Transmission Heat and Temperature

Objectives

The student will understand that transmission of electricity generates heat and leads to line losses.

Curriculum Focus

Science

Materials

For each student or student group

- 1.5 Volt D or C cell battery
- 6 Volt battery
- 9 Volt battery
- Digital thermometer
- Multi-meter
- Thermal gloves
- Enamel coated magnet wire (gauges 24, 26, 30)
- Ruler or meter stick
- Scissors
- Timing device

Key Vocabulary

Line losses
Transmission

Next Generation Science Correlations

- 5-PS1 - 3
- MS-PS1 - 2
- MS- PS2 - 3
- MS-PS2.B
- MS-PS3 - 5
- HS-PS3 - 2

Introduction

Electricity is generated at power plants and is then moved to substations by large, high voltage power lines called transmission lines. In the United States, the network of hundreds of thousands of miles of high voltage transmission lines is known as the grid.

A local distribution system of smaller, lower voltage distribution lines delivers power from substations and transformers to customers. (Source: *eia.gov/kids/energy.cfm?page=electricity_in_the_united_states-basics*, accessed December 2017)

Power lines that criss-cross our countryside or traverse unseen beneath city streets carry electricity at enormously high voltages from power plants to our homes. It is not unusual for a power line to be rated at 400,000 to 750,000 Volts. Appliances in our homes use voltages much, much smaller — typically about 110 to 250 Volts.

Why do power stations not simply transmit electricity at lower voltages for appliances and electronics? Why do they use such high voltages? How electricity travels through transmission lines helps to explain this dilemma. As electricity flows through a metal wire, the electrons that carry its energy move around crashing into other electrons and create heat. Wires get very hot, like the heating element inside a toaster. The higher the voltage you use along with a lower current, means less energy is wasted. So when electricity travels long distances through transmission lines the most efficient method is with high voltages.

Procedure

1. Cut 20 inch (0.5 meters) lengths of each gauge of enamel coated magnet wire for each student or student group.
2. Using the smallest diameter or gauge of wire (30), place the thermometer anywhere along the length on the wire, measure the temperature and record.
3. Put on thermal gloves to protect fingers against heat.
4. Connect the wire ends to the positive and negative ends of the 1.5 Volt battery.
5. After 30 seconds, measure the temperature of the wire at the same point on the wire as in step 2 and record.
6. Using the multi-meter on the resistance settings, measure the resistance in the wire.
7. Disconnect the wire from the battery.
8. Keeping the same gauge wire, repeat steps 2 – 7 but replace the 1.5 Volt battery with a 6 Volt battery and record both temperatures.
9. Keeping the same gauge wire, repeat steps 2 – 7 but replace the 6 Volt battery with a 9 Volt battery and record both temperatures.

   What conclusions can you make about the temperature of the wire with the increase in voltage?

10. Repeat the experiment with the larger gauges wire and record data.

    What conclusions can you make about the temperature of the wire with the increase in the thickness or gauge of the wire?

Gauge of Wire	Initial Temperature	Voltage	Final Temperature	Resistance (Ohms)
30		1.5 Volts		
30		6 Volts		
30		9 Volts		
26		1.5 Volts		
26		6 Volts		
26		9 Volts		
24		1.5 Volts		
24		6 Volts		
24		9 Volts		

To Know and Do More

Research sag in transmission lines due to heat generation.