HYDROGEN-OXYGEN ELECTROLYTIC REGENERATIVE FUEL CELLS

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ILLUSTRATIONS

1. INTRODUCTION

This report outlines the progress made during the fourth month of NAS Contract 3-2781 The objective of this program is to evaluate an electrolytrically regenerative hydrogen-oxygen fuel cell for orbital applications.

2. TECHNICAL ACHIEVEMENTS

Design of the fuel cell assembly has been completed and fabrication of the component parts has been initiated. The cycle controller design has been established, and assembly has begun. Experimental investigations were concerned mainly with corrosion studies on the materials of construction of the fuel cell. A review of previous single cell test data was also carried out.

2.1. Fuel Cell Assembly

A few modifications of the first fuel cell design were made in order to improve reliability and also to simplify fabrication. The first such modification consisted of increasing the diameter of the separators in order to provide more sealing area for the teflon gaskets. A second change consisted of increasing the thickness of the separators in order to simplify the machining of the inlet radial holes which serve as inlet gas ports. The resulting dimensional changes on all other parts were made, and fabrication of all machined parts was initiated.

Preparation of the platinized nickel electrodes was started during this reporting period. Five oxygen electrodes have been completed.

Components of the control equipment for cycling the fuel cell were received, and assembly of these parts into a complete unit was initiated. The major component of the unit is a recycle timer which will automatically switch the fuel cell from charge to discharge and back at the appropriate times. A rheostat is employed as the discharge load. The cycle controller will be available for delivery along with the fuel cell at the completion of the program.

2.2 Materials Study

One corrosion test was carried out on a sample of butyl rubber from which the pressure balance diaphragm is to be made. The sample was placed in a container which was pressurized with 100 psig of oxygen, and was held at 100°C for 5 days. The initial and final weights of the sample were 0.4729 gms and 0.4859 gms. There was no apparent change in surface properties or elasticity.

Samples of magnesium (type AZ231) and aluminum type 6061) were also subjected to the same conditions as the butyl rubber. The initial and final weights of the magnesium were the same. The aluminum weights were 0.9641 gms, and 0.9642 gms. There was no apparent change in the surfaces of either of the metals.

One other test was carried out in order to test the corrosion of Kanigen plated nickel under electrolysis conditions. (The magnesium cell separators are to be plated with the Kanigen electroless nickel.) A single cell, one end plate of which was plated with 3 mills of the Kanigen nickel, was charged at a current density of 50 m.a./cm^2 at an ambient temperature of 70°C. After 24 hours of continuous operation, the surface of the nickel was found to be slightly tarnished. However, there were no signs of penetration into the substrate material.

2.3 Single Cell Data

Single cell data not previously reported is given in figures 1 and 2. Figure 1 gives the cycle data for a 2.5 inch

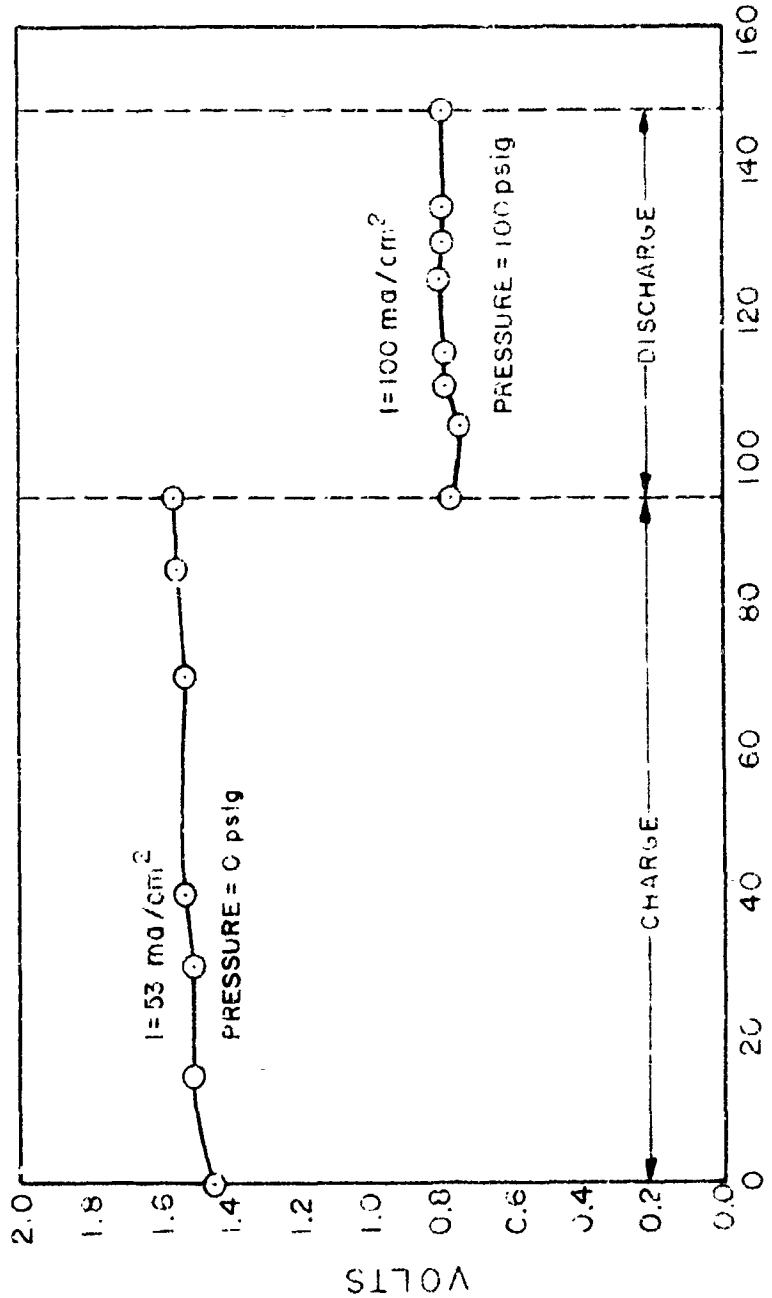

FIG. 1 CYCLING OF SINGLE CELL

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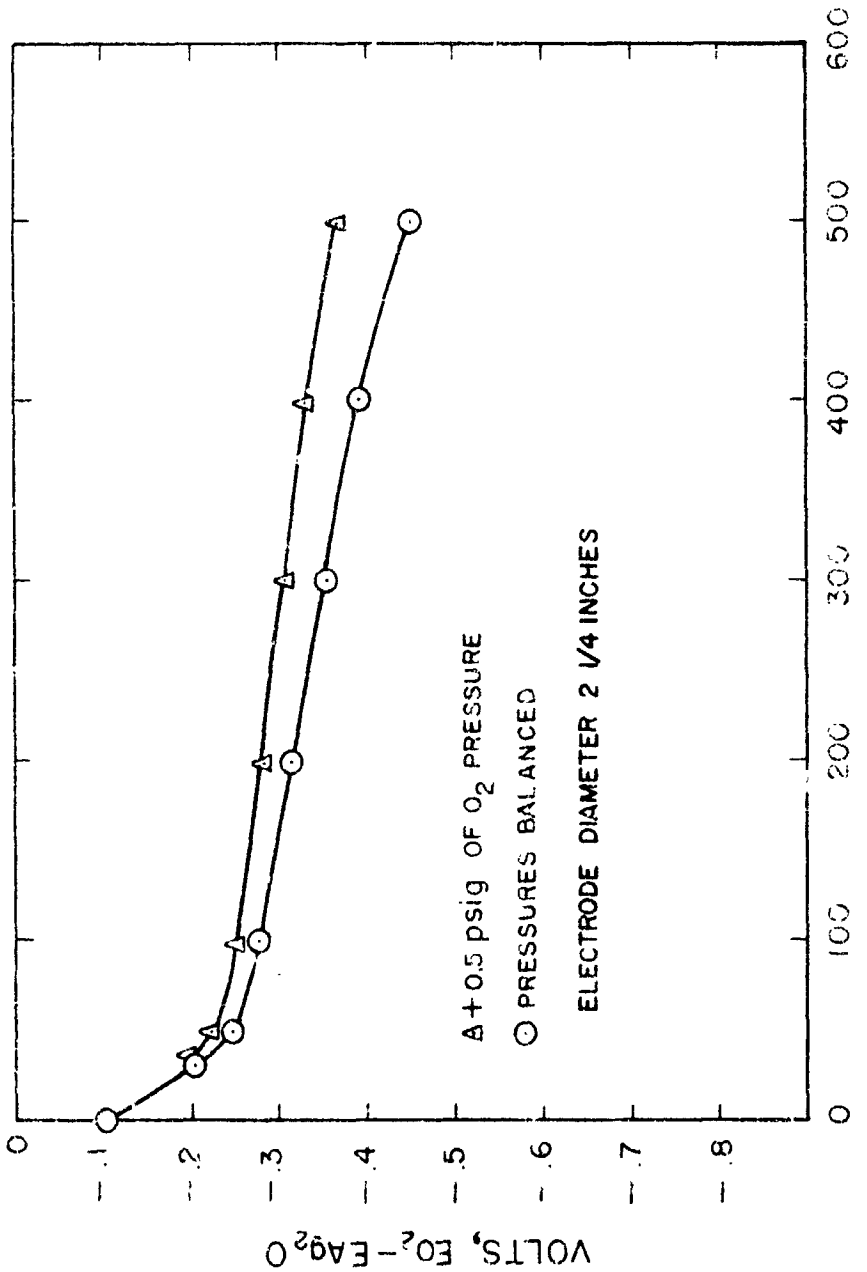

FIG. 2 EFFECT OF PRESSURE DIFFERENTIAL ON PERFORMANCE OF OXYGEN ELECTRODE

diameter cell run under conditions similar to that which the final unit is to be tested. The results indicate a relatively constant charge voltage near 1.5 volts for charge at 53 m.a./cm^2, and a relatively constant discharge voltage near 0.8 volts at 104 m.a./cm^2 for discharge. The small drop in voltage at the beginning of the discharge period is attributed to a short pressure imbalance. This was due to the gas pressures being applied manually for this series of tests.

Figure 2 presents the effect of a pressure imbalance on the performance of the oxygen electrode. The results are expressed in terms of the oxygen electrode voltage with respect to a silver oxide electrode versus the total cell current. The results indicate less polarization of this electrode with a slight positive oxygen gas pressure of 0.5 psi over that of the hydrogen. This result is believed due to minor electrode flooding, i.e., a slight positive oxygen pressure displaces some of the electrolyte solution from the electrode pores. This apparently increases the active electrode surface area.

3. PLANS FOR DECEMBER

Fabrication of the fuel cell assembly will be completed, the parts inspected, and plated with Kanigen electroless nickel. Preparation of the required number of electrodes plus adequate spares will be completed. The nickel screen back up plates will also be completed. Techniques will be developed to impregnate the edges of the asbestos electrolyte discs with a viton rubber cement and the required number of discs plus spares will be prepared. The control unit for cycling will be completed and tested.

4. MANHOURS AND DOLLAR EXPENDITURES FOR PERIOD 26 OCT.--30 NOV.,1965

Direct labor hours	529
Direct labor dollars	$2,221.58
Purchases and Committments	472.85
Total Dollar Expenditures	$6,576.34