Styrofoam Peanuts and Acetone

Properties of Polymers

Introduction

In this demonstration the properties of two space-filling packing materials will be examined.

Concepts

- Solubility
- Eye safety
- Biodegradable
- Safety goggles

Theory

Expanded polystyrene "peanuts," commonly known by the trade-name Styrofoam™, are familiar to all of us as a space-filling packing material. They are used to occupy empty space in packages to cushion, immobilize, and protect the package contents. Polystyrene, the raw material for these peanuts, is synthesized from petroleum byproducts (benzene, ethylene) and formed into beads. These beads are transformed into the ultra-low density peanuts by a process requiring the use of "blowing agents." Blowing agents are chemicals added to a substance (polystyrene in this case) for the purpose of generating gas to produce a foam.

When the polystyrene peanuts are added to the acetone, the peanuts seem to dissolve. They do not really dissolve in the acetone, but go through a process called "swelling" that allows the trapped gases to escape. To put it another way, the polystyrene is "de-foamed." If the bulk of the acetone is decanted off and the residual polystyrene/acetone is allowed to dry, the result is a solid polystyrene disk.

An alternative packing material that has been developed and became popular is starch-based peanuts. These peanuts are manufactured from a completely renewable resource—cornstarch! The cornstarch used must be slightly altered by the addition of a small percentage (5% or less) of an agent which increases its capacity to trap and hold air and to resist compression. The expansion method is similar to the production of "puffed" breakfast cereals and requires only heat and steam—a comparatively benign process.

Starch-based peanuts have the added benefits of being water soluble, non-toxic upon combustion, and 99+% biodegradable. It should be pointed out, however, that once a material is placed in a landfill, very little natural degradation takes place. Frequently, claims of biodegradability are not at all realistic if the item or material in question will be immediately buried in a landfill. The starch-based peanuts can be dissolved in water and flushed down the drain as an easy alternative means of disposal. Despite their solubility in water, the starch-based peanuts have been shown to withstand extended periods of warm temperature/high humidity.

Styrofoam and acetone can be used in a demonstration that is a good introduction to laboratory safety and the importance of wearing aprons and safety goggles.

Materials

Acetone, 100 mL

Polystyrene (Styrofoam™) peanuts, approximately 500

Starch-based peanuts, approximately 250

Acetone wash bottle, 20 mL

Beakers, 1000-mL, 2

Cardboard boxes, 2

Chemical splash goggles

Demonstration tray

Latex gloves

Marker, red

Stirring rods

Styrofoam® wig head

Warm tap water

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Safety Precautions

Provide adequate ventilation for this activity! Acetone is highly flammable and should be protected from sparks and open flame. Prolonged inhalation of acetone vapor is potentially toxic and should be avoided as should prolonged skin contact. Gloves must be worn if handling the polystyrene-acetone mixture. Do not ingest any components of this activity. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please consult Material Safety Data Sheets for additional safety information.

Procedure – Part 1

1. Add approximately 100 mL of acetone to a 1000-mL beaker. Add the same amount of tap water to a second 1000-mL beaker.
2. Place approximately 500 Styrofoam peanuts in a cardboard box and about half that amount of the starch-based peanuts in another box.
3. Show each type of peanut to the students. Pass them around and ask the students to visually inspect both types of peanuts and to note any apparent differences.
4. Touch one of the polystyrene peanuts to the warm tap water and have the students note what happens. Touch the same peanut to the acetone and note what happens.
5. Start adding the remaining polystyrene peanuts to the acetone a handful at a time, yet doing so as quickly as they will dissolve. A stirring rod may be used to aid the process.
6. Next add the remaining starch-based peanuts to the warm water. Again, add a handful at a time, yet as quickly as they will dissolve. A stirring rod will be essential for this task.

Procedure – Part 2

Preparation

1. Draw a set of eyes on the Styrofoam wig head using a red marker.
2. Fill an acetone wash bottle with acetone.

Procedure

1. Place a Styrofoam wig head on a chemical-resistant demonstration tray.
2. Place a pair of chemical splash goggles on the wig head.
3. Spray the front of the Styrofoam head with acetone. The head will start to dissolve.
4. Point out to your students that even though the acetone has thoroughly destroyed the wig head, the eyes are protected and safe behind the sight-saving safety goggles!

Disposal

The remains of the wig head may be disposed of in the trash according to Flinn Suggested Disposal Method #26a. Allow the acetone to evaporate in an operating fume hood or rebottle for later use. The polystyrene should also be allowed to dry in the hood and then be discarded with regular solid waste. The dissolved starch-based solution may be rinsed down the drain with excess clean water.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models and explanation
Constancy, change, and measurement
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Styrofoam Peanuts and Acetone* activity, presented by Lee Marek and Bob Lewis, is available in *Properties of Polymers*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Styrofoam Peanuts and Acetone* are available from Flinn Scientific, Inc.

Catalog No.	Description
A0009	Acetone, 500 mL

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.