Fuel Cell Cars
Fall 2007

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Introduction/Purpose:

In this exercise, you will become familiar with fuel cells. Using current, voltage and resistance, you will determine the efficiency of a fuel cell car.

Apparatus:

Fuel Cell Car, Methanol fuel cell, Water fuel cell, 2 Wash bottles, one with water and another with the methanol solution, Power supply, Decade resistor, 2 LoggerPro Voltmeter Probes, LoggerPro software, Banana plug leads, Alligator clips

Theory:

Fuel cells run using chemical energy. The fuel cells you will be working with in lab today are reversible; meaning they can convert hydrogen and oxygen gas into water AND spilt water into hydrogen and oxygen gas, also known as electrolysis. Batteries work similarly to fuel cells. In a battery, the chemicals stored inside react to produce electricity, which means that when the chemicals have used all of their potential energy, the battery "goes dead" and doesn't work anymore. In a fuel cell, the chemicals (hydrogen and oxygen) constantly flow into the cell so it never goes dead, unless the chemicals stop flowing.

As you learned earlier, power is the amount of energy produced over time. By rearranging this law to solve for energy:

$$E = P \times t \qquad (1)$$

In this lab, you will measure current, resistance and voltage in order to determine the amount of power and energy in the fuel cell. Voltage, current and resistance are related by:

$$V = I \times R \qquad (2)$$

The amount of power running through a circuit can be calculated by:

$$P = V \times I \qquad (3)$$

Procedure:

Charging the Fuel Cell

1. Hydrate the **oxygen** side of the fuel cell using a wash bottle with distilled water.
2. Pour distilled water into the tanks. Record the volume.
3. Disconnect the tubes from the tanks to the fuel cell to avoid a vacuum, and then reconnect them.
4. Set up fuel cell in series with the decade resistor and power supply.
5. Set the decade resistor to 1Ω.
6. Turn the current to the maximum on the power supply.
7. Attach two LoggerPro voltmeters, one in parallel to the power supply and the other in parallel to the fuel cell (do NOT attach a voltmeter in parallel with the resistor or it will not charge the fuel cell).
8. Open LoggerPro, the program should automatically sense the voltmeters and adjust accordingly.
9. Change the data collection settings on LoggerPro to read over a period of 600 seconds with a sampling rate of 1 second/sample
10. Hit “Collect” and then turn on the power supply.
11. When the first bubble floats to the surface, electrolysis is complete. Turn off the power supply and then stop collecting.
12. Note the amount of hydrogen and oxygen gas produced. What is the ratio of hydrogen to oxygen gas? What do you think that ratio stems from?
13. Record the time the power supply was on, the voltages across the power supply, and the fuel cell.
14. Using the data from the voltmeter connected to the resistor; determine the current across the circuit.
15. Calculate power by using the data from the voltmeter connected to the fuel cell and the current found in Step 8.
16. Calculate the energy.

Discharging the fuel cell

1. Measure the internal resistance of the fuel cell car.
    a. Use a decade resistor and adjust the amount of resistance across the circuit
    b. Measure the voltage and current across the circuit.
    c. Graph Power vs Resistance.
    d. The internal resistance will be where the power is at a maximum.
2. Connect a LoggerPro voltmeter across the car.

3. Lift the car off of the surface so there will be no friction between the wheels and the surface.
4. Hit “collect” and then turn the car on.
5. When the fuel cell is completely discharged, turn off power supply and stop LoggerPro.
6. Integrate over the curve of the voltage. Divide this by the time to get the average voltage.
7. Calculate the power using average voltage and internal resistance.
8. Calculate the amount of energy.

Methanol Fuel Cell:

1. Place the fuel cell on a level surface.
2. Fill the cell by using a syringe to pour the methanol solution (3% methanol) in one of the top holes.
3. Allow 5-10 minutes for the reaction to take place within the cell.
4. Plug the methanol fuel cell into the car.
5. Turn on the car and observe the energy output.
6. Is there a difference in the speed of the car compared to when it was running on a hydrogen cell? What might account for the difference?