CEN416
PROCESS DESIGN II

PACKED BED HEIGHT :

Height of packing, **Z**, in terms of the overall gas phase mass transfer coefficient K_G and the gas composition is given by:

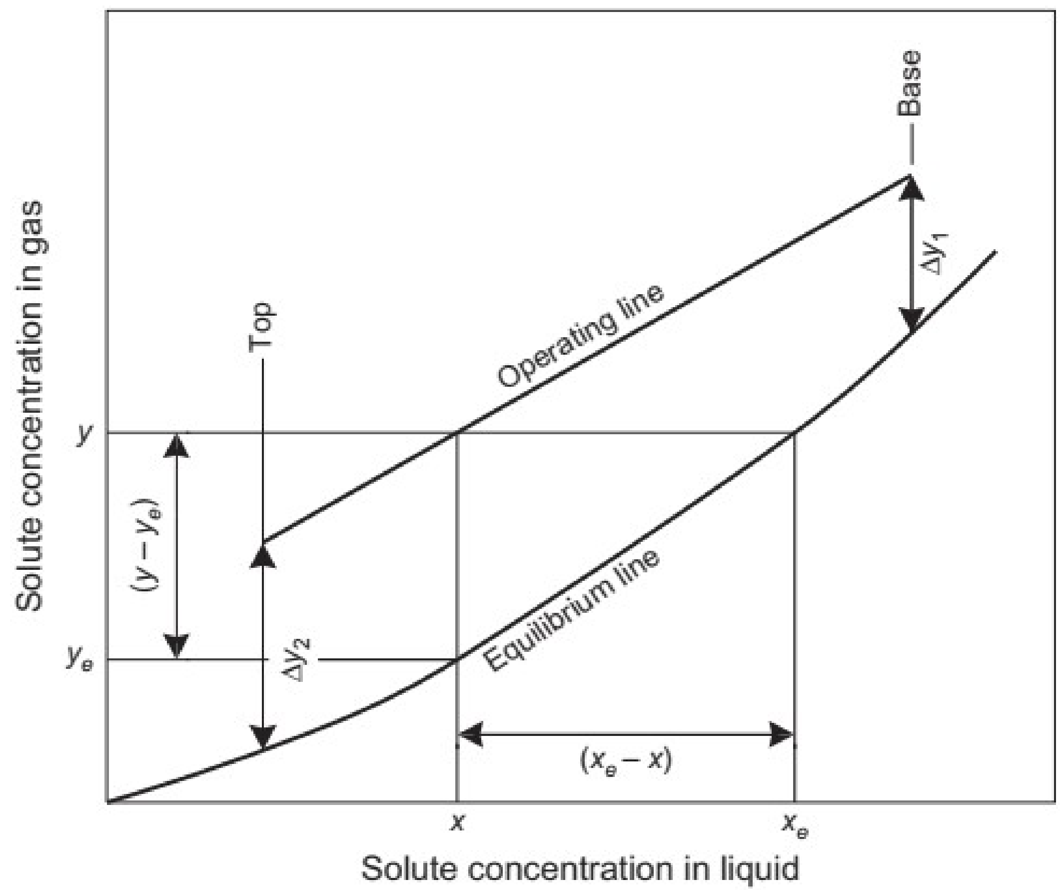
$$Z = \frac{G_m}{K_G a P} \int_{y_2}^{y_1} \frac{dy}{y - y_e}$$

In terms of the overall liquid-phase mass-transfer coefficient K_L and the liquid composition:

$$Z = \frac{L_m}{K_L a C_t} \int_{x_2}^{x_1} \frac{dx}{x_e - x}$$

$\mathbf{G_m}$: molar gas flow-rate per unit cross-sectional area,
$\mathbf{L_m}$: molar liquid flow-rate per unit cross-sectional area,
a : interfacial surface area per unit volume,
P : total pressure,
$\mathbf{C_t}$: total molar concentration,
$\mathbf{y_1}$ and $\mathbf{y_2}$: the mol fractions of the solute in the gas at the bottom and top of the column, respectively,
$\mathbf{x_1}$ and $\mathbf{x_2}$: the mol fractions of the solute in the liquid at the bottom and top of the column, respectively,
$\mathbf{x_e}$: the mole fraction in the liquid that would be in equilibrium with the gas concentration at any point,
$\mathbf{y_e}$: the mole fraction in the gas that would be in equilibrium with the liquid concentration at any point.

- **The relation between the equilibrium concentrations and actual concentrations**



$$Z = \mathbf{H}_{OG}\mathbf{N}_{OG} \qquad Z = \mathbf{H}_{OL}\mathbf{N}_{OL}$$

$\mathbf{H_{OG}}$ is the height of an overall gas-phase transfer unit

$\mathbf{N_{OG}}$ is the number of overall gas-phase transfer units

$\mathbf{H_{OL}}$ is the height of an overall liquid-phase transfer unit

$\mathbf{N_{OL}}$ is the number of overall liquid-phase transfer units

$$\mathbf{H}_{OG} = \mathbf{H}_G + m\frac{G_m}{L_m}\mathbf{H}_L$$

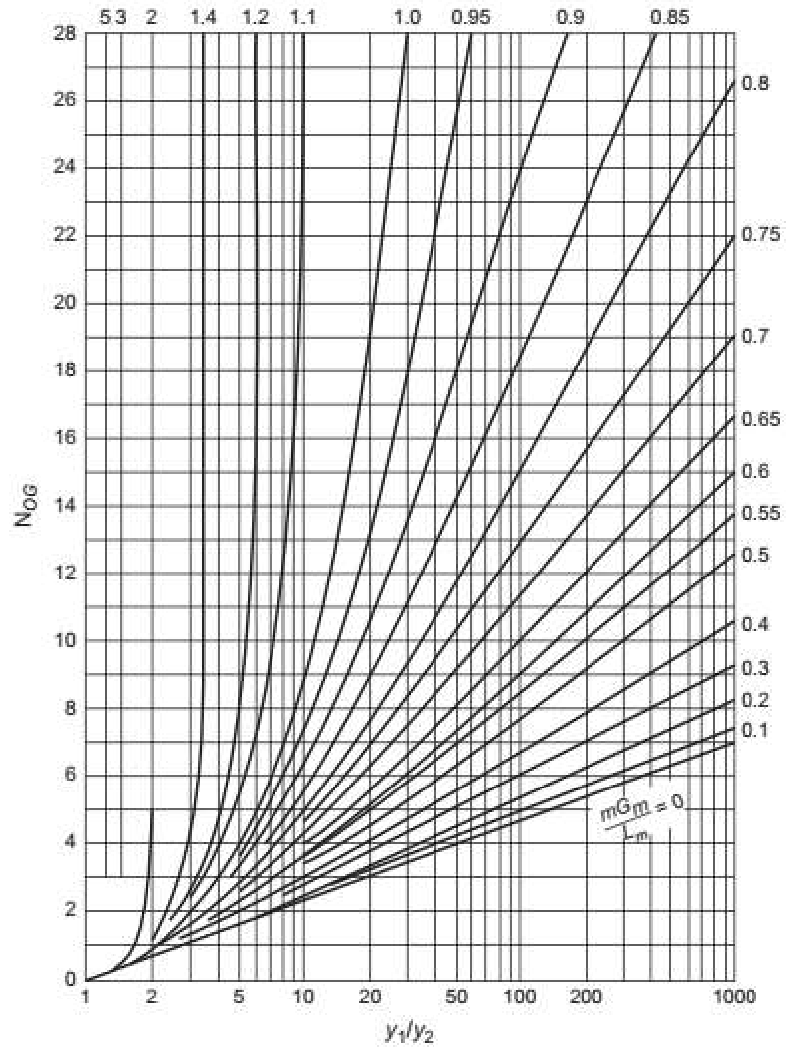
$$\mathbf{H}_{OL} = \mathbf{H}_L + \frac{L_m}{mG_m}\mathbf{H}_G$$

$$\boxed{\mathbf{N}_{OG} = \frac{y_1 - y_2}{\Delta y_{1\text{m}}}}$$

$$y_{1\text{m}} = \frac{\Delta y_1 - \Delta y_2}{\ln\left(\frac{\Delta y_1}{\Delta y_2}\right)}$$

$$\Delta y_1 = y_1 - y_e,$$
$$\Delta y_2 = y_2 - y_e.$$

- Number of transfer units $\mathbf{N_{OG}}$ as a function of $\mathbf{y_1/y_2}$ with $\mathbf{mG_m/L_m}$ as parameter



REFERENCES

1. Sinnot, R.K. 1999, Coulson's & Richardson's Chemical Engineering, Volume 6, Chemical Engineering Design, ButterWorth Heinemann, Oxford.

2. Turton R., Bailie R.C., Whitin W.C., Shaeiwitz J.A. 1998, Analysis, Synthesis and Design of Chemical Processes, Prentice Hall, New Jersey.