Biogas from Biomass

Objective:

The students will be able to describe how biogas is produced and how it is obtained.

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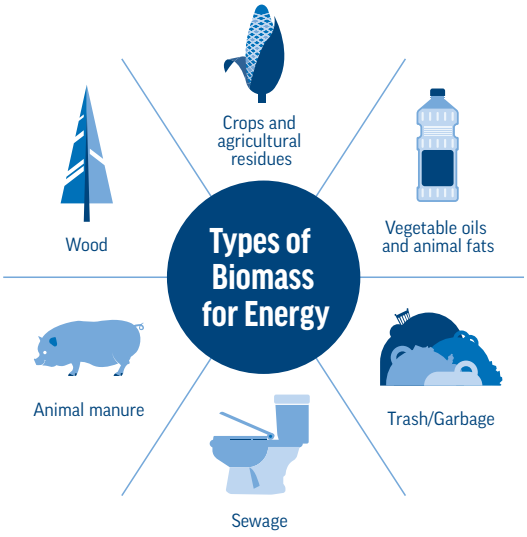
Materials and Curriculum Correlations ▼

Introduction

Biomass is renewable organic material that comes from plants and animals. It contains stored chemical energy from the sun that plants use during photosynthesis. Some types of biomass can be used in place of fossil fuels to reduce carbon dioxide emissions.

Biomass can be burned directly for heat like wood in a fireplace. It can also be converted to renewable liquid and gaseous fuels through different processes.



- Biogas is naturally produced from garbage in a landfill. When it has a high methane content (a greenhouse gas), it can be captured to prevent it's release into the environment. The captured gas can even be used to generate electricity.
- Gasification is a thermochemical conversion where organic materials are heated and injected with free oxygen and/or steam to produce a syngas that can be used for heating, fueling diesel engines or generating electricity.
- Anaerobic digestion is another biological conversion that produces biogas, which may be called renewable natural gas.
- Fermentation is one such biological process that converts biomass feedstocks into ethanol, a clear, colorless alcohol.

The "Fermentation Challenge," in this lesson, will use yeast to consume or metabolize the simple sugars like glucose (corn meal) or fructose and sucrose (table sugar) in the feedstock chosen to mix with the yeast. The goal is to cause a high fermentation rate with the chosen feedstock.

Procedure

1. Discuss biomass with students using the information above.
2. Engage students in the "Fermentation Challenge" by handing out the student sheet and materials.

To Know and Do More

1. Research landfill gas and methane as the main source of fuel for vehicles. Discuss how this gas has been liquefied or compressed to make liquified natural gas (LNG) and compressed natural gas (CNG) and used mainly in fleet vehicles.
2. Take an excursion to a place that produces biogas (for example, sewage treatment plants and landfills).
3. Visit the Alternative Fuels Data Center website at *afdc.energy.gov/fuels/natural_gas_renewable.html* to research biogas production, distribution, benefits, research and development.
4. How is propane different from methane? How is propane used as a fuel?

Materials Needed:

- Goggles
- Two snack-size resealable zipper bags
- Feedstocks, such as table sugar, corn meal, dead leaves, sawdust or finely ground grass clippings
- Yeast
- Thermometer
- Timer
- Warm tap water
- Ruler
- Copies of student sheet

Curriculum Correlations

4-PS3 - 2
4-PS3 - 4
4-ESS3 - 1
4-ESS3 - 2
4-ETS1 - 2
5-PS1 - 1
5-PS1 - 2
5-PS1 - 3
5-PS1 - 4
5-ESS3 - 1
5-ETS1 - 1
5-ETS1 - 2
MS-PS1 - 2
MS-PS1 - 6
MS-LS2 - 3
MS-ESS3 - 3
MS-ETS1 - 4
HS-PS3 - 3
HS-LS2 - 7
HS-ESS3 - 4
HS-ETS1 - 2
HS-ETS1 - 3

Answers to Student Sheet

1. Chemical reaction; The bag inflates with CO_2 and ethanol is produced
2. Answers will vary.

Student Sheet

Fermentation Challenge

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Background

In this experiment, you will observe and measure evidence of the chemical reactions associated with fermentation. Fermentation is a specific type of chemical reaction induced by microorganisms or enzymes that split complex organic compounds into more simple substances. The yeast in this experiment will consume the simple sugars in the feedstock that you chose to add. Your goal is to cause a high fermentation rate with the feedstock that you chose.

Materials Needed:

- Two snack-size resealable zipper bags
- Feedstocks, such as table sugar, corn meal, dead leaves, sawdust or finely ground grass clippings
- Yeast
- Thermometer
- Timer
- Warm tap water
- Ruler

Procedure

1. Put on the goggles and combine 1 teaspoon of feedstock and 1 teaspoon of yeast.
2. Add 1/4 cup of warm tap water (approximately 104 F).
3. Seal the bag, removing as much air as possible as it is closed.
4. Mix the ingredients in the bag gently and then lay it on a flat surface.
5. Start a timer. Observe for 20 minutes what happens in the bag. Use caution as the bag may pop as it expands.
6. Record experiment details and your observations on the chart below. The fermentation rate is the measurement of the widest/highest part of the bag at the end of 20 minutes or time when bag reached expansion capacity:
7. Repeat the experiment with another feedstock.
8. If time and resources allow, use an ethanol probe to take a reading of the percentage of ethanol at the end of each test.

Trial One		Trial Two	
Feedstock Chosen:		Feedstock Chosen:	
Start Time:		Start Time:	
End Time:		End Time:	
Fermentation Rate:		Fermentation Rate:	

Questions

1. What process is happening in the bag(s)? What evidence of that process do you observe?

2. What were the feedstocks and fermentation rates (measurement of the widest/highest part of the bag at the end of 20 minutes or time when bag reached expansion capacity) for your first trial? Second trial?