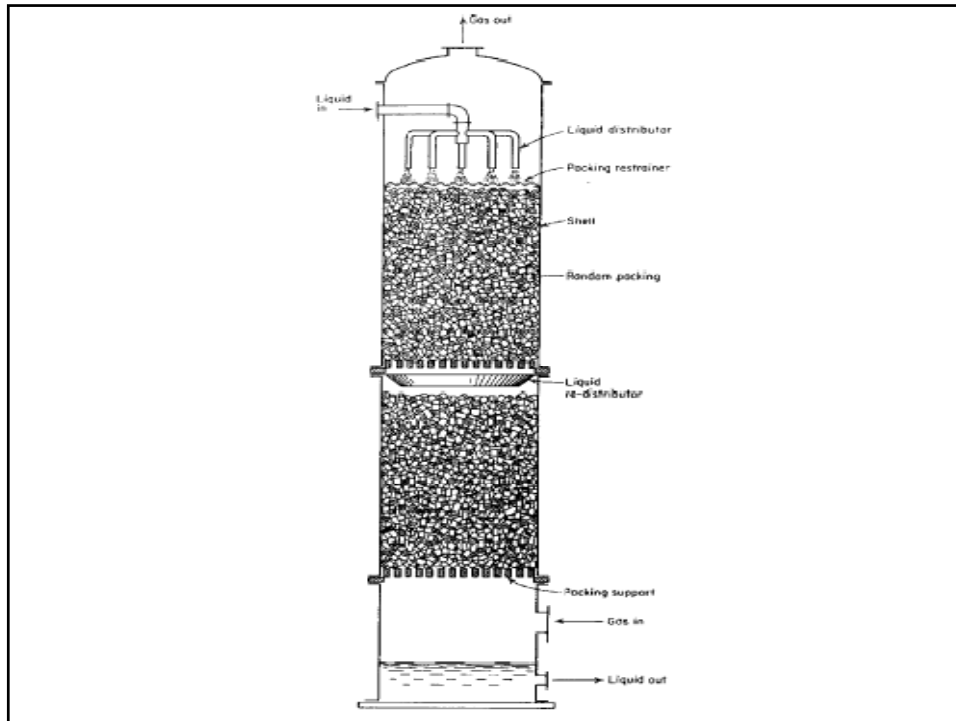


PACKED COLUMN FOR GAS ABSORPTION

PACKED COLUMN

- Provides large interfacial area for phase contact
- Can be used with agitator for gas liquid contact
- Mostly used for gas absorption applications.



Components of packed column

- Shell
- Gas & liquid inlet & outlet nozzles
- Packing with support
- Redistribution system
- Packing restrainer

Constraints

- $\Delta p < 30$ mm of water/m of packing
- Packing height < 6 m

$$\begin{aligned}\Delta p &= h\rho g \\ &= (30 \times 10^{-3}) \times 1000 \times 9.8 \\ &\quad \text{m} \quad \text{kg/m}^3 \quad \text{m/sec}^2 \\ &= 294 \text{ pascals}\end{aligned}$$

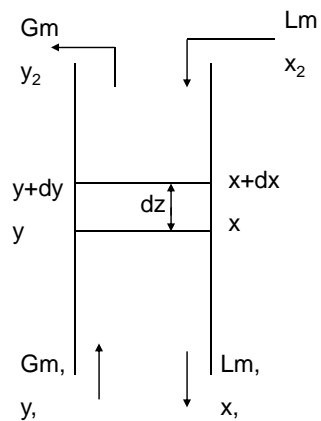
Mass transfer co-eff (k_L) & specific area (s) in packed towers

- Pall & rasching ring having same surface area
- Pall rings are 60% more efficient
- Tower packing selected on their hydraulic capacity
- Which decides cross sectional area of tower & efficiency ($K_G a$)
- Which decides packing height
- Where, $a = S(1-e)$
 - a = surface area/unit volume
 - S = surface area
 - e = voidage

Capacity of packed tower

- Liquid flow rate should be high in order to attain satisfactory wetting of packing
- Difficulty of wetting can be overcome by recirculating some liquid over tower

Height of column based on gas film



- Let,

G_m = mol of inert gas/(unit time.unit c/s area of tower)

L_m = mol of solute free liquid/(unit time.unit area of tower)

y = mol of solute gas A/mol of inert gas B in gas phase

x = mol of solute A/mol of inert solvent in liquid phase

$$A.G_m.dy = A.L_m.dx \quad (1)$$

$$A.G_m.dy = N_A' .a.dv \quad (2)$$

$$= k_G.a.(P_{Ai}-P_{AG}).A.dz \quad (3)$$

$$\left. \begin{aligned} P_{AG} &= \frac{y}{1+y} P \\ P_{Ai} &= \frac{y_i}{1+y_i} P \end{aligned} \right\} \quad (4)$$

Eq. (3) becomes,

$$G_m .dy = k_G aP \left(\frac{y_i}{1+y_i} - \frac{y}{1+y} \right) dz \quad (5)$$

$$= k_G aP \left(\frac{y_i - y}{(1+y_i)(1+y)} \right) dz \quad (6)$$

Integrating eq. (6), we get

$$\int_0^z dz = z = \frac{G_m}{k_G a P} \int_{y_1}^{y_2} \frac{(1+y_i)(1+y)}{(y_i - y)} dy \quad (7)$$

For weak mixtures, eq. (7) becomes

$$z = \frac{G_m}{k_G a P} \int_{y_1}^{y_2} \frac{dy}{y_i - y} \quad (8)$$

Height of column based on liquid film

$$AL_m d\chi = k_L a (C_{Ai} - C_{AL}) Adz \quad (9)$$

C = moles of solute/unit volume of liquid

If C_T = (moles of solute + moles of solvent)/unit volume of liquid

Then

$$\frac{C_A}{C_T - C_A} = \text{moles of A/moles of solvent} = x \quad (10)$$

$$C_A = C_T \cdot \chi - C_A \cdot \chi$$

$$C_A(1 + \chi) = C_T \cdot \chi$$

$$C_A = \frac{\chi}{1 + \chi} C_T \quad (11)$$

Substituting eq. (11) in eq. (9), we get similar eq. (8)

$$Z = \frac{L_m}{k_L a C_T} \int_{\chi_1}^{\chi_2} \frac{d\chi}{\chi - \chi_i} \quad (12)$$

Height based on the overall coefficients

If $(y - y_e)$ is the driving force based on the gas concentration
& K_G is the overall gas transfer coefficient, then

$$Z = \frac{G_m}{K_G a P} \int_{y_1}^{y_2} \frac{dy}{y_e - y}$$

$$Z = \frac{L_m}{K_L a C_T} \int_{\chi_1}^{\chi_2} \frac{d\chi}{\chi - \chi_e}$$

$$Z = (\text{HTU}) \times (\text{NTU})$$

Plate v/s Packed column

- Plate columns can be operate without flooding over wide range of liquid flow
- Plate columns provide positive contact between fluid phases than packed column
- Plate tower is more reliable & needs less safety factor than packed column at low liquid to gas mass velocity ratios
- Side streams can be easily taken out in plate towers
- Design information is readily available & more reliable for plate towers

Plate v/s Packed column

- Cleaning of plate towers is easy
- If interstage cooling is required plate towers are preferred
- Column diameter > 1200 mm plate towers are useful
- Column diameter < 600 mm packed towers are useful
- If liquid having tendency to foam then packed towers are preferred
- High liquid-gas ratio best handled in packed towers

Plate v/s Packed column

- When liquid deterioration occur with high temperature, packed towers are preferred
- Because of low pressure drop packed towers are preferred for vacuum
- Packed towers are more economical than plate towers when corrosive fluids are handled
- Plate towers are preferred when large temperature changes are involved