Waste to WOW!

Objective:

Investigate the process of fermentation and anaerobic digestion.
Apply the problem-solving model to a real world problem or product design challenge.

Keywords:

- Decision-making model
- Waste products
- Anaerobic digestion

21st Century Skills Represented:

- Environmental Literacy
- Economic, Business & Entrepreneurial Literacy
- Creativity & Innovation
- Critical Thinking & Problem Solving
- Communication & Collaboration
- Career & Life Skills

National Science Education Standards:

- Earth & Space Sciences: Earth & Human Activity
- Physical Science: Matter & its Interactions
- Engineering, Technology & Applications of Science: Engineering Design; Links Among Engineering, Technology, Science & Society

feedstocks	processes	uses
Feedstocks – municipal solid waste & food/ industrial by-products	Biological – fermentation, composting & anaerobic digestion	Methane, heat & electricity, fertilizer/soil amdendments

Background

Anaerobic digestion, or fermentation, is a biochemical process, which produces biogas from biodegradable materials. Microbes break down organic materials into biogas and a nutrient rich discharge (i.e. effluent). Technologies using this process have been developed in recent years to address issues of waste management related to organic materials from many sources, from livestock manure to leftover ingredients from local restaurants and grocery salad bars.

Food waste represents one of the largest categories of municipal solid waste. Diverting a portion of food waste from landfills to anaerobic digesters can provide a significant contribution to methane gas production for energy uses. Livestock manure and human waste are also sources of feedstock for anaerobic digestion.

These technologies, which mimic the process in a ruminant animal's stomach, can operate both at large and small scales. Anaerobic digestion occurs when organic material decomposes biologically in the absence of oxygen, producing methane. How can the technology be used to create energy and turn a profit?

Materials

- Access to industry professionals as panelists (fast food and restaurant owners, extension agents, grocery store managers, farmers or livestock operation managers, Municipal Solid Waste Departments, etc.)

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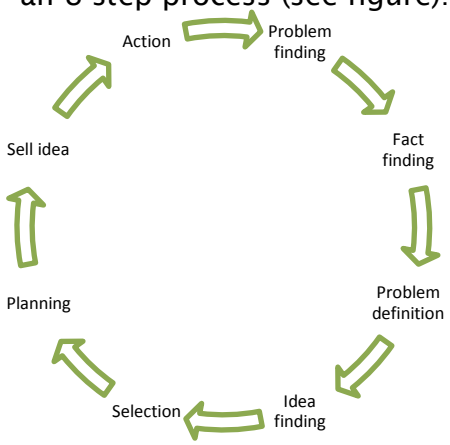
Pre-Lab Preparation

1. Introduce students to the problem-solving model - an 8 step process (see figure):
    a. State the problem, situation, or goal
    b. Research and gather information
    c. Analyze your resources
    d. Brainstorm
    e. Choose one idea
    f. Develop a plan of action
    g. Assign or assume responsibilities
    h. Conclusion
        i. Was the problem solved?
        ii. Was the situation improved?
        iii. Was the goal met?



2. Discuss with the students a real world application of the problem-solving model as an example.

Lab Procedures

1. Bring in a panel of industry representatives and have each leader present information about the organic waste with which they deal.
2. Encourage the students to ask the industry leaders about the waste and the problems associated with it.
3. Break students into groups of 2 or 3. Tell the students they are employed by a company that designs anaerobic digestion systems. Have each group choose an industry representative and their respective waste problem.
4. Each group will use the 8 step process to creatively solve that industry representative's problem. Sending the materials to a recycling center is not an option. Consider options that would yield some type of profit, too.
5. Students will have one week to solve the problem and put together a presentation on their solution and the process involved.
6. At the end of the week have each group give their presentation. Incorporate technology as needed (e.g. PowerPoint, podcast, online resources). Have the industry representatives attend the presentation and provide feedback to the students.

Post-Lab Discussion/Question

1. Have students record their answers to the following questions.
    a. What problem did you address?
    b. What information were you able to gather on the issue?
    c. What was your plan of action?
    d. Do you think the problem was solved? What else could be done to improve your solution?
    e. What would be the environmental impact of your solution?
    f. How can this problem-solving model be used in other career/life situations?
2. Hold a class discussion over the above questions.

Expansion Ideas

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- Have students turn this assignment into a service-learning project.
- Investigate other bioproduct processes for solving livestock manure challenges. Pyrolysis, a process using heat and pressure, is used to create paving and roofing shingles form hog manure. See the *Resources* section for additional information.

Evaluation of Learning

- Students demonstrate use of the 8 step problem-solving process.
- Students will successfully present the solution they created.

Resources

- Videos
  - OBIC Alliance Member: NuVention Solutions from YouTube by OBIC
  - Green Asphalt: Pavement from Hog Manure from YouTube by the St. Louis Science Center

- Websites and Articles
  - quasar energy group (includes a video)
  - Methane production by Agriculture and Consumer Protection, Food and Agriculture Organization of the United Nations
  - How Anaerobic Digestion (Methane Recovery) Works by the U.S. Department of Energy
  - Zero Waste at Ohio Stadium by The Ohio State University
  - Office of Energy and Environment and Sustainability by The Ohio State University
  - Basics of Energy Production through Anaerobic Digestion of Livestock Manure by Klein Ilelji, Chad Martin and Don Jones, Purdue University
  - Food Recycling: Trash to Treasure by John Ross, Columbus Alive
  - Anaerobic Digestion Presentation by Steve Baertsche and Mary Wicks, The Ohio State University
  - Developing the 'Model T' of Anaerobic Digesters Presentation by Jay Martin, The Ohio State University
  - Wanted: Hog manure by Nancy Allen, The Daily Standard
  - From Pig Manure to Paving Roads by University of Illinois at Urbana-Champaign

Contacts

- Ohio Soybean Council, Columbus, OH: http://www.soyohio.org
- Quasar Energy Group, Wooster, Columbus and Zanesville, OH: http://quasarenergygroup.com/
- NuVention Solutions, Inc., Valley View, OH: http://www.nuventionsolutions.com/
- Price Farms Organics, Ltd., Delaware, OH: http://www.pricefarms.org/
- Ohio Agricultural Research & Development Center, Wooster, OH: http://oardc.osu.edu
- Rumpke (offers tours), Cincinnati, OH: http://www.rumpke.com/education

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