Experiment

32 Supersaturation

Text reference:
Chapter 16, p. 376

Introduction

The *solubility* of a solute is defined as the maximum amount of that solute which will dissolve in a given amount of solvent. The solubility of most substances increases as the temperature is increased. At any given temperature, a particular solvent can normally dissolve a specific maximum quantity of a particular solute. If more than this maximum amount of solute is added to the solution, the additional solute will not dissolve. A solvent containing the maximum amount of solute it can dissolve at a particular temperature is said to be *saturated*.

It is possible, under certain conditions, for a solution to contain more solute than is normally contained in a saturated solution at the same temperature. This type of solution is called *supersaturated* and it is unstable. The addition of a single crystal of solute often causes the excess solute to crystallize. Sometimes simply jarring the supersaturated solution will cause crystallization.

Supersaturated solutions can form when a solution is cooled, if the solute is less soluble at the lower temperature than at the higher temperature. As the solution cools, the excess solute may crystallize out. If the excess solute remains in the solution, however, the solution is supersaturated.

In this experiment you will prepare a supersaturated solution and observe the effect of adding a seed crystal to it.

Objectives

1. To prepare a supersaturated solution of sodium sulfate.
2. To observe the effect of seeding a supersaturated solution.

Equipment

- 2 safety goggles
- 1 medium test tube
- 1 test tube rack
- 1 test tube holder
- 1 100-mL beaker
- 1 10-mL graduated cylinder
- 1 gas burner
- 1 plastic wash bottle

Materials

- sodium sulfate decahydrate, $Na_2SO_4 \cdot 10H_2O$
- ice
- distilled water

Safety

1. Wear safety goggles.

Procedure

As you perform the experiment, record your observations in Table 32·1 provided at the end of the Procedure section.

1. Place 5 g of $Na_2SO_4 \cdot 10H_2O$ in a clean test tube. Add 10 mL of distilled water.

2. Hold the test tube in a test tube holder and heat it in a burner flame, agitating the mixture *gently* until all of the solid has dissolved. **CAUTION:** *When heating a test tube, never point the mouth of the tube at yourself or anyone else. Make sure to warm the bottom and sides of the tube evenly. Never heat only the bottom of the tube.* Place the test tube in a test tube rack. Add one more crystal of $Na_2SO_4 \cdot 10H_2O$ to the warmed solution and record your observations in Table 32·1.

3. Place the test tube in a beaker of ice water to cool. Be careful not to disturb the test tube or its contents during the cooling process. If crystals begin to form in the solution, as it is cooling, reheat the tube to redissolve the crystals, and cool the tube again.

4. When the solution is cold, gently remove the tube from the ice water bath. Replace the test tube in the test tube rack and drop in one small crystal of $Na_2SO_4 \cdot 10H_2O$. Describe what you see. Touch the bottom of the test tube to the palm of your hand. Record your observations in Table 32·1.

5. Dispose of the crystals by washing them into the sink and flushing them down the drain with water.

Table 32·1 Observations

Step	Observation

Results and Conclusions

1. At the end of Step 2, is the solution unsaturated, saturated, or supersaturated? Explain.

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2. At the end of Step 3, is the solution unsaturated, saturated, or supersaturated? Give evidence for your answer.

3. At the end of Step 4, when crystallization is complete, is the solution unsaturated, saturated, or supersaturated? Explain.

4. Describe one simple test that will determine whether a solution is unsaturated, saturated, or supersaturated. Explain how to interpret the test.

Going Further

The concepts explored in this experiment are used in growing crystals. Find instructions for several crystal-growing labs. Ask your teacher which of these you can do in your school laboratory and which you can do at home. After you have successfully grown some crystals, design a crystal-growing lab for others in your class.