BIOMASS: BIOGAS GENERATOR

Curriculum: Biomass Power (organic chemistry, chemical/carbon cycles, plants, energy resources/transformations)

Grade Level: Middle School (6-8)

Small groups (3 to 4)

Time: 90 minutes to assemble, days to generate sufficient gas to burn

Summary: Students build a simple digester to generate a quantity of gas to burn. This demonstrates the small amount of technology needed to generate a renewable energy source. Biogas has been used in the past and is still used today as an energy source.

Provided by the Department of Energy's National Renewable Energy Laboratory and BP America Inc.

BIOGAS GENERATOR

Purpose: To construct a biogas generator and observe the energy contained in the generated gas.

Biogas Background Information

What happens to organic garbage when it is buried at the landfill? When bacteria grow on the organic material, especially without air (anaerobically), they digest it and give off carbon dioxide and methane gas as waste products.

Methane is the main component of natural gas, and is relatively clean burning, colorless, and odorless. When organic materials decompose, the methane is normally given off into the atmosphere, where it may contribute to global warming.

What if we could capture this gas and burn it for cooking and heating? Actually, this is already being done in many parts of the world. Even small farms and households can utilize biogas generators to provide heat. In China there are an estimated seven million biogas generators being used to convert plant and animal waste into fuel for cooking and heating. India has about seven hundred fifty thousand generators in operation.

In the United States, about fifty large landfills have perforated pipes or other methods of collecting the methane generated by the decomposition of garbage. It is estimated that there are two to three thousand land fills in the United

States that could be tapped for large-scale methane recovery.

Farms that produce a lot of manure, such as hog and dairy farms, can use biogas generators to produce methane. One biogas plant in California uses manure from near by feedlots. It produces enough methane to supply electricity to heat about twenty thousand homes. The remaining residue is used to fertilizer.

Biogas power plant can be built quickly, simply, and for much less money per kilowatt than coal, oil, or nuclear power plants. An added benefit is methane is a renewable resource.

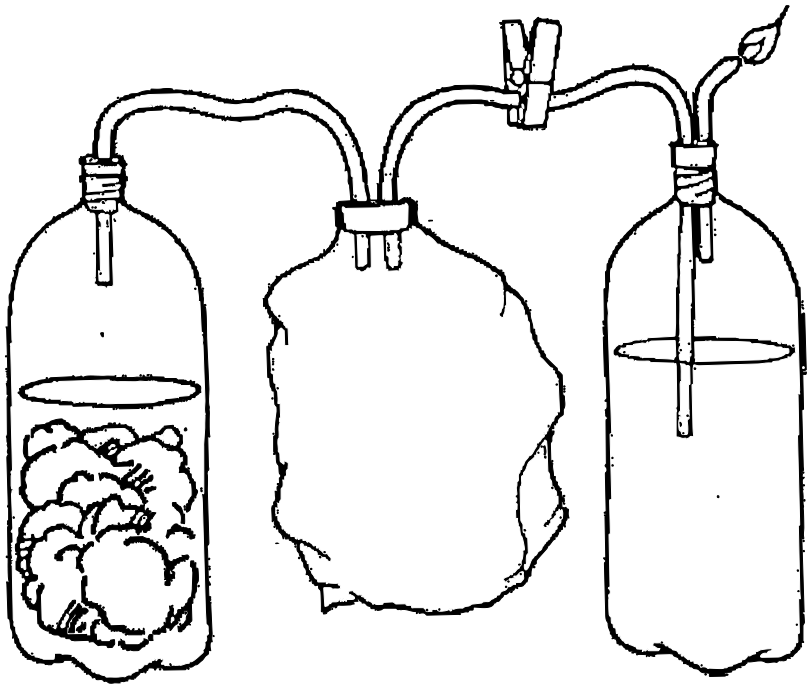
There are, of course, problems with using organic waste for biogas production. Some feel that organic plant waste should be used for compost, and that manure should be used for fertilizer. They point out that a lot of natural gas and other energy is used in the production of fertilizers and that using the manure and compost would reduce this use of natural gas.

Materials:

- Two plastic drink bottles (2 liter or larger)
- Manure (goat, sheep, rabbit work well, you can purchase manure from a garden shop) and water
- A wine cask inner bag
- Three stoppers (two-two-hole stoppers and one one-hole stopper (sizes to fit the bottles and bag)
- Plastic tubing
- A weak solution of sodium hydroxide
- Spring type clothespin or similar clamping device

Procedure:

1. Assemble the bottles, stoppers, tubing, bag, and clamp as shown in the drawing.
2. Put the manure and water into one of the bottles stopper the bottle. The manure needs to be kept in a warm place to help in the digestive process.
3. Now place the tubing into the two-hole stopper.
4. Place a second piece of tubing into the same stopper.
5. Place the stopper into the bag (tape may be needed to help hold the stopper)
6. Place the tube from the bag into the second stopper (this tube needs to extend far enough so the end of the tube will be in the sodium hydroxide solution. In the early stages of the reaction much of the gas released is carbon dioxide. The sodium hydroxide solution and the carbon dioxide will form a precipitate. The biogas will pass thru the solution. This also acts as a flashback suppressor.
7. Now remove the clothes pin or clap, as bubbles raise through the solution you will soon be able to ignite the gas. Do not ignite the gas without the help of your teacher.



Questions:

1. The first gas that was omitted was not flammable. This gas was carbon dioxide (CO_2); why was carbon dioxide produced? The gas produced next was Methane (CH_4); why was methane produced?

2. Do you think different materials would produce methane at a different rate? Why?

3. What could methane biogas be used for?

4. Methane is a renewable resource, what does this mean?

5. What are the advantages of biogas as a fuel source?

6. What are some disadvantages of biogas as a fuel source?