Chap. 31. Mass-Transfer Equipment

· Design of continuous-contacting mass transfer equipment

design for new equipment or improvement in performance

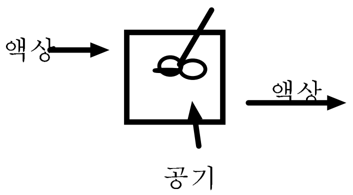
final design equations in terms of overall driving force and overall transfer coefficient

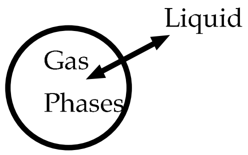
total contact area within mass exchanger changing the compositions using interphase mass-transfer principles

· Convective mass transfer (theory, experiment)

· Driving force (농도차) → flux → contacting area

· Ex: Interphase mass transfer (bubble)





(k_G ,k_L) & (K_G, K_L)

1. Types of mass-transfer equipment

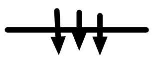
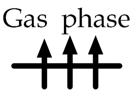
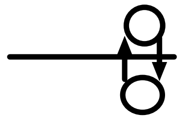
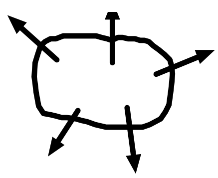
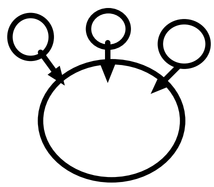
i) transfer of a solute from the gas phase into the liquid phase: absorption, dehumidification, distillation :

ii) transfer of a solute from the liquid phase into the gas phase: desoption, humidification

iii) transfer of a solute from one liquid phase into another immiscible liquid phase: liquid-liquid extraction, ex.) Purification of toluene (toluene+benzoic Acid) using water

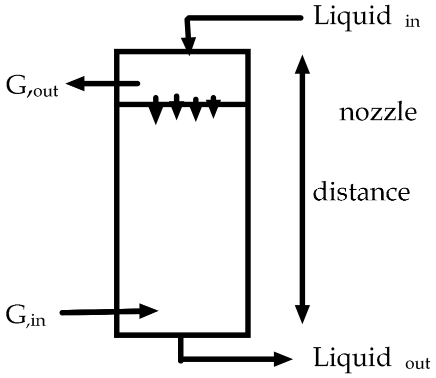
iv) transfer of a solute from a solid into a fluid phase: drying, leaching

v) transfer of a solute from a fluid onto the surface of a solid: adsorption, ion exchange

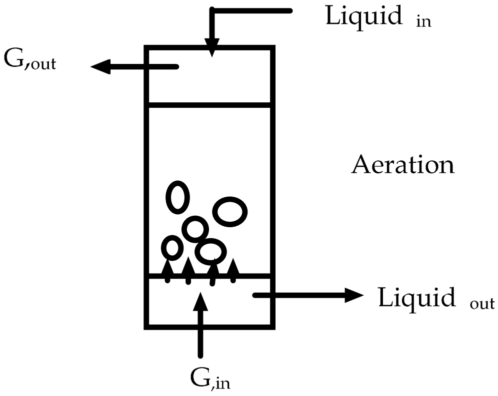
I	II	III	IV	V
Gas phase  Liquid phase	Gas phase  Liquid phase	Liquid I  Liquid II	 고형물로부터 액상물질의 기화	 고형물 표면위로 물질이 달라붙음

· Intimate contact of the two phases : 중력이용

ⅰ) Spray tower



ⅱ) Bubble tower

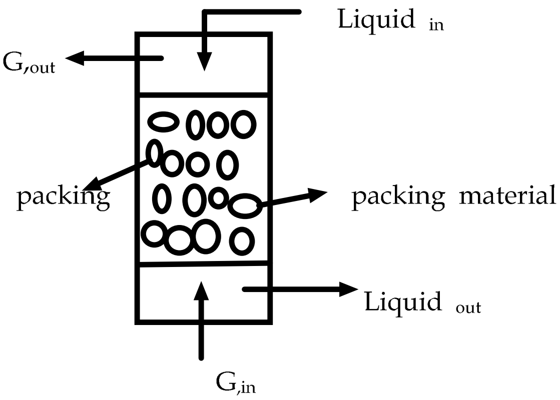


· 작을 경우

· solute a highly soluble gases

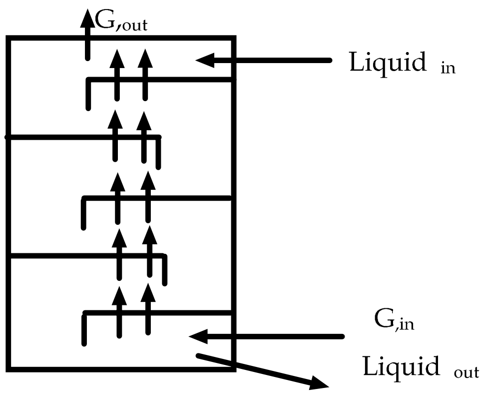
NH_3, SO_2

ⅲ) Packed tower



large interphase contact area

ⅳ) Bubble plate tower



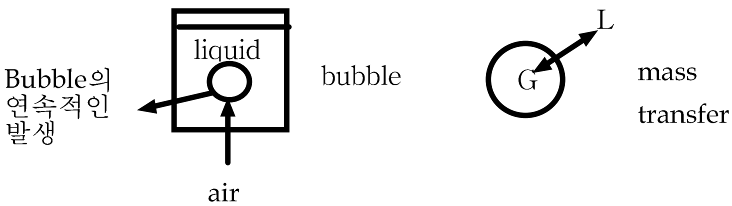
stagewise

(stage 별 평형관계 도출)

2. Batch mass-transfer tank or ponds

· Waste-water treatment undersirable gas → stripping or desorting

· 산소공급 (Oxygen) → aeration



· interphase mass transfer (concentration driving force)

· slightly soluble gas into liquid

mass transfer rate : $N_A = K_L(C_A^* - C_{A,L})$

$C_{A,L}$ 측정, $P_{A,G}$ 측정 → C_A^* 환산

$K_L = K_L(k_L, k_G, \& \ m)$ (m : Henry 상수)

$$W_A = K_L A(C_A^* - C_{A,L}) = d(mole\ \ of\ \ A)\ /dt = \frac{Vd\,C_{A,L}}{dt}$$

$$\frac{d\,C_{A,L}}{dt} = \frac{K_L A}{V}(C_A^* - C_{A,L}) \rightarrow \frac{d\,C_{A,L}}{(C_A^* - C_{A,L})} = \frac{K_L A}{V}dt$$

t = 0 → t = t

$C_{A,L}$ = 0 → $C_{A,L,t}$ 을 범위로 적분

$$\ln\left[\frac{C_A^* - C_{A,L}}{C_A^* - C_{A,L,t}}\right] = K_L\frac{A}{V}t$$

$$K_L\frac{A}{V} = \frac{\theta_g Q_g^{1+n} h^{0.78}}{V}$$

- θ : const , θ_g : gas flow rate, h : depth, V: liquid의 부피