Chap. 30. Convective Mass Transfer Correlation

→ Rate of Mass Transfer(중요한 요인)

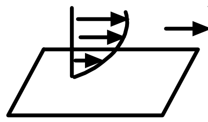
↓

Flux $N_A = k_c \Delta C_A$

$\Delta C_A = (C_{cause} - C_{Result})$

→ $Sh = \dfrac{k_c D}{D_{AB}} = f\,(Re, Sc)$

theoretical approval



→ 다양한 계 (R,C,S)

↓

empirical relation !

↓

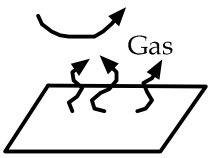
Grouping → Sherwood number

correlation → 상관관계

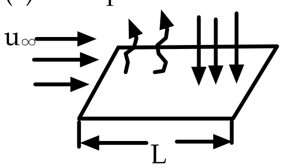
(경험식)

1. Mass transfer to plates, cylinder, spheres

between moving fluid & certain shape → vaporization & dissolution of solid/sublimation of solid



(1) Flat plate



점도 μ

Laminar : $Sh_L = 0.664 Re^{\frac{1}{2}} Sc^{\frac{1}{3}}$

Tubulent : $Sh_L = 0.036 Re^{0.8} Sc^{\frac{1}{3}}$

※ j-factor : $j_b = \dfrac{Sh_L}{Re_L Sc^{\frac{1}{3}}}$

(2) Single Sphere : $Sh = Sh_o + C Re^m Sc^{\frac{1}{3}}$

↓ (molecular diffusion) ← forced convection

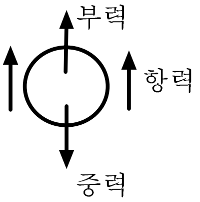
molecular diffusion = $Sh_o = 2$

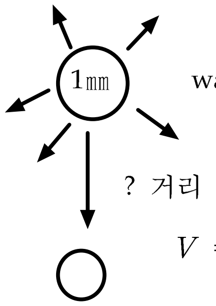
$Sh = (4 + 1.21 Re^{\frac{2}{3}})^{\frac{1}{2}}$: Brian & Hales (Pe = $RePL$)

※ $Sh = 2 + 0.552 Re^{\frac{1}{2}} Sc^{\frac{1}{3}}$: forced convection

※ $Sh = 2 + 0.57 (GrSc)^{0.25}$: natural convection

Ex. 1





water drop

$$\frac{4}{3}\Pi R^3 - \frac{4}{3}\Pi\left(\frac{R}{\sqrt[3]{2}}\right)^3$$

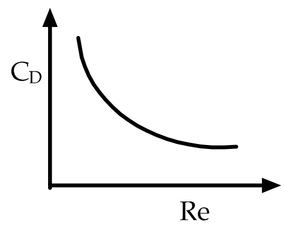
$$V = \frac{1}{2}V_O$$

$$\frac{1}{2}\times\frac{4}{3}\Pi R^3 = \frac{1}{2}\frac{4}{3}\Pi R_1^{\ 3} \qquad R_1 = \frac{1}{\sqrt[3]{2}}R$$

Terminal velocity $V_O = \sqrt{\dfrac{4dp(\rho_P-\rho)g}{3C_P\rho}}$

$$C_D = C_D(R_O) = C_D(V_O)$$

$$V_O = \sqrt{\frac{10.22}{C_D}}$$

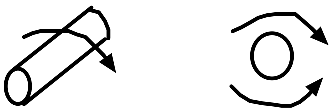


C_D 가정 $\rightarrow V_O$

$C_D =$ 결정 $\qquad V_O \rightarrow Re$

$$\frac{소멸된양}{W_A} = t \qquad t\times V_O = 거리$$

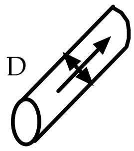
(3) Single Cylinder



$$\frac{k_G P Sc^{0.56}}{G_M} = 0.281(Re')^{-0.4} \qquad k_G = 1.34\times10^{-3} lb\ mole/hr\ ft^2\ mm$$

2. Turbulent flow through a pipe

2000 < Re < 35000



$$\frac{k_c D}{D_{AB}}\frac{P_{b.lm}}{P} = 0.023Re^{0.83}Sc^{0.44}$$

$\downarrow$

$$Sh = \frac{k_{Ld}}{D_{AB}} = 0.023Re^{0.83}Sc^{\frac{1}{3}} \qquad (\ k_L\ \Delta C_A \text{ or } k_G\ \Delta P\ )$$

Area : $\Pi\ DL\times N_A = W_A\dfrac{물질질량}{시간}$