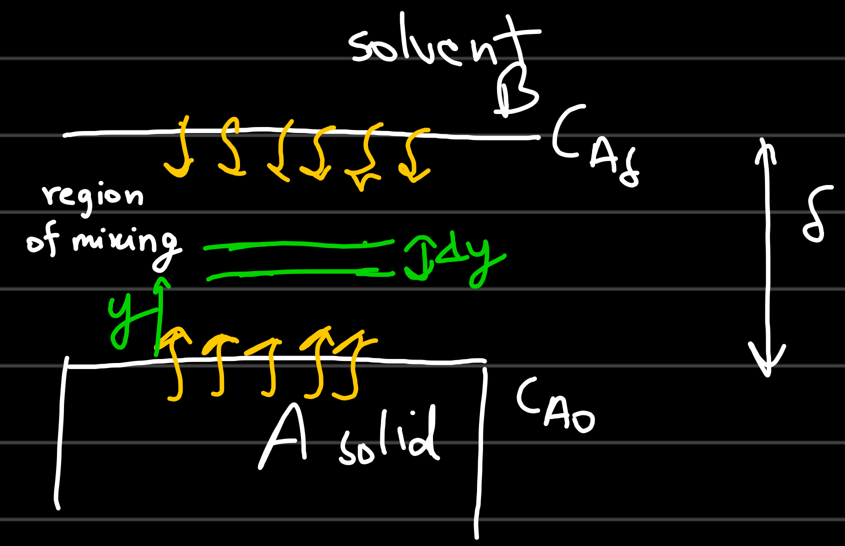
Tutorial-13

2) stagnant film.



Combined mass flux vector: N_{Ay}

$$\left(\text{Area} \times N_{Ay}|_y - \text{Area} \times N_{Ay}|_{y+\Delta y}\right) + \underset{\text{Vol}\times}{\text{source}} = \text{rate of change of mass}$$

$$Lw\left[N_{Ay}|_y - N_{Ay}|_{y+\Delta y}\right] + \underset{\text{Vol}\times}{\text{source}} =$$

$$Lw\left[N_{Ay}|_y - N_{Ay}|_{y+\Delta y}\right] = 0$$

$$\underline{N_{Ay} = \text{constant}}$$

$$N_{Ay} = \underbrace{J_{Ay}}_{-c\mathcal{D}_{AB}\nabla x_A \,=\, -\mathcal{D}_{AB}\nabla c_A} + \cancel{C_A v_y^*}^{\,0}$$

diffusion controlled
mean velocity ~ 0

$$\{ v_y^* = x_A(N_{Ay} + N_{By})$$

$$N_{Ay} = \frac{1}{(1-x_A)} J_{Ay} \Big\}$$

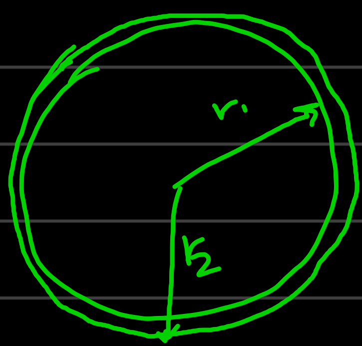
Here,

$$N_{Ay} = J_{Ay} = \text{Constant}$$

$$\mathcal{D}_{AB} \nabla_y C_A = C_1$$

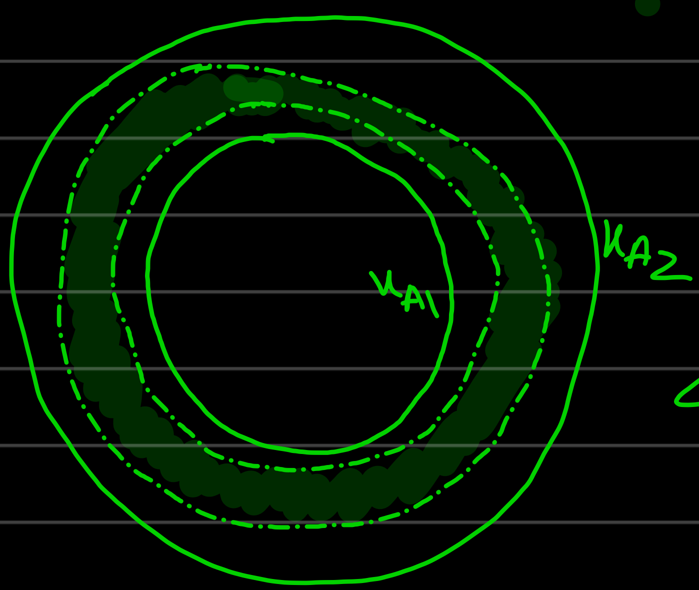
$$\underbrace{C_A = C_1 y + C_2}$$

1)



large r_1 implies $\frac{dr}{dt}$ (as evaporating) is negligible.

→ There is no radial direction velocity in play.



$$4\pi r^2 N_{Ar}|_r - 4\pi r^2 N_{Ar}|_{r+\Delta r} + \cancel{\text{Vol} \times \text{source}}^{\,0} = \frac{d\cancel{\,}^{\,0}}{dt}$$

$$\frac{\cancel{4\pi r^2} N_{Ar}|_r}{\cancel{4\pi r^2}\Delta r} - \frac{\cancel{4\pi r^2} N_{Ar}|_{r+\Delta r}}{\cancel{4\pi r^2}\Delta r}$$

$$\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 N_{Ar}\right) = 0$$

$$r^2 N_{Ar} = \text{constant}$$

$$N_{Ar} = \frac{C}{r^2}$$

$$J_{Ar} + C_A v_r^* = \frac{C}{r^2}$$

$$v_r^* = \frac{N_A + \cancel{N_B}^{\,0}}{C} = \frac{N_A}{C}$$

$$N_{Ar} = J_{Ar} + C_A \frac{N_{Ar}}{C}$$

$$N_{Ar} = \frac{J_{Ar}}{(1 - x_A)}$$

$$\frac{C D_{AB}}{(1 - x_A)}\frac{\partial x_A}{\partial r} = \frac{C_1}{r^2}$$

$$\boxed{-\ln(1 - x_A) = \frac{C_1}{C D_{AB}}\left[-\frac{1}{r}\right] + C_2}$$