PolySnow™

Superabsorbent Polymer

Introduction

When water is poured into a cup containing a small amount of solid, an overflowing mass of fresh powdered "snow" is produced.

Concepts

- Superabsorbent polymers
- Osmosis
- Cross-linking

Materials

PolySnow,™ 3 g

Distilled or deionized water, 150 mL

Beakers, 250-mL, 2

Sodium chloride, NaCl, 1 g

Safety Precautions

PolySnow is nontoxic. However, it is irritating to the eyes and to the nasal membranes if inhaled. Wear chemical splash goggles whenever working with chemicals, heat or glassware. Please review current Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

Before class, add 3 g of PolySnow to a 250-mL beaker.

Procedure

1. Add approximately 150 mL of distilled or deionized water to a second beaker.
2. Slowly add the water to the beaker containing the PolySnow. The polymer will turn fluffy white and start to grow. Within a minute the fluffy white solid will overflow the beaker.
3. Add a small amount (1 g) of sodium chloride to the beaker of PolySnow. The polymer will begin to release water and transform to a slurry.

Inquiry Activities with PolySnow

- Place 3 grams of PolySnow into a 1000-mL graduated cylinder. Add 150 mL of deionized water and measure the amount of swelling that occurs. Conduct experiments to determine the following:

—How does the swelling rate change with different amounts of polymer?
—How does the swelling rate change with different amounts of deionized water?
—How does the rate of swelling change when PolySnow is treated with hot water versus cold water?
—Does deionized water produce greater swelling than tap water?
—Determine conditions to achieve the greatest amount of swelling.

- Use food coloring to color the water before adding it to the PolySnow. Fill a graduated cylinder with layers of colored "snow." Let the snow layers sit undisturbed to see if color mixing occurs.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. PolySnow and the snow material may all be disposed of according to Flinn Suggested Disposal Method #26a. Do not put these materials down the sink!

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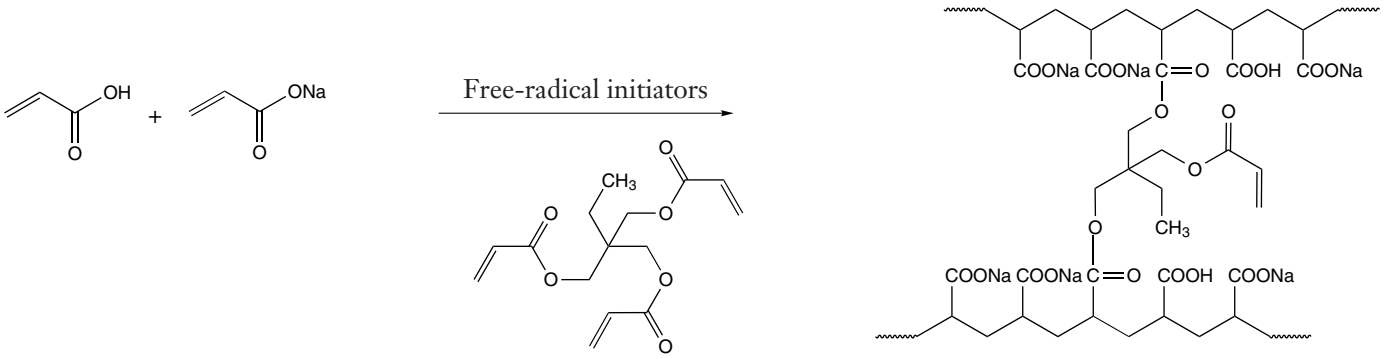
Discussion

PolySnow is an example of a superabsorbent polymer. Superabsorbents operate on the principle of osmosis—the passage of water through a semipermeable membrane. In PolySnow, osmotic pressure results from a higher concentration of sodium ions inside the polymer lattice compared to the solution in which it is immersed. This osmotic pressure forces water into the solid polymer lattice in an attempt to equilibrate the sodium ion concentration inside and outside the polymer membrane. The electrolyte concentration of the water will affect the osmotic pressure and the amount of water absorbed by the polymer. For example, PolySnow will absorb approximately 500–800 times its own weight in distilled water, but will only absorb about 300 times its own weight in tap water, due to the high ion concentration of tap water.

PolySnow is manufactured by the free-radical polymerization of a mixture of sodium acrylate and acrylic acid with a cross-linking agent such as trimethylol propanetriacrylate (see Figure 1).



Trimethylol propanetriacrylate

Sodium polyacrylate or PolySnow

Figure 1.

Both "regular" sodium polyacrylate and PolySnow absorb many times their weight in water due to osmosis. PolySnow has more cross-linking between the polymer chains. The greater amount of cross-linking reduces how much water is absorbed. It also changes the structure of the hydrated polymer network. Think of either polymer network as a three-dimensional net. With more cross-linking there are many individual "clusters" within the net. These clusters absorb water and form hydrogen bonds internally and they stay separate so the polymer becomes a fluffy solid instead of a gel.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
MS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
Disciplinary Core Ideas: High School
HS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter

Science and Engineering Practices
Asking questions and defining problems
Planning and carrying out investigations
Constructing explanations and designing solutions

Crosscutting Concepts
Patterns
Cause and effect
Structure and function

Reference

Buchholz, F. L., *J. Chem. Ed.*, **1996,** *73* (6), 512–515.

PolySnow is available from Flinn Scientific, Inc.

Catalog No.	Description
P0283	PolySnow, Sodium Polyacrylate Powder, 25 g
P0284	PolySnow, Sodium Polyacrylate Powder, 100 g

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