Winter Wonderland

Precipitation of Potassium Sulfate

Introduction

Adding isopropyl alcohol to a saturated solution of potassium sulfate produces a beautiful snowfall of white, flaky precipitate.

Concepts

- Solubility
- Precipitation
- Solvation

Materials

Isopropyl alcohol, $(CH_3)_2CHOH$, 70%, 100 mL

Potassium sulfate, K_2SO_4, 30 g

Beaker, Berzelius (tall form) or graduated cylinder, 500-mL

Magnetic stirring plate and stir bar

Safety Precautions

Isopropyl alcohol is a flammable liquid; keep away from heat, sparks, open flames, and hot surfaces. It is slightly toxic by ingestion and inhalation and causes mild skin and severe eye irritation. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

Prepare a saturated solution of potassium sulfate by stirring 30 g of K_2SO_4 per 200 mL deionized water for 30 minutes. All the K_2SO_4 may not dissolve. Decant off solution.

Procedure

1. Fill a Berzelius (tall-form) beaker or a large graduated cylinder with the 200 mL of saturated potassium sulfate solution.
2. Carefully add 100 mL of 70% isopropyl alcohol to the saturated potassium sulfate solution.
3. A "cloud" of potassium sulfate forms immediately and begins to "snow" as the K_2SO_4 precipitates out and drifts to the bottom of the container.

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. Isopropyl alcohol may be disposed of according to Flinn Suggested Disposal Method #18a. The solution and precipitate may be disposed of by Flinn Suggested Disposal Method #26b.

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

PS1.B: Chemical Reactions

Disciplinary Core Ideas: High School

HS-PS1 Matter and Its Interactions

PS1.A: Structure and Properties of Matter

PS1.B: Chemical Reactions

Science and Engineering Practices

Asking questions and defining problems

Developing and using models

Crosscutting Concepts

Cause and effect

Structure and function

Publication No. 653
032417

Tips

- After "snowing" has stopped, note the three resulting layers by gently swirling the beaker or cylinder (this works better in the graduated cylinder) and looking for a meniscus. The three layers are 70% isopropyl alcohol (top), isopropyl alcohol/K_2SO_4 aqueous solution, and a saturated K_2SO_4 layer (bottom).
- Gently stirring the middle and lower layers will mix more isopropyl alcohol and saturated K_2SO_4 solution and create another, "lower altitude" cloud for another snow storm.
- Blinding "blizzards" of precipitate are generated if equal volumes of isopropyl alcohol and saturated K_2SO_4 solution are mixed or if a super-saturated solution of K_2SO_4 is used.
- Demonstrate ionic solubility versus solvent polarity by varying the amount of isopropyl alcohol added and measuring the final amount of precipitated K_2SO_4.

Discussion

Isopropyl alcohol and water are miscible, i.e., mutually soluble in all proportions. This miscibility is due to the similar polarity and hydrogen bonding characteristics of water and isopropyl alcohol. Isopropyl alcohol is polar, but because of its organic portion, is less polar than water and less able to dissolve ions. When isopropyl alcohol is added to an aqueous salt solution, the polarity of the resulting mixture decreases and the solubility of the ions in solution decreases accordingly.

A saturated potassium sulfate solution already contains the maximum concentration of potassium and sulfate ions. In this demonstration, the polarity of the solution changes when isopropyl alcohol is added and the concentration of these ions that can be solvated and kept in solution dramatically decreases. The result is a loss of solvation and the formation of potassium sulfate precipitate.

If the isopropyl alcohol is added slowly, three layers are formed in the mixture, an upper isopropyl alcohol layer, a mixture of isopropyl alcohol and K_2SO_4 solution, and a saturated K_2SO_4 lower layer. A cloud of unsolvated K_2SO_4 immediately forms in the middle layer due to the decrease in polarity and loss of solvation. K_2SO_4 particles formed in this layer grow larger and heavier, before they begin to slowly fall through the isopropyl alcohol–water meniscus into the saturated K_2SO_4 layer. After all the precipitated K_2SO_4 has fallen from the upper layers, the mixture can be stirred to mix more saturated K_2SO_4 solution with the isopropyl alcohol and precipitate more K_2SO_4.

Materials for *Winter Wonderland* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0087	Potassium sulfate, 100 g
P0088	Potassium sulfate, 500 g
I0021	Isopropyl alcohol, 70%, 500 mL
I0037	Isopropyl alcohol, 70%, 4 L
GP1060	Beaker, Berzelius, Borosilicate, 500 mL
GP2060	Cylinder, Borosilicate Glass, Graduated, 500 mL

Consult the Flinn Scientific website for current prices.