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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%, 200 mL
Potassium sulfate, K_2SO_4, 60 g
Beaker, Berzelius (tall form) or graduated cylinder, 500-mL
Magnetic stirring plate and stir bar

Safety Precautions

Isopropyl alcohol is a flammable liquid, a moderate fire risk, and moderately toxic by ingestion and inhalation. 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.

Preparation

Prepare a saturated solution of potassium sulfate by stirring 60 g of K_2SO_4 per 400 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 about two-thirds full with the saturated potassium sulfate solution.
2. Carefully add 70% isopropyl alcohol to the saturated potassium sulfate solution. Adding about one-half the volume of the potassium sulfate solution works well.
3. A "cloud" of K_2SO_4 forms immediately and begins to "snow" as the K_2SO_4 precipitate drifts to the bottom.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The solution and precipitate can be disposed of by Flinn Suggested Disposal Method #26b.

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 solution 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 amount 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 the lower saturated K_2SO_4 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.

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 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

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, Pyrex®, Berzelius, 500 mL
GP1059	Beaker, Pyrex®, Berzelius, 400 mL

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

