GOVERNOR'S OFFICE OF ENERGY DEVELOPMENT

Advancing Utah's Energy Future

Energy From Biomass

Grade/Subject: 8th grade Integrated Science

Strand/Standard 8.4.3 Design a solution to monitor or mitigate the potential effects of the use of natural resources. Evaluate competing design solutions *using a systematic process to determine how well each solution meets the criteria and constraints of the problem.* Examples of uses of the natural environment could include agriculture, conservation efforts, recreation, solar energy, and water management. (ESS3.A, ESS3.C, ETS1.A, ETS1.B, ETS1.C)

Lesson Performance Expectations (description): Students will design a fermentation tank to reduce biomass into its component parts.

Materials: Each pair of students needs

- Ziploc freezer bag
- Sugar
- Corn meal
- Leaves
- Grass clippings
- Sawdust
- Vegetables
- Fruit
- Crackers
- Yeast

Time: 1 fifty minute period to set up, as many follow-up measurements as you can handle. 50 minutes to finish.

Teacher Background Information:

- Biomass is organic material that comes from plants or animals. When biomass is decayed or fermented, it breaks down into a number of smaller molecules. These molecules can be used as energy sources, such as methane and ethanol.
- Wasatch Resource Recovery is Utah's first and only anaerobic digester dedicated to food waste diversion. This facility processes organic waste such as food scraps, liquid waste and manufacturing food waste. The process will turn the organic matter into renewable natural gas and bio-based fertilizer. (WRR)
- Utah State University is researching how to convert microalgae into biofuel and using pinyon juniper trees as biomass to produce fuels and wood pellets. Utah's Trans Jordan Landfill captures methane from decomposing trash and burns it to generate electricity. The Blue Mountain Biogas Power Generation plant uses two digesters to produce methane from hog manure, generating enough electricity to power 3000 homes.
- Although biomass can be more expensive than conventional energy resources, requires considerable space and produces emissions when burned, it also reduces waste and may provide rural communities a source of industry.
- More information on biomass use can be found at:

https://www.eia.gov/energyexplained/?page=biomass_home
https://www.energy.gov/eere/bioenergy/bioenergy-basics
https://www.nationalgeographic.org/encyclopedia/biomass-energy/

Student Background Knowledge:

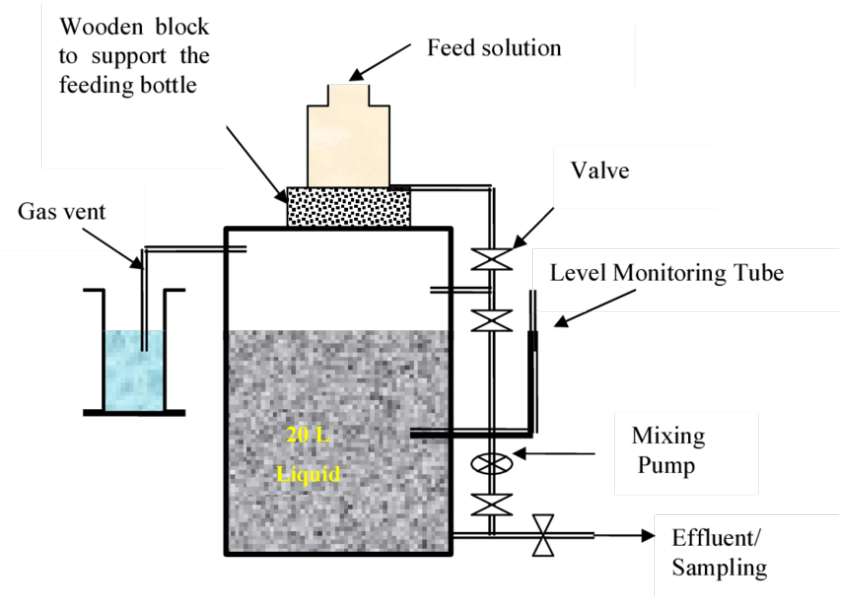
- Students should know that there is a demand for reliable and sustainable energy sources. They should understand that photosynthesis stores energy in sugar molecules, which the plant may convert to larger carbon molecules (fats and starches). When plants die, the decaying processes breaks down these molecules and the energy and matter are released back into the environment. This is called decomposition.

Teacher Step by Step:

1. **Introduce *Phenomenon:*** *Observation of video clip, link. (55 sec)* Ask students to write down what they notice and the questions that they have about the phenomenon. You may use the student sheet below or ask students to use their own notebooks. Students record the questions on their student sheet or a large piece of paper and should pick three from their group to write on post-it notes. Collect the post-it notes group them and explain to students that they will be addressed during the activity.
2. Provide experiences that help students to explain the decomposition process. Students should carefully consider the guiding questions before they design their procedures. Explain to students that this will be an ongoing activity that takes several weeks to complete (daily or weekly observations). Ask students to trade procedures with other groups and guide the discussion to make sure students develop "criteria" (what the goals are) and "constraints" (limitations on the design).
3. Students may notice gases formed in the bag or changes in color, shape or size of the starting substance. They may realize that the only way to test the gases or liquids formed might be to light them. Be sure to use safety equipment and supervise this step.
4. To address the second question, students will need to do some research. The websites will help them write a Claim, Evidence, Reasoning (CER) paragraph to explain what substances could have formed.

Assessment of Student Learning.

Diagram of a biomass digester:



1. What kind of substances can be added to the "Feed Solution"?
    a. The remains of living organisms*
    b. Any type of petroleum product
    c. Substances that will burn
    d. Livestock feed that is leftover

2. Where is the energy collected that can be used for a new purpose?
    a. In the large, center tank
    b. In the gas vent*
    c. In the effluent

3. Biomass can be used as an energy source but where did it's energy originate?
    a. soil
    b. sunshine*
    c. water
    d. Fertilizer

4. What are advantages to using biomass as an alternative energy source? Choose all that apply.
    a. The source material would otherwise be wasted.
    b. Decomposition is a rapid and inexpensive process.
    c. The methane that is often produced is a clean burning fuel.*
    d. The digesters are inexpensive and already many are in use.
    e. Decomposing waste materials reduces the need to dispose of them.*

Extension of lesson and Career Connections:

Have student's research countries that use biomass as a main source of energy. Report on the type of digesters they use, the amount of energy they release and type of raw materials they require. Suggest a potential location for a local biomass digester.

Biomass

Name_____

Phenomenon: Watch the watermelon decompose in this video:

https://www.youtube.com/watch?v=S12zZhdOckc

What do you notice about changes to the watermelon over time?

Ask three questions about the phenomenon.

1.

2.

3.

Design Question: Can you produce a useful substance using decomposition?

Use the following websites to research the products that could form in your bag:
https://www.eia.gov/energyexplained/?page=biomass_home
https://www.reenergyholdings.com/renewable-energy/what-is-biomass/

Materials: Ziploc freezer bags, sugar, corn meal, leaves, grass clippings, sawdust, vegetables, fruit, crackers, yeast, triple beam balance or electronic balance.

Procedures: Write down the steps your group will take to design a "digester":

Compare your procedures to another group. Make changes if you wish.

Data: What happened? How will you show a useful substance was produced?

Explanation

Questions:

1. Under what conditions do organic substances break down quickly and thoroughly?

2. Could decomposition produce useful substances?

3. Make a claim concerning your investigation. Did you produce a biofuel?

Claim
Evidence
Reasoning