2) Diffusion equation

$$N_A = C_A u_A$$
$$J_A \left(\equiv -D_v \frac{dC_A}{dz} \right) = C_A (u_A - u_0)$$

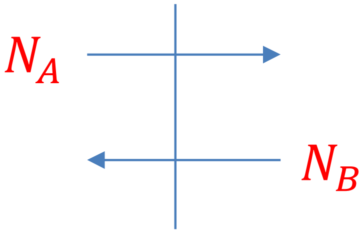
$$J_A = C_A(u_A - u_0) = C_A u_A - C_A u_0 \frac{C}{C}$$
$$= C_A u_A - C_A u_0 + C u_0 \frac{C_A}{C}$$
$$= N_A - N \frac{C_A}{C}$$
$$\therefore N_A = J_A + N \frac{C_A}{C}$$

- again,

$$N_A = J_A + N \frac{C_A}{C} = -D_v \frac{dC_A}{dz} + N \frac{C_A}{C}$$
$$N_A = N y_A - D_v C \frac{dy_A}{dz} \text{ for gases}$$
$$N_A = N x_A - D_v C \frac{dx_A}{dz} \text{ for liquids}$$

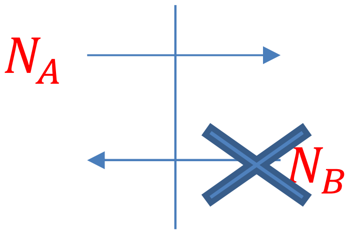
Special cases

1) Equimolar counter diffusion



$N_A = N_B$ ➔ $N = 0$

2) One-way diffusion



$N_B = 0$ ➔ $N_A = N$

1) Equimolar counter diffusion

$$N_A = -N_B, \rightarrow N = 0$$

Diffusion equation

$$N_A = J_A + N\frac{c_A}{c} = -D_v\frac{dC_A}{dz} + N\frac{c_A}{c} = J_A$$

$$N_A = J_A = -D_v\frac{dC_A}{dz}$$

integration

$$N_A = -D_v\frac{C_{A2} - C_{A1}}{\Delta z} = D_v\frac{C_{A1} - C_{A2}}{\Delta z}$$

$$\boxed{N_A = -D_v\frac{\Delta C_A}{\Delta z}}$$

2) One-way diffusion

$$N_B = 0, \rightarrow N_A = N$$

Diffusion equation

$$N_A = J_A + N\frac{C_A}{C} = -D_v\frac{dC_A}{dz} + N_A\frac{C_A}{C}$$

$$\left(1 - \frac{C_A}{C}\right)N_A = -D_v\frac{dC_A}{dz}$$

$$N_A = -D_v\frac{C}{C-C_A}\frac{dC_A}{dz} \text{ or } N_A = -D_v\frac{C}{C_B}\frac{dC_A}{dz} = D_v\frac{C}{C_B}\frac{dC_B}{dz}$$

$$\frac{dC_A}{dz} = -\frac{dC_B}{dz}$$

integration

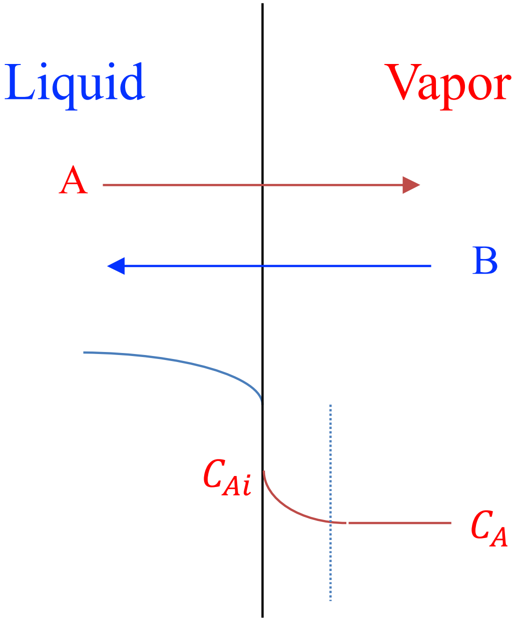
$$N_A = D_v\frac{C}{C_B}\frac{dC_B}{dz} \rightarrow N_A = D_vC\frac{\ln\frac{C_{B2}}{C_{B1}}}{z_2-z_1}\frac{C_{B2}-C_{B1}}{C_{B2}-C_{B1}}$$

$$N_A = D_vC\frac{C_{B2}-C_{B1}}{z_2-z_1}\frac{\ln\frac{C_{B2}}{C_{B1}}}{C_{B2}-C_{B1}}$$

$$= D_vC\frac{C_{B2}-C_{B1}}{z_2-z_1}\frac{1}{(C_{B2}-C_{B1})/\ln\frac{C_{B2}}{C_{B1}}}$$

$$N_A = D_v\frac{C}{\bar{C}_{Bm}}\frac{C_{B2}-C_{B1}}{z_2-z_1}$$

* Film theory 물질이동의 저항은 어느 특정한 두께의 film내에 집중된다.



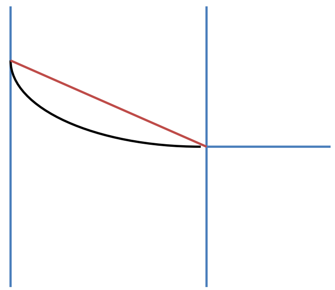
δ (film thickness)
Boundary layer

$$N_A = D_v \frac{C_{Ai} - C_A}{\delta} \left(= D_v C \frac{y_{Ai} - y_A}{\delta} \right)$$

$$N_A = \frac{C_{Ai} - C_A}{\delta / D_v} \qquad \text{rate} = \frac{\text{driving force}}{\text{resistance}}$$

$$N_A = D_v \frac{C}{\bar{C}_{Bm}} \frac{\Delta C_A}{\Delta z} \left(= D_v \left(\frac{1}{\bar{y}_{Bm}} \right) C \frac{\Delta y_A}{\Delta z} \right) \qquad \Delta C_A = C_{Ai} - C_A$$

$$\boxed{N_A = D_v \left(\frac{C}{\bar{C}_{Bm}} \right) \frac{\Delta C_A}{\delta} \left(= D_v C \left(\frac{1}{\bar{y}_{Bm}} \right) \frac{\Delta y_A}{\delta} \right)}$$



농도구배를 직선으로 간주

$\frac{N_A}{D_v}$ =slope