Chapter 17. Principle of diffusion & Mass transfer between Phases

- **Driving forces**

- Heat : ΔT
- Mass: ΔC

Diffusion

✓ molecular diffusion – ordinary diffusion : concentration , cogredient
✓ Thermal diffusion : Temp
✓ Pressure diffusion : .Pressure difference
✓ Force diffusion : External Force

<Assumptions>

1) Steady-State
2) Binary mixture
3) Ordinary mixture

17.1 Molecular Diffusion

A. Concentration & Velocity

1) Concentration

① mass concentration

$\rho = \rho_A + \rho_B$

$\rho_A = C_A M_A$ ： Mass concentration of mixture

$w_A = \frac{\rho_A}{\rho}$ (mass fraction)

$w_A + w_B = 1$

② Molar concentration

$C = C_A + C_A$: Total Molardensity

$C_A = \frac{P_A}{M_A}$

x_A(mole fraction) $= \frac{C_A}{C}$

$x_A + x_B = 1$

2) Velocity

u_A: Velocity of "A" on fixed Plane

u_B: Velocity of "B" on fixed Plane

① Mass Average velocity of Bulk flow

$$u = u_A w_A + u_B w_B$$

② Molar (or volume) Average velocity of Bulk Flow

$$u_\circ = u_A x_A + u_B x_B$$

③ Diffusion Velocity (velocity related to bulk flow)

i) Based on mass average velocity u

$$u_A - u$$
$$u_B - u$$

ii) Based on molar average velocity $u_\circ$

$$u_A - u_\circ$$
$$u_B - u_\circ$$

4) Fluxes Relative to bulk flow ; Diffusion flux

① Mass Flux $\left[\frac{\text{kg}}{\text{m}^2\cdot\text{s}}\right]$

$j_A = \rho_A(u_A - u)$: diffusion velocity of A (mass average velocity)

$j_B = \rho_B(u_B - u)$

② Molar Flux $\left[\frac{\text{m ol}}{\text{m}^2\cdot s}\right]$

$J_A = C_A(u_A - u_0)\left[\frac{\text{m ol}}{\text{m}^2\cdot s}\right]$ diffusion velocity of A (molar average velocity)

$J_B = C_B(u_B - u_0)$