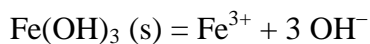


Problem 9-05 Heterogeneous ionic equilibria – precipitation from solution

Acid mine water contains $0.001 \text{ mol Fe}^{3+}/\text{dm}^3$. Determine the pH at which begins the precipitation of $\text{Fe}(\text{OH})_3$. The solubility product of $\text{Fe}(\text{OH})_3$ at the temperature of 18°C is $3.8 \cdot 10^{-38}$, the ionic product of water $5.78 \cdot 10^{-15}$ (both for the standard state of infinite dilution, $c^{\text{st}} = 1 \text{ mol dm}^{-3}$). Assume that activities can be replaced by relative concentrations.

[pH = 2.8]

Solution:



$$c_{\text{Fe}^{3+}} = c, \quad c_{\text{OH}^-} = 3c$$

$$K_S = a_{\text{Fe}^{3+}} \cdot a_{\text{OH}^-}^3 = \gamma_+ \cdot \frac{c_{\text{Fe}^{3+}}}{c^{\text{st}}} \cdot \left(\gamma_- \cdot \frac{c_{\text{OH}^-}}{c^{\text{st}}} \right)^3 = \frac{\gamma_{\pm}^4}{c^{\text{st}}} \cdot c_{\text{Fe}^{3+}} \cdot c_{\text{OH}^-}^3$$

$$a_i = c_i / c^{\text{st}} \quad (\gamma_{\pm} = 1), \quad c^{\text{st}} = 1 \text{ mol dm}^{-3}$$

$$c_{\text{OH}^-} = \left(\frac{K_S}{c_{\text{Fe}^{3+}}} \right)^{1/3} = \left(\frac{3.8 \cdot 10^{-38}}{0.001} \right)^{1/3} = 3.362 \cdot 10^{-12} \text{ mol dm}^{-3}$$

$$c_{\text{H}^+} = \frac{K_v}{c_{\text{OH}^-}} = \frac{5.78 \cdot 10^{-15}}{3.362 \cdot 10^{-12}} = 1.719 \cdot 10^{-3} \text{ mol dm}^{-3}$$

$$\text{pH} = -\log(1.719 \cdot 10^{-3}) = 2.7647$$

pH = 2.8