Solubility of Gases

Temperature

In an earlier lesson, you learned that a higher temperature increases the amount of solid that can dissolve in a liquid. This is because the dissolving process requires energy. Adding heat supplies more energy, and thus increases the amount of solute that can dissolve.

However, the effect of temperature on the solubility of a gas in a liquid is the opposite: **the solubility of gases decreases as temperature increases**. Thus, the solubility of most gases in liquid solvents is greater at colder temperatures.

The reason for this is that gases respond to temperature changes to a much larger extent than solids or liquids. Increasing the temperature increases the kinetic energy of the gas particles so much that the liquid solvent is no longer able to hold the gas particles in solution. The gas particles actually *boil* out of the solution.

Pressure

The solubility of solids and liquids are not noticeably affected by changes in pressure. The solubility of a gas in a liquid, however, is greatly influenced by pressure.

When pressure is increased, the rate at which gas molecules strike the surface and enter the solution is increased. Thus, **the solubility of a gas in any solvent is increased as the pressure of the gas over the solvent increases**.

In 1803, the English chemist William Henry conducted experiments on the solubility of gases in liquids. He found that the solubility of a gas was proportional to the pressure of the gas above the liquid. This is known as **Henry's law**.

The effect of pressure on solubility is used in producing carbonated beverages. These are bottled under a carbon dioxide pressure slightly greater than one atmosphere. When the bottles are opened, the pressure of carbon dioxide above the solution is decreased. With the pressure of carbon dioxide reduced, the solubility of the gas drops and bubbles of carbon dioxide can be seen escaping throughout the liquid. If the bottle is left open, eventually all of the dissolved carbon dioxide will escape.

Factors Affecting the Rate of Dissolving

The rate at which a solid solute dissolves in a solution depends on three factors: surface area, stirring, and temperature.

Surface Area

Because dissolving occurs at the surface of a solute, it can be sped up by increasing the surface area of the solute that is exposed to the solvent. A common method of increasing the surface area of a solute is to grind it into smaller particles. The more finely divided the particles become, the greater the exposed surface area.

Stirring

Since dissolving occurs at the surface of a solute, dissolved solute particles tend to accumulate in the solvent close to the surface of the solute. This will cause dissolving to slow down. By stirring the solution, the heavy concentration of solute particles is swept away from the surface of the undissolved solute. This makes fresh solvent available to continue the solvation process.

The effect of stirring is very similar to that of grinding—contact between the solvent and the solute surface is increased, increasing the rate of dissolving.

Temperature

Raising the temperature of a solvent increases the rate at which a solute dissolves. This is because, as temperature increases, solvent particles move faster. When solvent particles move faster, more particles come in contact with the solute. In addition, the solvent particles have more energy to remove particles from the solid solute.