Science Lessons for Grades 9-12

"Building a Working Biodigester"

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Discipline: Agricultural Sciences/Environmental Science
Grade: 9 to 10, 11 to 12

Standard
3: The Nature of Technology; C: Issue of Technology; H3: In deciding on proposals to introduce new technologies or curtail existing ones, some key questions arise concerning possible alternatives, who benefits and who suffers, financial and social costs, possible risks, resources used (human, material, or energy), and waste disposal.
8: The Designed World; b: Materials and Manufacturing; H2: Waste management includes considerations of quantity, safety, degradability, and cost. It requires social and technological innovations, because waste-disposal problems are political and economic as well as technical.
8: The Designed World; C: Energy Sources and Use; H2: When selecting fuels, it is important to consider the relative advantages and disadvantages of each fuel.

Purpose/Goal
The Student will be able to:
1) Identify critical components of a working biodigester
2) Characterize the relationships between the components
3) Construct a working biodigester

Context
This lab fits into a series of lessons (geared toward an agriculture science classroom) that focus on best management practices for agriculture.

Motivation
The series begins with an "issues forum" where the class is assigned to read newspaper articles about manure spills and possible EPA taxes on farm animals. Objectives include discussing manure management techniques. An introductory lesson to biodigesters focuses on what biogas is, how it can be used and how manure digesters are integrated into both large and small farms. There is an international component, because my personal research involves researching the use of small biodigesters on small farms in the developing world. The next lesson focuses on the scientific processes behind biogas creation and what materials can be used to create it. Here, I also discuss the differences between renewable and non-renewable energy sources. The next lesson is a lab in which the students are presented with an array of items from which they can attempt to design and build model biodigesters. Materials include straws, Styrofoam cups, and plastic bags. These lessons lead up to the current lesson, in which small scale biodigesters are built in the classroom.

Description/Materials
This lesson does require quite a few materials. However, most are easy to find at your local hardware store. Manure is provided by a local farm (in our case it comes from beef cattle, but it doesn't really matter), and in order to get the biodigesters going faster we also add a biodigester "starter culture" which we get from a local biodigester research facility.

- Large plastic container such as a used 18 liter plastic water bottle
- Mylar helium balloon
- Plastic water bottle cap (or rubber stopper)
- Copper tubing (40 cm long, 6.5mm inside diameter)
- T-connector for plastic tubing (barbed, 6mm or ¼" long)
- 1 cork (tapered)
- Clear vinyl tubing (1.5 m long, 4mm inside diameter)
- 2 barb fittings

- Ball valve
- Rubber gloves
- Large plastic funnel

An instruction sheet is handed out to each student. All the lessons that lead up to this one are meant to inspire students to find creative and effective manure management solutions.

The lab is composed of two main steps:
A. Students prepare the biogas collection system by assembling the materials listed above according to a diagram.
B. Students prepare the manure mixture (animal manure plus starter culture and water) and put it in the biodigester.

Assessment
The performance assessment consists of measuring the production of biogas. Students are also tested on information presented in the entire unit.

Follow-Up Activities
This unit could be one of a series that focus on renewable energies. It would be easy to segue into lessons on other renewable energies that are currently hot topics in the agriculture industry such as wind power. Follow-up lessons include the burning of the methane gas from the digesters and a field trip to a local biodigester research facility.