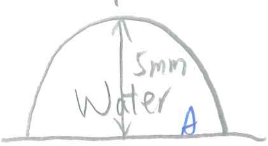
26-10



$N_A \uparrow$ air$_B$ $\begin{cases} 30^\circ C \fallingdotseq 303K \\ 1 atm \end{cases} \Rightarrow P_A \approx 0.04$ atm.

Assume $D_{AB} = 0.28\ cm^2/s$ is known

for differential eq'n of mass transfer.

$$\vec{\nabla}\cdot\vec{N}_A + \overbrace{\cancel{\frac{\partial C_A}{\partial t}}}^{\text{steady state}} - \overbrace{\cancel{R_A}}^{\text{no reaction}} = 0$$

$$\Rightarrow \vec{\nabla}\cdot\vec{N}_A = 0$$

for spherical coordinates. in r direction only

$$\frac{1}{r^2}\frac{\partial(r^2 N_{A,r})}{\partial r} + \frac{1}{r\sin\theta}\frac{(\overbrace{\cancel{N_{A,\theta}}}^{0}\sin\theta)}{\partial\theta} + \frac{1}{r\sin\theta}\frac{\partial \overbrace{\cancel{N_{A\phi}}}^{0}}{\partial\phi} = 0$$

$$\Rightarrow \frac{\partial(r^2 N_{A,r})}{\partial r} = 0 \Rightarrow r^2 N_{A,r} \text{ is not a function of } r$$

from Fick's eq'n

$$N_{A,r} = -CD_{AB}\frac{\partial y_A}{\partial r} + y_A(N_{A,r} + \overbrace{\cancel{N_{B,r}}}^{0\ \text{still air}})$$

$$\Rightarrow N_{A,r}\,dr = -\frac{CD_{AB}}{1-y_A}\,dy_A \qquad \text{at} \begin{cases} r=R. & y_A = 0.04 \\ r\to\infty & y_A = 0 \end{cases}$$

②

$$r^2 N_{A,r} \int \frac{1}{r^2} dr = -\int \frac{C D_{AB}}{1-y_A} dy_A$$

$$\Rightarrow -r^2 N_{Ar} \frac{1}{r} \Big|_R^{\infty} = C D_{AB} \ln(1-y_A) \Big|_{0.04}^{0}$$

$$\Rightarrow r^2 N_{Ar} \left(\frac{1}{R}\right) = -C D_{AB} \ln(0.96)$$

$$\Rightarrow W_A = \underset{\text{mass out}}{(-)}\frac{1}{2} \times 4\pi r^2 N_{A,r} = -\,-2\pi C D_{AB} \ln(0.96) \cdot R_t$$

(mol/s)

$$= \frac{\rho_A}{M.W_A} \cdot \frac{dV}{dt}$$

$$= \frac{\rho_A}{M.W_A} \frac{1}{2} \times 4\pi R_t^2 \frac{dR_t}{dt}$$

$$\Rightarrow \int_0^{\theta} dt = \frac{\rho_A}{M W_A} \frac{+1}{C D_{AB} \ln(0.96)} \int_{R_i}^{R_f} R_t \, dR_t .$$

$$\Rightarrow \theta = \frac{\overset{1\,g/cm^3}{\rho_A}}{\underset{18\,g/mol}{M.W_A}} \frac{+1}{\underset{\substack{PV = nRT \\ \Rightarrow P = CRT}}{C} D_{AB} \ln(0.96)} \frac{1}{2} \left(\underset{0\,mm}{R_f^2} - \underset{5\,mm}{R_i^2}\right) \Rightarrow \text{get } \theta$$