Kevin Zhang Lab Report 3

Introduction

The goal of this lab is to prepare sodium thiosulfate pentahydrate ($Na_2S_2O_3 \cdot H_2O$) by combining elemental sulfur (S) with sodium sulfite (Na_2SO_3). This can be done by dissolving powdered sulfur in a solution of sodium sulfite, and then crystallizing the compound.

Chemical Responsibility

Some of the chemicals in this lab are skin irritants: Sodium sulfite, sulfur. There are other chemicals that are toxic and corrosive: HCl, Iodine. We will also be heating solutions until boiling, so care should be taken to avoid splatter.

Report Sheet

Qualitative Tests

1. Add 2 drops of 0.1 M NaCl and 2 drops of 0.1 M silver nitrate in about 5 mL of water in a test tube to produce AgCl. Add a few crystals of your reactant product and shake. Describe your observations. Cloudy solution with a clear bottom -> seems to separate in two separate immiscible liquids
2. Add 1 or two drops of 0.1 M iodine solution to about 5 mL of water in a test tube. Add a few crystals of your product and describe your observations. Solution becomes completely clear with some solids on the bottom (might be excess crystals)
3. Dissolve a small amount of your product in about 5 mL of water in a test tube. Add about 1 mL of 6 M HCl. Warm the solution and sniff it cautiously. Describe your observations. Solution becomes cloudy after heating. Smelled of a strong sulfur smell.

Yield

1. Weight of empty filter paper: 0.605g
2. Weight of paper + crystals: 9.915g
3. Weight of crystals: 9.310g
4. Theoretical yield: 21.61g

$$\text{mol of } Na_2SO_3 = \frac{mass_{Na_2SO_3}}{\text{molar mass}_{Na_2SO_3}} = \frac{12.598g}{126.037g/mol} = 0.100mol$$

$$\text{mol of S} = \frac{mass_S}{\text{molar mass}_S} = \frac{3.498g}{32.06g/mol} = 0.109mol$$

$$\text{molar mass of } Na_2S_2O_3 \cdot 5H_2O = 216.111g/mol$$

$$\text{mass of } Na_2S_2O_3 = 0.100mol \times 216.111g/mol = 21.61g$$

5. Percentage Yield: 43.08%

$$\text{percentage yield} = \frac{yield}{expected} \times 100\% = \frac{9.310}{21.61} \times 100\% = 43.08\%$$

Sample Calculations

$$\text{weight}_{\text{crystals}} = \text{weight}_{\text{crystals and filter}} - \text{weight}_{\text{filter}} = 9.915g - 0.605g = 9.310g$$

Discussion of Results

The outcome of this lab was approximately 43.08% yield. This was somewhat expected -- we could not dissolve all of the sulfur in the solution during the initial heating process, so we likely had a much lower amount of crystals produced. Furthermore, some of the crystals remained in the beaker (and filter) during the vacuum filtration process, so we probably also loss some mass there.

Post-Lab Questions

1. List two possible reasons why a 100% yield was not obtained
    1. Not all of the sulfur dissolved. Some of this happened during the initial mixing process -- some sulfur got stuck in the beaker used to measure the sulfur and we couldn't get it out. Some of this happened during the heating process: the sulfur stayed in large clumps, and refused to fully dissolve, even after long period of heating and stirring.
    2. Some of the crystals were lost during pouring and vacuum filtration. Some of the crystals got stuck in the beaker when transferring to the vacuum filter, and some of the crystals did not budge when trying to scoop to transfer to watch glass.
2. What is a hydrate? A hydrate is a substance that absorbs water / bonds with water.
3. Write a balanced net ionic equation for the reaction that occurs when NaCl and $AgNO_3$ are mixed.

$$Cl^-(aq) + Ag^+(aq) \longrightarrow AgCl(s)$$

4. Write a balanced net ionic equation for the reaction that occurs when some of your product is added to precipitate in Q3.

$$AgCl(s) + 2Na_2S_2O_3 \cdot 5H_2O \longrightarrow 4Na^+(aq) + Cl^-(aq) + [Ag(S_2O_3)_2]^{3-}(aq)$$

5. Why does brownish color of aqueous elemental iodine solution disappear when a few crystals of your product are added? The iodine reacts with the sodium thiosulfate to form a different compound. The new compound is colorless.

6. You dissolved a small amount of product in about 5 mL of distilled water in a test tube. You then added about 1 mL 6M HCl solution and finally heated the solution. What precipitate formed in the test tube? Sulfur (S) is formed.
7. What is a supersaturated solution? A supersaturated solution is a solution that is heated to dissolve more solute, and then slowly cooled to prevent the solute from crystallizing again. This creates a solution that should theoretically only hold so much solute, but actually holds more than that.
8. What is efflorescence? Efflorescence is when hydrate salts (such as sodium thiosulfate pentahydrate) spontaneously lose water.

Conclusion

In conclusion, you can form sodium thiosulfate by dissolving sulfur in sodium sulfite.