Basic Operating Instructions: Fuel Cell Experiment

ver 05.12

Start-Up

1. Perform a visual inspection of all hoses and connections.
2. Inspect the humidifier bottles. Operation of the fuel cell for a period of time longer than an hour requires at least 1 cm of DI water above the orange Kapton heater coils. The water level should not exceed 3 cm above the coils. Please ask a lab assistant to refill the bottles if necessary.
3. Close the hydrogen and air valves on the gas tanks and the fuel cell.
4. Start the ControlWolf software
5. Turn on the fuel cell by flipping the power switch. Inspect the dials and controllers to ensure that they are functioning normally. Press the blue button on each temperature controller to make sure that they are set to 25 °C or less.
6. Open the valve on the air gas tank. Slightly open the air needle valve by an angle of 30 °, just enough to allow gas flow (bubbles should appear in the air humidifier bottle). If bubbles appear, proceed by checking the regulator on the air tank. It should be set to 12 psig. Repeat for the H_2.
7. Close both needle valves (needle will be horizontal)
8. In the ControlWolf software, on the Set Points userform, change the control of the fuel cell from Computer to Manual. Click 'Yes' when it instructs you to close the needle valves. Immediately change control back to Computer.
9. Change the set points for the H_2 and air flow rates to 60 and 200 mL/min. Click 'Update'
10. Open both needle valves all the way. If the rotameters show that the H2 and air flow rates are approximately equal to the set points in the computer then the fuel cell is ready for operation.
11. Run 2 staircases which each are: current 0-6 amps over 10 minutes. If no problems appear, then startup is completed.

Operation

- The Bailey pressure reading for the north side of the lab should be recorded each day.
- During operation the bottom half of the Disconnect Switch should jut out.
- All set points and back pressure readings for each run must be recorded by hand.
- Previous experience has shown that power density output is linearly proportional to the flow rate and pressure of H_2 and air, while multiple interactions exist amongst the factors H_2 humidifier temperature, air humidifier temperature, and fuel cell temperature.

Data Analysis

- Staircases are the most informative when the mass transport limitation region is reached. Depending on operating conditions, this region may begin from 5-9 amps.
- The O_2 partial pressure inside the fuel cell is simply Total=Ambient + Back Pressure. Don't multiply the air pressure by 0.21 to estimate the O_2 pressure.
- Analysis of multiple cells or the overall stack (there are 3 cells total) requires a few adjustments
    - Current Density = # Cells * Current / Area
    - Power Density = Voltage * Current Density / # Cells
    - β parameter = # Cells * Slope of *ln(i)* vs ΔV plot.
    - i_o value = exp(Intercept of *ln(i)* vs ΔV plot) / # Cells * O_2 pressure.

Shutdown

1) Disconnect the fuel cell (the top of the Disconnect switch should jut out)
2) Close the valves (not the regulators) on the gas tanks and both needle valves.
3) Turn off the fuel cell and close the ControlWolf Software