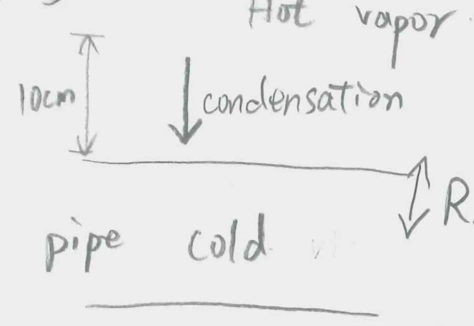
25-6 a. b. ①



Differential eq'n of mass transfer

$$\vec{\nabla}\cdot\vec{N}_A + \cancel{\frac{\partial C_A}{\partial t}} - \cancel{R_A} = 0$$

s.s. no reaction

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

in cylindrical coordinates.

$$\vec{\nabla}\cdot\vec{N}_A = \frac{1}{r}\frac{\partial}{\partial r}(rN_{A,r}) + \frac{1}{r}\frac{\partial N_{A\theta}}{\partial \theta} + \frac{\partial N_{Az}}{\partial z}$$

for mass transfer in r direction only.

$N_{A\theta}$, $N_{A,z} = 0$.

$$\Rightarrow \frac{1}{r}\frac{\partial}{\partial r}(r\cdot N_{Ar}) = 0 \Rightarrow \frac{\partial}{\partial r}(r\cdot N_{Ar}) = 0$$

$\Rightarrow r\cdot N_{Ar}$ is not a function of r

c. Fick's 1st eq'n

$$\vec{N}_A = -CD_{AB}\vec{\nabla} y_A + y_A\sum_{i=1}^{n}\vec{N}_i$$

for constant T.P. C. D_{AB} are constants

$$= -CD_{AB}\vec{\nabla} y_A + y_A(\vec{N}_A + \cancel{\vec{N}_B})$$

the solubility of air in water $\to 0 \Rightarrow N_{B,z} = 0$

$$\Rightarrow N_{Ar} = -CD_{AB}\frac{\partial y_A}{\partial r} + y_A N_{Ar}$$

$$\Rightarrow \quad N_{Ar} = \frac{-CD_{AB}}{1-y_A}\frac{\partial y_A}{\partial r}$$

d. at $\begin{cases} r=R. & y_A = 0. \quad \text{(no water vapor)} \\ r=R+10 & y_A = y_{A,10}. \end{cases}$

$$N_{Ar}\,dr = -CD_{AB}\frac{1}{1-y_A}\,dy_A$$

$$\underbrace{r \cdot N_{Ar}}_{\text{constant}}\left(\frac{1}{r}\right)dr = -CD_{AB}\left(\frac{1}{1-y_A}\right)dy_A$$

$$\Rightarrow \quad r N_{A\cdot r} \ln r \Big|_{r=R}^{r=R+10} = CD_{AB} \ln(1-y_A)\Big|_{y_A=0}^{y_A=y_{A,10}}$$

substitute B.C.s into eq'n