Direct Ethanol Fuel Cell Membrane Diffusion

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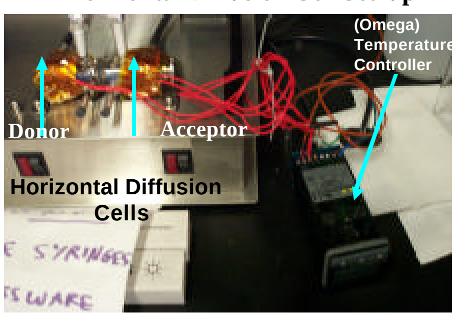
Abstract:

A porous silicon carbide (SiC) membrane has been tested for application in a direct ethanol proton exchange (PE) fuel cell. Nafion, the current material of choice exhibits alcohol cross-over to the cathodic electrode greatly decreasing cell efficiency. A horizontal diffusion cell from Permegear Inc. was modified for temperature control; high viscosity oil and heating pads SRFG-101/10 are used. For sample analysis an Agilent GC 6890N equipped with a Flame Ionization Detector and an HP-5 capillary column were used. The SiC membrane showed a six-fold decrease in permeability for ethanol as compared to Nafion for a given temperature. Literature searches were also performed to find relevant data that will assist in Fuel Cell development.

Experimental:

Horizontal Diffusion Cell Set-up



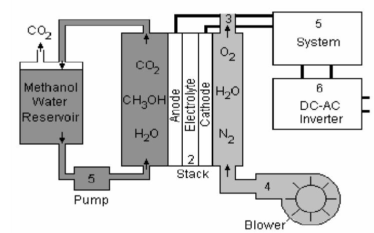
The temperature controller is instrumental in regulating the temperature of the horizontal fuel cells. Data points can be accumulated from different temperatures.

The Agilent GC 6890N is equipped with a Flame Ionization Detector and an HP-5 capillary column. The Flame Ionization Detector detects ethanol. These data points may be used to determine alcohol cross-over to the cathodic electrode. The GC 6890N utilized a program written in Labview titled GCWorkmate/VL.vi. This program will graph and store data points that will document trends in cross-over.

Close-up image of temperature Controller

An alternative to the high viscosity oil and heating pads in the Horizontal Diffusion Cells is a water bath. The temperature is regulated with a hot plate. The diffusion cells will be clamped onto the wall of the beaker, and the magnetic beads will stir the solution.

DIRECT ALCOHOL FUEL CELL (DAFC)



Above is an example of a 30 kw Direct Methanol Fuel Cell. In this type of fuel cell, neither methyl DMFC or ethyl DEFC alcohol is converted into hydrogen gas but is placed directly in a simple fuel cell. Its operating temperature of 50-100°C is ideal for multiple size uses.

Results: (data graphs)

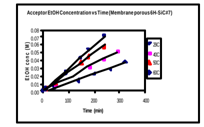


Fig.2 Acceptor cell EtOH Concentration vs. time. Initial conditions: 1.41M EtOH in donor, 0M EtOH in acceptor cell.

Note that the yintercept is not zero due to the time lag.

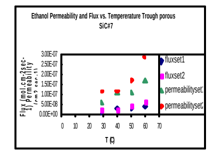


Fig.3 EtOH flux and permeability vs diffusion temperature. Set1 and set2 are independent runs at similar conditions.

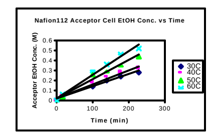


Fig.6 Acceptor cell EtOH concentration. Initial conditions are 1.41M EtOH and 0.05M 1-Butanol in donor, and 0.05M 1-butanol in acceptor cell. Note positive yintercept.

Problems with Fuel Cells

Hydrogen is difficult to store and distribute, so it is more efficient if fuel cells could utilize fuels that are easier to have access to. This problem is ameliorated by a reformer. A reformer converts hydrocarbon or alcohol fuels into hydrogen. However, reformers also consist of disadvantages. They give off heat and create other gases different from hydrogen. However, the hydrogen that that is discharged is not pure, and makes the fuel cell less efficient as well.