

At what rate (g/min) would a 4 cm diameter sphere of Ag dissolve in a flowing Pb stream with a velocity of 20 cm/s at 800 K.

Data:

Ag-saturated molten Ag-Pb alloy at 800 K has a silver mole fraction of 0.73.

Assume the diffusivity of Ag in Pb at 800 K is 0.0001 cm²/s.

Assume the viscosity of Molten Pb at 800 K is 0.015 cP.

$$W := A \cdot km \cdot \Delta C$$

$$r := 2 \cdot \text{cm} \quad d := 2 \cdot r = 0.04 \text{ m} \quad \rho := 10.5 \cdot \frac{\text{g}}{\text{cm}^3} \quad \eta := 0.015 \cdot \frac{\text{g}}{\text{cm} \cdot \text{s}}$$

$$A := 4 \cdot \pi \cdot r^2 = 50.265 \text{ cm}^2$$

$$V := 20 \cdot \frac{\text{cm}}{\text{s}} \quad D := 0.0001 \cdot \frac{\text{cm}^2}{\text{s}}$$

$$Sh(Re, Sc) := 2 + 0.6 Re^{\frac{1}{2}} \cdot Sc^{\frac{1}{3}}$$

$$km(Re, Sc, d, D) := (Sh(Re, Sc)) \cdot \frac{D}{d}$$

$$Re := \frac{d \cdot V \cdot \rho}{\eta} = 5.6 \cdot 10^4 \quad Sc := \frac{\eta}{\rho \cdot D} = 14.286 \quad Sh(Re, Sc) = 346.519$$

$$km(Re, Sc, d, D) = 0.00866 \frac{\text{cm}}{\text{s}}$$

$$\Delta C(CS, CB) := (CS - CB)$$

$$CB := 0 \cdot \frac{\text{mol}}{\text{m}^3} \quad CS := \frac{73 \cdot \text{mol}}{73 \cdot \text{mol} \cdot 107.8 \cdot \frac{\text{g}}{\text{mol}} + 27 \cdot \text{mol} \cdot 205.7 \cdot \frac{\text{g}}{\text{mol}}} = 0.056 \frac{\text{mol}}{\text{cm}^3}$$

$$\frac{10.08 \frac{\text{g}}{\text{cm}^3}}{10.08 \frac{\text{g}}{\text{cm}^3}} + \frac{10.5 \cdot \frac{\text{g}}{\text{cm}^3}}{10.5 \cdot \frac{\text{g}}{\text{cm}^3}}$$

$$\Delta C(CS, CB) = 0.056 \frac{\text{mol}}{\text{cm}^3}$$

$$W := A \cdot km(Re, Sc, d, D) \Delta C(CS, CB) = 0.024 \frac{\text{mol}}{\text{s}}$$

$$m := W \cdot 107.8 \frac{\text{gm}}{\text{mol}} = 2.617 \frac{\text{gm}}{\text{s}}$$

$$m = 156.992 \frac{\text{gm}}{\text{min}}$$