Speed Up That Solution

To demonstrate that the rate of solution is dependent upon temperature, agitation and surface area.

Application

Solutions • Solvation • Rate of Solution

Theory

The rate of solution can be increased by changing three factors: temperature, if or not the solvent–solute mixture is agitated and the surface area of the solute.

As the temperature of the solvent–solute mixture increases so does the average kinetic energy of the solvent particles. As the solvent particles collide with the solute particles they tend to break the solute into smaller and smaller pieces until solvation is achieved. Heating such a mixture will increase the number of collisions per unit time. Solvation is therefore reached sooner.

Agitation of the solvent-solute mixture also contributes to the solution process. Stirring literally brings more of the solvent particles into contact with the solute particles, resulting in an increase in the rate of solution. Agitation also causes the solute particles to break apart, thereby increasing their surface area. Dispersal of solvated complexes away from the solute particles also prevents the dissolved particles from recrystalizing onto the undissolved particles.

Finally, breaking the solute particles into smaller pieces increases the surface area of the solute. Exposed surface area is important to solvation since the solute particles dissolve from the outside towards the center of the particle. If a particle is split into two parts, its inner core is also exposed to the solvent. As a result solvation is achieved sooner.

Materials

Copper sulfate, $CuSO_4 \cdot 5H_2O$, large crystals, 50 g

Beakers, 150-mL, 6

Mortar and pestle

Stirring rod

Water

Hot water, approx. 80 °C

Overhead projector

Safety Precautions

Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron and always follow laboratory safety rules while performing demonstrations.

Demonstration

Set six 150-mL beakers on an overhead projector.

Add 100 mL water to the first beaker and 100 mL hot water (approx. 80 °C) to the second beaker. Add a 5 g sample of $CuSO_4$ to each beaker. Do not stir. If necessary push the crystals to one side of the beaker so that light from the projector can pass through the solution. The sample in the hot water will immediately begin dissolving, forming a dark blue image on the screen.

Using a mortar and pestle crush a 5 g sample of copper(II) sulfate into a fine powder. Add 100 mL water into the second pair of beakers. Place a 5 g sample of $CuSO_4$ into the first beaker and the 5 g sample of crushed $CuSO_4$ into the second beaker. The crushed sample dissolves faster.

Add 100 mL water to the last pair of beakers and add a 5 g sample of $CuSO_4$ to each beaker. Stir one of the samples with a stirring rod. The stirred sample will dissolve faster.

Disposal

Solutions may be flushed down a drain with excess water.