Melting Bottle

Chemical Safety Demonstration

Introduction

Ever read the hazard warnings concerning the preparation of sulfuric acid solutions?

> *Considerable heat of dilution with water; mixing with water may cause spraying and splattering. Solutions might best be made by immersing the mixing vessel in an ice bath.*

The meaning of this hazard warning is clearly explained in this demonstration.

Concepts

- Acid Safety
- Diluting Acids
- Exothermic Reactions

Materials

Sulfuric acid, concentrated, H_2SO_4, 100–120 mL
Water, deionized, H_2O, 100 mL
Beaker, Pyrex®, 1000-mL
Graduated cylinder, 100-mL
Neutralizer, sodium carbonate or sodium bicarbonate
Plastic chemical solution bottle, HDPE, 500-mL
Video camera (optional)

Safety Precautions

Concentrated sulfuric acid is severely corrosive to eyes, skin, and other body tissue. Considerable heat of dilution is generated when sulfuric acid is mixed with water; spraying and splattering of acid is possible. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron must be worn.
2. Place a clean, 500-mL HDPE plastic bottle in a large Pyrex beaker or crystallizing dish. Make sure the Pyrex dish will hold at least 1000 mL.
3. Place 100 mL of water in the plastic bottle.
4. Using a dry graduated cylinder, carefully add 100–120 mL of concentrated sulfuric acid to the plastic bottle containing the water. ***Do not use a funnel.***
5. *Optional:* Place a thermometer into the bottle containing the acid solution. Monitor the temperature change of the solution.
6. Observe the bottle. After about 5–10 seconds, the sides of the bottle should begin to swell along the bottom of the bottle.
7. Within about 15–30 seconds, the bottle will begin to melt in one or more places. When the bottle melts, the solution will push on the melted portion of the bottle and a "bubble" will appear and begin to grow. This bubble will continue to grow and the plastic will become thinner until it ruptures, releasing the sulfuric acid solution into the containment beaker.
8. After the sulfuric acid has cooled, take the beaker to a sink area, remove the bottle from the acid solution, and thoroughly rinse it with slow-running water.
9. The 9 M sulfuric acid left in the beaker can be disposed of using Flinn Suggested Disposal Method #24b. Please consult a current *Flinn Scientific Catalog/Reference Manual* for proper disposal procedures.

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Tips

- This activity uses hazardous materials in order to demonstrate an important safety rule. Follow all directions and practice this demonstration before presenting it in front of your students.
- Use a video projection system to view the demonstration on a TV or monitor.
- The demo works well using a used but empty, clean, and dry 500-mL solution bottle from Flinn Scientific. Other bottles may have different melting points and may not work as well.
- If the "plastic bubble" is too close to the side of the beaker, the beaker will support the molten plastic and it may not rupture. Move the bottle away from the wall of the beaker to allow the weight of the solution to continue to expand the plastic to its breaking point.
- The temperature increase is not immediate, but occurs over 5–10 seconds. The final temperature of our trials was about 140°C.
- It does take a few seconds for the plastic to melt and the bubble to form. If your bottle is robust and is only softening instead of melting, try lifting the bottle slightly. The additional weight on the bottom of the bottle may facilitate expansion and rupture of the plastic. Do not lift the bottle out of the beaker.

Discussion

Concentrated sulfuric acid has a very strong affinity for water. It is sometimes used as a drying agent and can dehydrate materials such as skin, cellulose, sugar, and other plant or animal matter. Diluting concentrated sulfuric acid with water is a very exothermic process—enough heat can be released to boil the water and splatter the acid. In this demonstration, the temperature rise is about 120°C and the heat of reaction is estimated to be at least 17 kcal/mole.

Most plastic chemical bottles are made out of high-density polyethylene (HDPE). Although most polyethylene may look similar, there are thousands of different grades. The properties of polyethylene can be adjusted to fit the needs of a specific application by adjusting the average molecular weight, adding copolymers, increasing or decreasing branching, or adding additives. Therefore, there is no one characteristic melting point for polyethylene. On average, however, most HDPE will start to melt around 120 °C. As the plastic bottle starts to melt, the weight of the sulfuric acid solution pushes against the bottle and expands the plastic. As the bottle expands, the plastic becomes thinner and will melt faster until it ruptures.

Materials for *Melting Bottle* are available from Flinn Scientific, Inc.

Catalog No.	Description
S0145	Sulfuric Acid, 18 Molar, 2.5 L
AP4560	Chem Cam Video Camera

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