure on them. Samples of the heat treated sheets are being used to measure their physical properties.

A second one hundred full-size substrate precursors were experimentally heat treated in a one-step process. This trial was a repeat of a previous run that was deemed unsuccessful because the parts were wavy after heat treat. Improvements were made by putting only one-half as many sheets between each heat treat spacer and locating the parts at the bottom of the entire heat treat load thus increasing the compressive load on the parts. These improvements resulted with essentially 100% of the substrate precursors surviving heat treat with satisfactory flatness. Samples of these heat treated substrates are compared to Vendor A substrates for density, thickness, and thru-plane pressure drop in Figure 3.1-1.

Figure 3.1-1. Properties Comparison Vendor A vs. IFC Substrate

The electrolyte reservoir plates that completed the one-step heat treatment were characterized. Results are summarized in Table 3.1-1.

Table 3.1-1. One Step Heat Treat Electrolyte Reservoir Plates		
Property	Targets	Measured
Density (g/cc)	0.90-1.25	1.07
Compressive Yield Strength (psi)	> 125	370
Compressive Modulus (psi)	—	12,759
Flexural Strength (psi)	> 350	723
Electrical Resistance (mV/mil @ 100 ASF)	< 0.01	0.002
Thermal Conductivity (Btu/HrFt°F)	> 8.0	11.6
Corrosion Potential (mV)	> 1150	1190

Another experimental substrate sample submitted by Vendor B was characterized. The results are summarized in Table 3.1-2.

Table 3.1-2. Vendor B Substrate Property Comparison		
Property	Sample 1	Sample 2
Density (g/cc)	0.37	0.35
Compressive Yield Strength (psi)	< 100	182
Flexural Strength (psi)	1085	2800
Electrical Resistance (mV/mil)	0.033	0.075
Thermal Conductivity (Btu/HrFt°F)	0.24	0.20
Mean Pore Size (microns)	80	31
Porosity (%)	76	78

Subtask 3.2 – Integral Separator

Objective

The objective of this subtask is to develop the process technology to fabricate integral separators, up to 10-ft² in size, that meet the technical requirements and cost objectives established in the conceptual design.

Activity

A series of screening tests were developed for evaluating ISP's removed from stack and rigs which have operating times up to 2600 hours. These tests measure sample electrical resistance, gas permeability, gas diffusivity, fluorescent dye penetration and electrochemical acid pumping. The results of the tests confirmed that the used ISP's showed evidence of both through plane and edge acid electrolyte transfer between adjacent cells.

A subscale (.25 ft²) laboratory program was conducted to evaluate ISP fabrication processes. New alternate design ISP's were also fabricated in addition to the standard designs in an attempt to improve the approach; approximately 400 samples were involved.

The samples were aged in ovens both with and without acid at cell stack operational temperatures and periodically removed for evaluation by the testing described above.

This activity enabled the selection of the following three (3) ISP configurations for further cell stack evaluation.

1. An improved ISP utilizing a 50% thicker skived sheet.
2. A multilayer design using two skived sheets separated by a fibrous structure.
3. A "solid" separator media.

Design improvements to minimize electrolyte transfer around the edge are incorporated in all of these designs.

Approaches 1 and 2 also utilize higher purity graphite for improved corrosion resistance.

Larger size samples (up to 7 ft²) were fabricated to demonstrate scaleup; no problems were encountered. Samples of these three (3) candidate designs have begun a modified aging test. No further conclusions are available as of the end of the quarter period.

Preparations have begun for ISP shop process modifications to enable fabricating the three (3) candidate designs for actual testing in the next scheduled short stack.

Subtask 3.3 – Seals and Matrix

Objective

The objective of this subtask is to develop the technology to fabricate higher integrity seals and matrices that meet the technical requirements and cost objectives established in the conceptual design.

Activity

Fillerband

This quarter work on simultaneously forming fillerband, edge seals, and matrix was discontinued. Forming fillerbands with the submicron SiC lead to mudcracking and poor reliability. The submicron SiC of the fillerband is being changed to the 90% five micron, 10% submicron SiC to avoid mudcracking. The particle size change and accepting separate processing operations will insure meeting the technical requirements.

The fillerband has been curtain coated on production equipment with an active area mask. The result is a defect free layer. Bubble pressure is 7 psid for 2 mil layer and 9 psid for a 3.5 mil layer (50 psia compressive load). A matrix coated fillerband sample has been measured to have 14 psid bubble pressure with 50 psia compressive load. Process development trials on production equipment have been run to verify readiness to begin short stack electrode fabrication.

The higher than normal "sinter" temperature used with the matrix raised questions about the wettability of the fillerband. Alternate binders were evaluated for improved wettability as a function of sinter temperature and sinter time. The binder type and content also effect matrix integrity. None of the alternate binders offered an improvement over the baseline. Tests demonstrated that the matrix coated and sintered fillerband could be filled with acid through the matrix or through the substrate.

Electrode/ERP Edge Seals

Trials this quarter with the extruded polymer compressed into a machined channel showed that higher axial loads were required for high break through pressures. The geometry chosen for scale up allows the load on the seal to be localized, but accommodates the polymeric material within the machined channel.

Two production techniques can be envisioned to fabricate the polymer seals, extrusion and molding, both are being evaluated. The first set of extrusion nozzles were machined off center to allow use of existing nozzles. When used to extrude polymer the seal coiled tightly as a result of the off center die. The uncoiled material had a rough surface and is unacceptable. A second die was machined from a blank and produced a smooth continuous seal.

The full scale seal mold is complete and has been used to mold ~6 full size seals. The last two seals molded had ± 0.002 " thickness variation.

One approach to quantifying the creep characteristics of the polymer seal is load relaxation. Three samples were prepared and tested. The first sample loaded to 28 pounds/linear inch (pli) initially dropped to 15 pli after 100 hours which extrapolates to an acceptable life.

The second sample was cut from the locked up seal tested for 410 hot hours. This was done to get data with more time at temperature and pressure. Initial load was 26 pli. Data scatter on the second sample was significant. The bottom of the data band showed load falling off to 13 pli after 50 hours which doesn't project to acceptable life.

The third sample prepared for load relaxation testing received the maximum post cure recommended by the supplier. The extended post cure increased the compressive modulus and required higher initial load (50 pli) to seat the sample. Extrapolated end of life load was acceptable.

Subscale testing with the locked up fixture was concluded. After 328 hours the first build of the rig was torn down to verify the usefulness of the test fixture. The endplate was blocked. After removing the blockage, the reassembled seals leaked at 1-2 psid at room temperature. Attempts to rebuild this seal test fixture have been unsuccessful.

Polymeric edge seals will not be harvested for use in the short stack. Subscale work indicates that dimensional control on the machined channel isn't practical for a production operation. Development work has been discontinued.

Matrices

Endurance bench cells with matrix containing dispersant and no Teflon binder continue to perform well. Performances are between 0.61 and 0.64 volts at 300 ASF at times of 100 to 2000 hours.

Subtask 3.4 – Advanced Coolers

Objective

The objective of this subtask is to develop material and process technology to fabricate coolers 10–ft² in size that meet the technical requirements and cost objectives established in the conceptual design.

Activity

Full-size (small area) cooler assemblies were molded in trials to improve the mold compound deposition, to reduce or eliminate bowing of the finished composite, and to further evaluate molding with arrays treated to eliminate gaps between the tube and resin/graphite matrix.

A mold compound feeder was fabricated to shorten the mold cycle while providing a more uniform thickness of mold material across the mold. The feeder functioned satisfactorily, although modifications will be required to completely eliminate manual dressing and to shorten the cycle.

Five full-size coolers were molded after completing the feeder capability trials. The first three (3) coolers were molded with process parameters varied to optimize array centering. The last two (2) coolers contained treated arrays and were successfully molded with the selected parameters, and were flat and free of cracks after post-bake.

A flattening cycle was developed concurrently during the molded trials to eliminate a bow in the assembly that developed after removal from the mold. The bowing condition was observed in the earlier full-size molding trials, and is attributable in large part to the current method used to extract the cooler from the mold. Flattening was achieved in a cold press under load.

Development of an alternate encapsulated cooler with commercial graphite cooler holders was continued. A series of component tests were aimed at evaluating edge seal and cover plate approaches. Test conditions were severe in an attempt to accelerate the findings. One set of samples were fully immersed in 400°F phosphoric acid and a parallel set of samples were immersed in penetrating dye. The configurations tested are described in Table 3.4–1 and the results are shown in Table 3.4–2 and Table 3.4–3.

Table 3.4-1. Edge Seal Encapsulation Approaches For Cooler Holder Assembly

Type	Edge Seal Acid Barrier Approaches	
	External Barrier	Internal Barrier
1	Fluoropolymer Dispersion Coating	Fluoropolymer and Graphite Film
2	Fluoropolymer Dispersion Coating	Thin Fluoropolymer Film
3	Fluoropolymer Dispersion Coating	Thick Fluoropolymer Film
4	Fluoropolymer Dispersion Coating	Two Separate Fluoropolymer Films

Table 3.4-2. Cooler Edge Seal Encapsulation Trials

Seal Edge Approach	Thermal Cycle @ 400°F W/Acid	Acid Thru Outer Edge Coating Yes/No	Dye Thru Outer Edge Coating Yes/No	Acid Thru Inner Edge Barrier Yes/No	Dye Thru Inner Edge Barrier Yes/No
1	Yes Yes Yes Yes	Yes @ 94 Hrs.	Yes @ 168 Hrs.	No @ 94 Hrs. No @ 408 Hrs. No @ 600 Hrs. No @ 840 Hrs.	No @ 168 Hrs.
2	Yes Yes Yes Yes	No @ 72 Hrs. Yes @ 384 Hrs.	Yes @ 72 Hrs.	No @ 72 Hrs. No @ 384 Hrs. No @ 576 Hrs. No @ 816 Hrs.	No @ 72 Hrs.
3	Yes Yes	No @ 126 Hrs.	Yes @ 126 Hrs.	No @ 126 Hrs. No @ 456 Hrs.	No at 126 Hrs.
4	Yes Yes	No @ 48 Hrs. Yes @ 312 Hrs.	Yes @ 48 Hrs.	No @ 48 Hrs. No @ 312 Hrs.	No @ 48 Hrs. No @ 312 Hrs. No @ 487 Hrs.

**Table 3.4-3. Dye Test Results
for Subscale Encapsulated Coolers
with Separate Fluoropolymer Film
Edge Seals**

Sample #	Hrs.	Results	Comments
A	239	No dye penetration of any acid barriers, edges, corners or sides	
B	626	Dye penetrated along one of the tubes to the interior of the part but did not penetrate the internal barrier to what would be the upper half of the cooler holder	Part thermocycled 10 times to 400°F
C	1032	Dye has penetrated the lower half of the plain corners and down the sides of the mock tubes but did not get into the interior of what would be the top and bottom cooler holders	

The effect of tube diameter and pitch on the thermal resistance of subscale coolers is being examined. The thermal resistance of the smaller diameter tube for the short stack as a function of tube to groove spacing is shown in Figure 3.4-1. Tests to evaluate the tube to groove gap are continuing.

Figure 3.4-1. Subscale Cooler Thermal Performance

TASK 4 – STACK DESIGN

Objective

The objective of this task is to update the full-scale conceptual design and to define designs for one small area development stack and three 10-ft² subscale stacks.

Activity

A series of drawings of the electrode and ISP components and substrates are being worked concurrently with the development and evaluation activities being conducted in Task 3.

A series of drawings of the commercial graphite cooler holder assembly and details showing alternate manufacturing techniques which provide acid protection for the cooler are being worked concurrently with the development and evaluation activities being conducted in subtask 3.4

TASK 5 – FABRICATION

Subtask 5.1 – Repeat Components

Objective

The objective of this effort is to fabricate the repeat components for one small area development stack and three 10-ft² subscale stacks each consisting of approximately 30 cells. These stacks will be of the Configuration B cell design. The repeat components consist of the substrates, electrodes, electrolyte reservoir plates, and cooler assemblies.

Activity

A complete inspection of the 100 full-size electrode substrates graphitized in an experimental one-step heat treat process indicated the substrates were too wavy to process without breakage.

A second batch of full-size electrode substrates were successfully graphitized by the same one-step heat treat process. The second batch of substrates had been stacked in smaller substacks and were relocated within the furnace to improve the loading and temperature distribution.

One hundred and fifty full-size electrolyte reservoir plates were graphitized. Yield was 86%.

Edge seal impregnation of carbonized electrolyte reservoir plates was completed, and graphitizing is in progress.

Subtask 5.2 – Non-Repeat Components

Objective

The objective of this effort is to fabricate the non-repeat components for the small area development stack and three 10-ft² subscale stacks of approximately 30 cells each. These stacks will be of the Configuration B cell design. The non-repeat components consist of reactant manifolds, coolant manifolds, axial load system, power take-off hardware and pressure containment vessel.

Activity

Two new types of cooler connecting hoses are being evaluated to reduce hose costs and to qualify an additional supplier. The test configuration used is shown in Figure 5.2-1.

One new hose assembly type tested is fabricated with a modified dielectric hose formulation. All other hose materials and connecting system hardware are identical to the baseline assembly. The second type of hose assembly employs an alternate dielectric concept and connectors. Four hoses of each type were tested.

Test conditions are as follows:

Coolant Flow Rate	150 pph
Coolant Inlet Temperature	350°F
Coolant Inlet Pressure	145 psig
Coolant Inlet Subcooling	13°F
Applied Voltage	200 Volts d.c.
Water Quality	
pH	6–8.5
O ₂ Conc.	30–500 ppb
Turbidity	0.5–1.0 NTU
Conductivity	< 0.5 x 10 ⁻⁶ mho's

The hoses accumulated a total test time of 3500 hours. Visually, both sets of hoses are in very good condition. One hose of each type was submitted for detailed inspection and photomicrographs. The remaining hoses are to be burst pressure tested at 428°F.

The evaluation of the ceramic coatings as an alternative to PFA coatings is continuing. The final set of samples supplied by Vendor A have been evaluated at 250°F for possible use in application in other areas within the powerplant. Test results of samples tested at temperatures ranging from 250°F to 400°F indicate that this vendor's material is not suitable for use in a PAFC fuel cell powerplant.

Figure 5.2-1. Cooler Connecting Hose Evaluation Set-Up

Subtask 5.3 – Stack Assembly**Objective**

The objective of this effort is to assemble the small area development stack and two 10-ft² subscale stacks of Configuration B cells for testing at 120 psia. The third 10-ft² subscale stack will be assembled and tested under an anticipated EPRI program.

Activity

There is no scheduled activity during this report period.

TASK 7 - MANAGEMENT AND DOCUMENTATION

Objectives

The objective in this task is to provide the program management necessary to maintain technical and budget control of the program activities, and to provide adequate documentation of its progress per contract requirements.

The following reports were submitted during the period October 1 - December 31, 1989.

- Monthly Technical Progress Report No. 16 for August (FCR-10588) was submitted on October 24, 1989.
- Cost Management Report No. 17 for September (FCR-10670) was submitted on October 17, 1989.
- Cost Management Report No. 18 for October (FCR-10736) was submitted on November 21, 1989.
- Quarterly Technical Progress Report No. 17 July - September (FCR-10669) was submitted on November 28, 1989.
- Cost Management Report No. 19 for November (FCR-10780) was submitted on December 18, 1989.

END

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