Thermoelectric Generators

Goals

- Produce electricity with a thermoelectric generator
- Observe the effects of thermal energy
- Make calculations based on data

Background

Heat is a way of transporting thermal energy from one object to another. Since it's caused by the motion of atoms and molecules, it's constantly spreading to nearby particles through collisions and causing fluids to circulate and transfer its energy to new places.

Under the right conditions, moving heat can also generate electricity using the thermoelectric effect. Thomas Johann Seebeck discovered that whenever heat moves between two different semiconducting materials, electric charges move as well. Semiconductors are unique substances that are used in computer chips and in numerous ways inside many electronic devices.

When two different semiconductors are next to each other, the thermoelectric effect transfers electric charge from one to the other as heat moves between them. Since heat moves naturally from hot objects to cold objects, getting it to move really quickly between them creates a larger, useable electric current.

A thermoelectric generator is thus a way to create useful energy from heat, which is usually thought of as wasted energy in most mechanical processes.

During this activity, we will use the thermoelectric effect to allow us to visualize heat transfer through the generation of electricity.

Assembly:

If generator is already assembled, go to the Procedure section.

1. Look at the thermoelectrical system (the two connected containers with red and black wires on the top). Which of the other parts do you think will attach to it?
2. How does the thermoelectrical system fit into its base? Does it matter how you attach them?
3. Why do you think the seals are colored red and blue? The thermoelectrical system's wires are also different colors. Do you think there's a right and wrong side to put each seal? Write down anything you've observed in the Observations section below.

Procedure

1. Fill two beakers with water, one hot and one cold.
2. Before you fill your generator, be sure to put cold water in the side with the red wire and hot water in the side with the black wire, or all of your results will be backwards!

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3. Open the tops of the two containers to fill your generator with hot and cold water.
4. Close the lids and insert the thermometers into the seals, pushing them down gently but firmly until they're almost touching the bottom of the containers.
5. Start the stopwatch and record the temperatures of each thermometer in the table below.
6. Connect the red and black sockets on the generator to the fan with the red and black wires and observe what happens.
7. Disconnect the wires from the fan and connect the generator to the LED lights instead. Observe what happens.
8. After 2 minutes have gone by, record the temperature again, then repeat steps 6 and 7.
9. Repeat step 8 until you've filled in the table below.

Observations

Experimentation

1. What happens to the system over time? Record your data from the Procedure section here:

Time (min):	Hot Temp (°C):	Cold Temp (°C):	Observations:
0			
2			
4			
6			
8			
10			

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2. What happens to the system when you increase the temperature of the hot water? Run your generator as before and record your data below:

Time (min):	Hot Temp (°C):	Cold Temp (°C):	Observations:
0			
2			
4			
6			
8			
10			

3. What happens to the system when you decrease the temperature of the cold water? Run your generator as before and record your data below:

Time (min):	Hot Temp (°C):	Cold Temp (°C):	Observations:
0			
2			
4			
6			
8			
10			

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4. Now try colder cold water and hotter hot water. What happens when you run the generator now? Record your data below:

Time (min):	Hot Temp (°C):	Cold Temp (°C):	Observations:
0			
2			
4			
6			
8			
10			

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. Record the highest current in Amps and highest voltage in Volts produced while the generator is powering the motor. Record your answers below:

Current: _____ A

Voltage: _____ V

2. Record the highest current in Amps and highest voltage in Volts produced while the generator is powering the LEDs. Record your answers below:

Current: _____ A

Voltage: _____ V

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3. Voltage is equal to the current in amps multiplied by the resistance in ohms (V = IR), so according to your data what is the resistance of the motor in ohms?

Resistance: _____ Ω

4. What is the resistance of the LEDs in ohms?

Resistance: _____ Ω

5. Power is current multiplied by voltage (P = IV). What is the maximum power in watts that your thermoelectric generator created?

Power: _____ W

Analysis

1. Make a scientific claim about what you observed while running your generator.

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

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

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4. Design an experiment that would test how to keep the thermoelectric generator running for a longer period of time. Describe your experiment below:

Conclusions

1. What is the relationship between the difference in temperature of the generator's sides and the amount of electric current it produces?

2. Do you think the thermoelectric generator would work with substances other than water? Why or why not?

3. Could a thermoelectric generator be used as a source of renewable energy? Explain your answer.