6. Continuous-contact equipment analysis

($k_G a$, $K_G a$, $k_L a$, $K_L a$) → variable

(1) constance overall capacity coefficient ($K_G a$, $K_L a$)

$$\frac{moles\ of\ A\ transferred}{(hr)(cross-\sec tional\ area)} = L_S\ dX_A = G_S\ dY_A \quad \text{for dz}$$

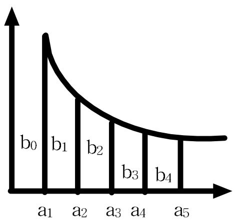
$$N_A a\ dz = K_Y a(Y_{AG} - Y_A{}^*) \Rightarrow dz = \frac{G_S d\ Y_A}{k_Y a(Y_A - Y_A{}^*)}$$

적분하면

$$z = \frac{G_S}{K_Y a}\int_{Y_{A_1}}^{Y_{A_2}} \frac{dY_A}{Y_A - Y_A{}^*} \quad \text{or} \quad z = \frac{G_S}{K_G a}\int_{Y_{A_1}}^{Y_{A_2}} \frac{dY_A}{p_{A,G} - p_A{}^*}$$

또 이는 $K_X a$ 로 나타낼 수 있다.

$$z = \frac{L_S}{K_X a}\int_{X_{A_2}}^{X_{A_1}} \frac{dX_A}{X_A{}^* - X_A}$$



$$S = \int_{Y_{A_1}}^{Y_{A_2}} \frac{dY_A}{Y_A - Y_A{}^*} = \frac{1}{2}(b_0 + b_1)a_1 + \frac{1}{2}(b_1 + b_2)a_2 + \frac{1}{2}(b_2 + b_3)a_3 \cdots\cdots$$

(if $a_1 = a_2 = a_3 = a_4 = \bar{a}$) $\quad = \frac{1}{2}\bar{a}\ [b_0 + 2(b_1 + b_2 + b_3) + b_4]$

(2) Variable overall capacity coefficient-allowance for resistance in both gas and liquid phase

· mass balance for components A over differential length dz : $L_d dX_A = G_s dY_A$

· differentiation of $Y_A = \frac{y_A}{1-y_A}$: $dY_A = \frac{d_A}{(1-y_A)^2}$ → $L_d dX_A = G_s\frac{dy_A}{(1-y_A)^2}$

· individual gas-phase capacity coefficient : $N_A a dz = k_G a(p_{A,G} - p_{A,i})dz$

$$dz = G_s\frac{dy_A}{k_G a(p_{A,G} - P_{A,i})(1-y_A)^2} \quad \text{or} \quad dz = G_s\frac{dy_A}{k_G a P(y_A - y_{A,i})(1-y_A)^2}$$

· interfacial composition $y_{A,i}$ and $x_{A,i}$ from a point on the operating line toward the another point on equilibrium curve

· slope between the two points: $-k_L/k_G$ on p_A vs. c_A plot

(3) Logarithmic-mean driving force

· 기하학적 적분의 방법보다 간단한 방법으로서, 비교적 묽은농도의 경우 또는 조업영역에 대하여 평형곡선(equilibrium curve)과 조작선(operating line)이 몰분율에 대하여 선형으로 주어지는 경우에 적용된다.

· 이와같은 조건에서는 $G_1 \approx G_2 \approx G$ 그리고 $L_1 \approx L_2 \approx L$ 이다.

· mass balance for component A

$$L(x_{A1} - x_A) = G(y_{A1} - y_A) \quad \text{or} \quad L dx_A = G dy_A$$

· rate of interphase transfer in terms of overall gas-phase capacity coefficient

$$N_A a dz = K_G a(p_{A,G} - p_A^*) dz \quad \text{or} \quad N_A a dz = K_G a P(y_A - y_A^*) dz$$

· let $\Delta = y_A - y_A^*$, $\dfrac{d\Delta}{dy_A} = \dfrac{\Delta_{end1} - \Delta_{end2}}{y_{A1} - y_{A2}} = \dfrac{\Delta_1 - \Delta_2}{y_{A1} - y_{A2}}$

$$dz = \frac{G}{K_G a P} \frac{dy_A}{y_A - y_A^*} = \frac{G}{K_G a P} \frac{dy_A}{\Delta} \quad \text{or} \quad dz = \frac{G}{K_G a P} \frac{y_{A1} - y_{A2}}{\Delta_1 - \Delta_2} \frac{d\Delta}{\Delta}$$

$$z = \frac{G}{K_G a P} \frac{y_{A1} - y_{A2}}{\Delta_1 - \Delta_2} \ln \frac{\Delta_1}{\Delta_2} \quad \text{or} \quad z = \frac{G}{K_G a P} \frac{y_{A1} - y_{A2}}{(y_A - y_A^*)_{lm}}$$

· overall liquid-phase capacity coefficient

$$z = \frac{L}{K_L a c} \frac{x_{A1} - x_{A2}}{(x_A^* - x_A)_{lm}}$$

· logarithmic-mean difference

$$(y_A - y_A^*)_{lm} = \frac{(y_A - y_A^*)_{end1} - (y_A - y_A^*)_{end2}}{\ln[(y_A - y_A^*)_{end1}/(y_A - y_A^*)_{end2}]}$$

$$(x_A^* - x_A)_{lm} = \frac{(x_A^* - x_A)_{end1} - (x_A^* - x_A)_{end2}}{\ln[(x_A^* - x_A)_{end1}/(x_A^* - x_A)_{end2}]}$$