Lab: Power That Stinks

FOR THE TEACHER

Summary
In this lab, students will experiment with creating and capturing biogas, and have an opportunity to see how energy is created from waste. They will explore the differences between non-renewable and renewable energy sources as well as global uses of biogas in a follow-up research investigation.

Grade Level
Middle or High School

Objectives
By the end of this lab, students should be able to
- Understand how to create and capture biogas.
- Describe the differences between non-renewable and renewable energy sources.
- Record and analyze data.
- Discuss the impact of the emission of biogas and its effect on the environment.

Chemistry Topics
This lab supports students’ understanding of
- Renewable and Non-renewable resources
- Chemical Reactions
- Conservation of Mass
- Biomass
- Observations
- Gases

Time
Teacher Preparation: 45 minutes (time to collect materials)
Lesson: 1-2 classes, and allow additional time throughout the next 3 weeks for data recording

Materials
- Clear, plastic bottles—1 per group (1 liter clear plastic; wide mouth preferred)
- Balloons—1 per group (thick quality latex)
- Permanent Markers
- Large Spoon
- Funnel
- Rulers
- Duct Tape
- String
- Scraps of raw vegetables and grass (about 4 cups)
- Soil from outside (NOT bagged potting soil) (about 6 cups)
- Mythbusters TV episode: Season 6, Episode 8 “Young Scientist Special” about Methane Power (optional)
Safety
- Always wear safety goggles when handling chemicals in the lab.
- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
- Parts of this experiment are to be done in a ventilated area or fume hood, as a flammable gas is released.

Teacher Notes

Teacher Prep:
- The amount of materials listed is sufficient for about 6 student groups of 4-5 students.
- Make sure to collect soil from outdoors to use in the bottles.
- Pre-cutting the vegetable scrapes into tiny pieces is advised. This will help when the materials are transferred into the bottle.
- It will take about three weeks for the microbes to digest all of the food in the soil. Allow approximately 10 minutes of class time every other day during the three week period for students to collect the necessary data,
- Upon completion of the experiment dispose of the gas by popping the balloons in a well ventilated area, such as a fume hood or outdoors. Be sure that it is away from any heat sources as methane gas is highly flammable.

Helpful Links:
- What is biogas? And what is it good for?
- Renewable Energy 101: Biogas (video introduction)

Introduce the topic:
- Ask the students, “How do you use energy? What types of energy can you identify?”
- Ask the students to list five activities they do each day that use energy. (Thinking, walking, using a light, driving, etc.)
- Ask the students, “Where does energy come from?”
- Explain the concepts of renewable and non-renewable energy:
  a. Renewable energy- comes from sources that do no run out or can be replenished within a human lifespan (about 100 years).
  b. Non-renewable energy-comes from sources that cannot be replenished within a human life span, or ever.
- Discuss biogas as a form of energy. Biogas is energy that comes from living things. It is generally made from animal manure. People use biogas digesters to convert manure into methane gas, which is a type of biogas.
- If time allows, show the Mythbusters episode, from Season 6, Episode 8 “Young Scientist Special” about Methane Power. Part of this episode investigates using cow manure as ‘fuel’, so it’s a little different than our investigation, but still a really good example of the outcome/uses in the real world.
- Explain to the class that the goal of this experiment is to create methane gas (a type of biogas). You will be doing this by using microbes (living organisms that are so small you cannot see them without a microscope) in the soil to create methane gas. When you feed the microbes food scraps, a byproduct of digestion is the emission of methane gas.
• Mix the scraps of vegetables and grass into the soil thoroughly. Ask the students, “Why is soil being added to the mix?” (Microbes will be living in the soil).

Cross-Disciplinary Extensions

Connect to Math
• Graphing and charting their data throughout the experiment
• Measuring circumference of the balloon and the height of decomposed material in bottle

Connect to Social Studies
• The efficiency of biogas to be used as a renewable resource
• Areas in the world where this concept would be applicable

FOR THE STUDENT

Lesson

Power that Stinks!

Background
Over the next few weeks, you will observe the microbes in soil can digest the vegetables in the bottle. This process with produce methane gas in the bottle and it will begin to inflate the balloon. At the same time, the amount of mixture in the bottle should decrease as the microbes are digesting it.

Safety
• Always wear safety goggles when handling chemicals in the lab.
• Wash your hands thoroughly before leaving the lab.
• Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.
• Parts of this experiment are to be done in a ventilated area or fume hood, as a flammable gas is released.

Materials
• 1 clear plastic bottle
• 1 balloons
• Permanent Marker
• Funnel
• Ruler
• Duct Tape
• String
• Scraps of raw vegetables and grass
• Soil from outside

Procedure:

Day 1:
1. Collect an empty bottle for your group.
2. Mix the scrapes of vegetables and grass that you were given into the soil thoroughly.
3. Place the mixture of vegetables, grass and soil into the bottle carefully. A wide-mouth funnel may help.
4. Stretch the balloon over the mouth of the bottle so that it tightly fits over the opening of the bottle.
5. Use duct tape to seal the edge of balloon to the bottle to make sure that gases cannot get in or out of the bottle.
6. Make a horizontal line on the bottle with a permanent marker to show the height of the original mixture. Write the date next to it.
7. Measure the distance (cm) from the bottom of the bottle to the top of the mixture. Write this value in the data table below.
8. Record the circumference of the balloon as zero on the data table.
9. Place the bottle in on a window ledge or in a location where it will receive sunlight.

Follow Up: Every other day, for approximately 3 weeks you will collect additional data.
10. Each time you collect data, make a horizontal line on the bottle to mark the height of mixture in the bottle and label the line with the date. You should measure the distance from the bottom of the bottle to the top of the mixture. Write this value in the data table below.
11. Also measure the circumference of the balloon (cm) by wrapping a string around the widest part of the balloon and measuring the length. Write this value in the data table below.
12. On the final day dispose of the gas by popping the balloons in a well ventilated area, as directed by your teacher. Be sure the gas is released away from any heat source.

<table>
<thead>
<tr>
<th>Day</th>
<th>Height of Mixture in Bottle (cm)</th>
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Analysis
Use your findings from the investigation to answer the following sentences, providing good details and evidence from your research.

1. Using the data in the table, plot a double bar graph with Days along the x-axis and the Level of Mixture and Circumference of Balloon along the y-axis.

2. As the days went by, what happened to the circumference of the balloon?

3. As the days went by, what happened to the level of the mixture in the bottle?
4. What caused the circumference of the balloon to change?

5. What caused the level of the mixture to change?

6. How did the microbes get into the bottle?

**Research Questions**

1. Describe the differences between non-renewable and renewable energy sources. Explain how biogas relates to non-renewable or renewable energy.

2. Is biogas currently used as a source of energy in the world today? If so, explain how it is used including an example.

3. Discuss the advancements in technology of renewable energy.

4. Discuss the emission rates of biogas and its effect on the environment.