Soy Foam: Egg Drop

Objective:

Recognize & classify products as polymers. Compare the usability of conventional polymers to bio-based packaging materials.

Keywords:

- Bioproduct
- Polymer

21st Century Skills Represented:

- Environmental Literacy
- Financial Literacy
- Creativity & Innovation
- Critical Thinking & Problem Solving
- Communication & Collaboration
- Life & Career 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
Crop – oil from soybeans	Chemical conversion	Foam

Background

A large variety of agricultural chemicals are made from vegetable oils. Soybean oil can be processed into soy polyols to create polyurethanes such as foams, binders, coatings, adhesives and sealants. Soy-based foam, developed from soy polyols, is used in a lot of products: home insulation, furniture, mattresses, wind-turbine blades, wake surfboards and military drones used for target practice.

Could soy-based polymers also work well as packaging material? How do the ingredients in spray soy foam work? What is the appeal? When a soy-based polyol is combined with isocyanate, a polyurethane resin system, soy foam is created. Some are rigid, while others are flexible.

The earth-friendly properties of soy allow manufacturers to reduce their environmental footprint (i.e. reduce use of petroleum-based products) while producing great products. Check out the range of growing applications for soy foams.

Materials

For class demonstration:

- 2 Tbs of A component – soy polyol
- 2 Tbs of B component – isocyanate
- MSDS sheets for A & B components
- 1 pair safety goggles
- Rubber gloves
- Large glass container
- Stirring stick

Per group of 3-4 students:

- 2 pair safety goggles
- Rubber gloves
- 1 piece 8.5 x 11 paper
- Egg
- Container to hold egg (such as a plastic bag, reusable plastic container with lid, Styrofoam food container)
- $10 play money

For classroom groups:

- 2 Tbs of A component (price attached, for example, $1 for 2 Tbs)
- 2 Tbs of B component (price attached, for example, $1 for 2 Tbs)
- Supply of packaging materials, prices attached (for example, wraps can cost $1 per foot, packing peanuts $1 per cup, etc.)
    - Bubble wrap, plastic wrap, packing peanuts & rigid foam
- Scrap Paper (priced, for example $1 per piece)
- Masking Tape (priced, for example $1 per foot)
- Play Money
- Ladder
- 1-2 garbage bags

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Pre-Lab Preparation

1. Show the Akron Global Polymer Academy's presentation titled, "What Are Polymers?"
2. Hold a class discussion on the following questions:
    a. What is a polymer?
    b. How are polymers used?
    c. What are some different types of polymers?
3. Put on safety glasses and rubber gloves. Pour component A into a large glass container.
4. Pour component B into the same glass container as component A.
5. Immediately stir so that component A and B are mixed thoroughly.
6. Ask the students, "What do you think this is?" Answer: soy foam insulation.
7. Ask the students, "What class of materials does it belong to?" Answer: polymers.
8. Tell students that the foam is a bioproduct and explain to them why.
9. Hold a class discussion on the following questions:
    a. What is a bioproduct?
    b. What are some other examples of bioproducts?

Lab Procedures

1. Divide students into groups of 3 or 4.
2. Tell the students they are going to conduct an experiment to see if soy foam is a viable alternative for oil-based packaging materials. Create a scenario involving the shipping of a fragile package (i.e. an egg). What types of force and motion would this fragile package need to be able to "survive" during the shipping process? Make a list of potential situations; then, plan testing situations accordingly.
3. Give each group a container and $10 to purchase packaging materials. Materials should be in a central location with pre-determined prices clearly noted.
4. Describe to the students what materials they have to work with and how much each costs.
5. Give the students time to develop and plan. Have them draw out their plan on a white piece of paper.
6. Have the students purchase their materials and construct their "package". Tell them their package must be able to protect an egg from an 8 - 10 foot drop and other testing situations that they have designed.
7. When packages are finished have each group place an egg into their container. Groups that used components A and B will need to place the egg in the container as the foam begins to rise.
    a. NOTE: Be sure to read the MSDS sheets for components A & B and have students wear safety goggles and rubber gloves when handling the chemicals.
8. Test each design.
9. Have each group present their design and explain why they believe it did or did not protect the egg.

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Post-Lab Discussion/Question

1. Hold a class discussion over the following questions:
    a. Why did certain packaging work while others didn't?
    b. If you had the opportunity to redo your design, how would you change it?
    c. Did the soy foam perform better, the same, or worse than the petroleum-based materials? Why?
    d. What are the negatives of using soy foam compared to using petroleum-based materials?
    e. What other experiments could be done to test the ability of soy foam as a packaging material?
    f. What if all packaging materials could be made from renewable materials instead of petroleum-based materials?
2. Research the importance of soybean, corn and polymer production in Ohio. What impact would a bio-based packaging industry have on Ohio's economy?

Expansion Ideas

- Develop marketing strategies.
- Do cost comparison of soy foam to petroleum-based foam and other packaging materials.
- Test and rate product claims for reliability and performance.

Evaluation of Learning

- Create a list of reasons for using soy-based foam.
- Write a letter to the Ohio Department of Development encouraging the use of bio-based packaging materials. Include thoughts about the potential impact on Ohio's economy.

Resources

- Videos
    - Growing Ohio's Economy: Poly-Green Technologies from YouTube by The Ohio State University-OARDC
    - Ford Soy Foam from YouTube by Ford Motor Company
    - SoyFoam Seating Technology Thanks to Ford, Lear, MI Soybean and United Soybean Board from YouTube by Michigan Farm Bureau

- Websites and Articles
    - Soy Plastics: Versatile and Cost Effective from United Soybean Board
    - BiOH polyols for foam and polyurethane manufacturing from Cargill
    - BioFlex Hybrid Foam from Flexible Foam Products, Inc.
    - Norwalk Furniture Incorporates 10% Soy Based Foam by Furniture World Magazine
    - Head's Up: Ford Increases Soy Content in Foam, Adds Head Restraint as Newest Component for Sustainable Material by Ford Motor Company
    - OARDC Helps Mansfield Company Produce 'Green' Polyurethane Foam, Jobs by Mauricio Espinoza, The Ohio State University-Extension

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- Green Insulation Technologies, LLC, Garrettsville, OH: http://www.greeninsulationtechnologies.com/
- Norwalk Furniture, Norwalk, OH: http://www.norwalkfurniture.com/
- Flexible Foam Products, Inc., Spencerville, OH: http://flexiblefoam.com/
- Poly-Green Technologies, Mansfield, OH
- Ohio Soybean Council, Columbus, OH: http://www.soyohio.org

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