Answer on the question #48050, Chemistry, Physical Chemistry

Question:
If the equilibrium of a slightly soluble salt shift to the left due to common ion, then why and how the solubility decrease? please explain.

Answer:

Consider the dissolution process of the salt AgCl:

$$AgCl = Ag^+ + Cl^-$$

The solubility constant of AgCl is:

$$K_{sc} = [Ag^+][Cl^-]$$

According to this equation, the raise of chloride concentration causes the decrease of silver concentration:

$$[Cl^-] \uparrow \Rightarrow [Ag^+] \downarrow$$

K_{sc} value depends on the ion force of the solution:

$$K_{sc} \sim I_f = \frac{1}{2}\sum z^2 c_i$$

To avoid that influence, chemists use the activities instead of equilibrium concentrations:

$$K_s = a_{Ag^+} * a_{Cl^-} = [Ag^+][Cl^-] * \gamma_{\pm}^2$$

Where $\gamma_{\pm}$ is activity coefficient. According to the Huccel equation:

$$log\gamma_{\pm} = -A\sqrt{I}$$

Where $A \approx 0.51$. Then, with the increase of the concentration of solution ion force rises. It causes the activity coefficients decrease. As the K_s value remains constant in constant temperature conditions, the decrease of activity coefficients causes the increase of $[Ag^+][Cl^-]$ product, named solubility.