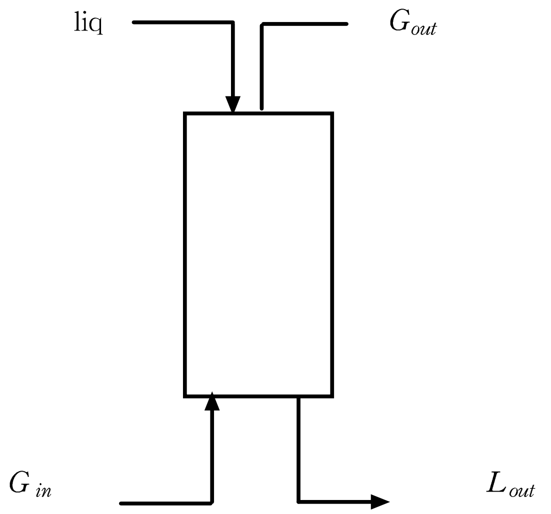
3. Mass Balances for continuos contact towers

· Operating line equation

· Continuous contact towers



i) Mass & enthalpy balance : conservation of mass & energy

ii) Interphase equilibrium

iii) Mass transfer equation(flow)

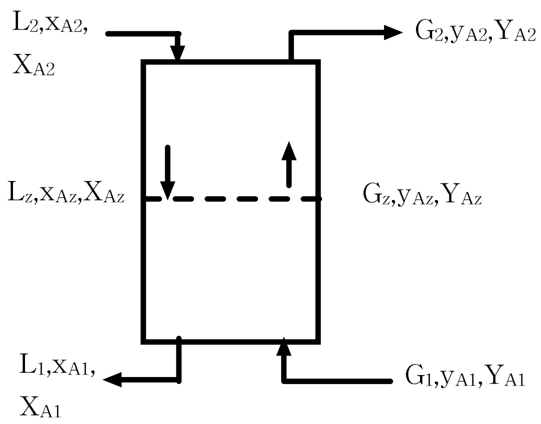
iv) Momentum transfer equation

(1) Countercurrent flow

· steady-state mass-transfer operation

· two immiscible phases

· 정의



- Balance equation(tower기준)

moles of A entering the tower = moles of A leaving the tower

· total (1-2) : $G_1 y_{A_1} + L_z x_{A,2} = G_2 y_{A,2} + L_1 x_{A_1}$

· local (z=z) : $G_1 y_{A_1} + L_z x_{A,z} = G_2 y_{A,z} + L_1 x_{A_1}$

- Solute-free units

$Y_A = \frac{y_A}{1-y_A}$: moles of A in G per mole of A free G

$X_A = \frac{x_A}{1-x_A}$: moles of A in L per mole of A free L

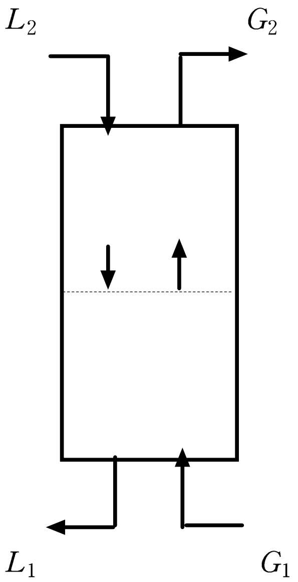
L_s : moles of phase L on solute free basis

G_s : moles of phase G on solute free basis

$G_s Y_{A_1} + L_s X_{A_2} = G_s Y_{A_2} + L_s X_{A_1}$ or $G_s(Y_{A_1} - Y_{A_2}) = L_s(X_{A_1} - X_{A_2})$

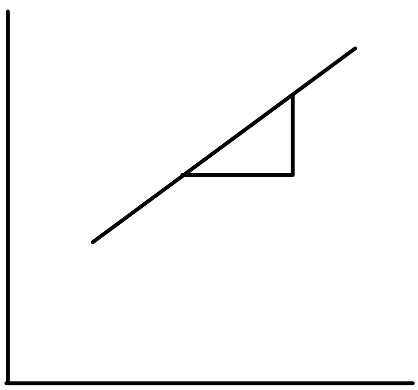
at z=z, $\frac{L_s}{G_s} = \frac{Y_{A_1} - Y_{A,z}}{X_{A_1} - Y_{A,z}}$: slope (operating line)

- Countercurrent mass exchange

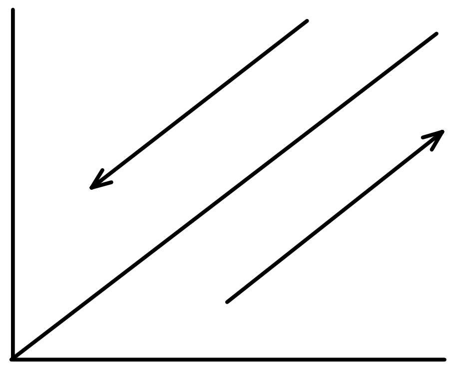


· solute-free basis (mixture 중에서 solute 양을 제거한 양)
· mass balance를 세우면 (for z=z)

$$\frac{L_s}{G_s} = \frac{Y_{A_1} - Y_{A,z}}{X_{A_1} - Y_{A_z}}$$



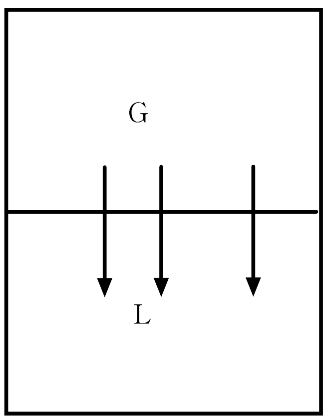
slope from (X_{A_1}, Y_{A_1}) through (X_{Az}, Y_{Az})



거리를 짧게 생각하면

$L_s dX_A = G_s dY_A$ for dz :

moles transfer from one phase to 2^{nd} phase per hour cross-sectional area in dz



solute-free basis

G_s, L_s 양이 없으므로 이동변화량 없다

$G = G_s + $(solute의 양)

$L = L_s + $(solute의 양)

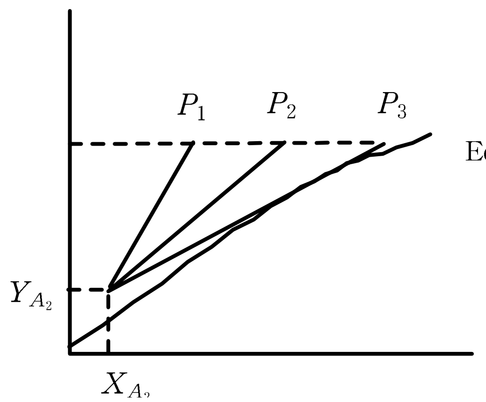
$L : G_1 y_{A_1} + L_z x_{A_z} = G_z y_{A_1} + L_1 x_{A_1}$

$L_s : G_s(Y_{A_1} - Y_{A,z}) = L_s(X_{A_1} - X_{A,z})$

$\frac{L_s}{G_s} =$ slope (linear profile): operating line

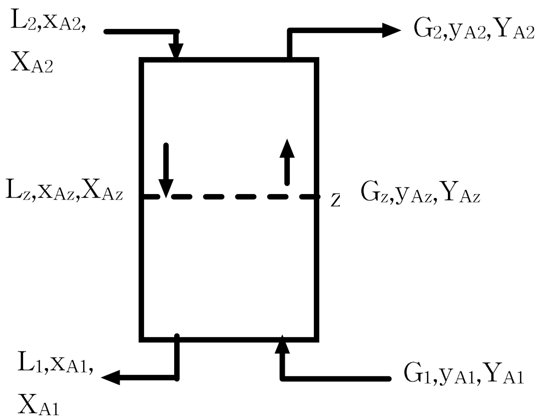
ex) Given one -phase-flow rate

3 of 4 entering & existing compositon



$Y_{A_1} \rightarrow Y_{A_2}$ 로 목표치에 해당하는 물질전달이 수행된다 (1st→ 2^{nd})

4. Enthalpy balance



온도가 다른 물질 유입 유출되는 경우
(물질의 비열)×(온도차)=열에너지

엔탈피 수지식 : $L_2H_{L_2}+GH_G = G_2H_{G_2}+LH_L$

normal enthalpy 식: $H_L = c_{pL}(T_L-T_O)M_{avg}+\Delta H_S$

같은 기준온도와 표준상태의 용질에 대한 기체의 몰 엔탈피는

$$H_G = [y_{solute}c_{p,G\ solute}M_{soiute}+(1-y_{solute})(c_{p,Gsolute-free\ G-phase})$$
$$(M_{solute-free\ G-phase})](T_G-T_O)+y_{solute}h_{f-g\ solute}M_{solute}$$

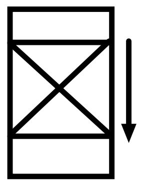
5. Mass transfer capacity coefficient

개별 물질전달계수: k_G

$N_A = k_G(p_{A,G}-p_{A,i})$ individual

$N_A = K_G(p_{A,G}-p_A^*)$ overall

$$N_A[\frac{moles\ of\ A\ transferrde}{(hr)(interfacial\ area)}][a(\frac{interfacial\ area}{ft^3})]dz(ft)$$
$$= \frac{moles\ of\ A\ transferred}{(hr)(cross-\sec tional\ area)}$$



length ?

$N_Aa\ dz = k_Ga(p_{A,G}-p_{A,i})dz$ k_Ga : individual capacity coefficient

$N_Aa\ dz = K_Ga(p_{A,G}-p_A^*)dz$ K_Ga : overall capacity coefficient

$\Rightarrow k_Ga,\ K_Ga\ \frac{moles\ of\ A\ transfered}{(hr)(volume)\times(pressure)}$

$N_Aa\ dz = k_La(c_{A,i}-c_{A,L})dz$

$N_Aa\ dz = K_La(c_A^*-c_{A,L})dz$

$\Rightarrow k_La,\ K_La : \frac{moles\ of\ A}{(hr)(V)\times(mole/V)}$