Energy Conservation and Transformation

Goals

- Understand how energy can change
- Observe the transformation of energy
- Make calculations based on data

Background

Energy is what allows all objects in the universe to move. The energy of atoms or molecules and the energy of stars or galaxies is all the same, just at different sizes. Though we talk about energy being consumed, lost, or used up, it can never be destroyed. It can also never be created. The only thing that energy can do is transform from one kind to another.

Using this fuel cell car, we can use the chemical potential energy of hydrogen to create electrical energy, which will be turned into kinetic energy to cause the car to move. But there are other ways that energy is transformed, even in this small car, which mean that not all the energy in each transformation remains in a useable form.

Thermal energy is an example of a type of energy that isn't always useful. Though we can use it for some applications, such as cooking food, the transformation of different kinds of energy into heat energy is usually a bad thing for most machines.

In the case of a car, more heat energy means less kinetic energy, so a smaller percentage of the energy put into the car is used to actually run it.

Fuel cells are much more energy efficient than the internal combustion gasoline engines that power most cars today, but they still have their sources of inefficiency.

Procedure

1. Once the fuel cell starts producing hydrogen and oxygen gas from water, we will need to trap the gases to be able to use them for the reverse reaction. How can the gases be trapped using the materials provided?
2. The Oxygen side of the fuel cell needs to be filled with water. Observing the hydrogen fuel cell, why do you think only one side needs to be filled with water? Do you think it matters if the water is injected into the top or bottom outlet?
3. How can we tell how much gas has been generated from our reaction?
4. Does it matter how the battery pack is attached to the fuel cell? Why or why not?
5. If you're ready to capture the gases produced by the fuel cell, attach the battery pack. Observe what happens and record your observations below.

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Observations

Experimentation

1. You've produced hydrogen and oxygen from water. Now, connect the fuel cell to the motor. What happens?

2. What could you change about your car that might make the car run faster? Try it and observe what happens.

3. What if you wanted to make your car run for a longer time? Would you change the same thing or something different? Try it and observe what happens.

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Measurement

For this section, you will need a multimeter or the Horizon Renewable Energy Monitor. For an introduction to using a multimeter, click here.

1. Measure the current in Amps and the voltage in Volts while generating hydrogen and oxygen. Record your answers below:

Current: _____ A

Voltage: _____ V

2. Voltage is equal to the current multiplied by the resistance (V = IR), so according to your data what is the resistance of the fuel cell?

Resistance:_____ Ω

3. Measure the current in Amps and the voltage in Volts while the car is running. Record your answers below:

Current: _____ A

Voltage: _____ V

4. Why is there a difference between the current/voltage when producing hydrogen and the current/voltage when the car is running? Where has the energy gone?

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Analysis

1. Make a scientific claim about what you observed while running the fuel cell car.

2. What evidence do you have to back up your scientific claim?

3. What reasoning did you use to support your claim?

4. Use your observations to design an experiment you could run to try to increase the energy efficiency of the fuel cell. Describe your experiment below.

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Conclusions

1. What kinds of energy did you observe while running your experiments with the fuel cell car?

2. Describe the ways that energy changed from one form to another during this activity.

3. Describe three ways that energy was transformed that didn't help your car move faster or farther.

4. Would it ever be possible to use 100% of the electric energy produced by the fuel cell to move the car? Why or why not?