The Common Ion Effect

This concept involves how the solubility of a salt changes when some ion that is common to both added substance and the salt in question. Let us consider the equilibrium reaction involving the saturated solution of silver chloride that is described below.

$$AgCl(s) \rightleftharpoons Ag^{+}(aq) + Cl^{-}(aq)$$

Let us add some amount of silver nitrate ($AgNO_3$) to the above equilibrium system and see what happens to the solubility of silver chloride.

Silver nitrate dissociates and produces silver ion (Ag^+) and nitrate ion (NO_3^-) according to

$$AgNO_3(s) \longrightarrow Ag^{+}(aq) + NO_3^{-}(aq)$$

where Ag^+ is a common ion to both $AgNO_3$ and AgCl. Adding $AgNO_3$ to a saturated solution of AgCl increases the concentration of the Ag^+ ion thereby increasing the collisions between Ag^+ ion and NO_3^- ion that results in the formation of more solid AgCl. According to Le Chatelier's principle, it is a shift in equilibrium from right to left by forming more solid AgCl. The net result is the decrease in the solubility of AgCl because Ag^+ ion and Cl^- ion are removed from the solution in the form of solid AgCl.

Therefore, the effect of common ion is to decrease the solubility of the salt.

If NaCl is added, the effect will be still the same (decrease in solubility of AgCl), as Cl^- ion is common to both NaCl and AgCl.

If $NaNO_3$ is added, there is no effect on the solubility, as there is no common ion.

Example

Explain how the solubility of saturated solution of $MgCO_3$ decreases by adding K_2CO_3.

Answer

The equilibrium reaction for the saturated solution of $MgCO_3$ is written as

$$MgCO_3(s) \rightleftharpoons Mg^{2+}(aq) + CO_3^{2-}(aq)$$

When K_2CO_3 is added, it increases the concentration of CO_3^{2-} ion making equilibrium shift from right to left by forming more solid $MgCO_3$. The net result is to decrease the solubility of $MgCO_3$.