Gas Absorption

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Processos de Separação

Gas Absorption- Packed columns

- CONTACT LÍQUID/GAS INTERFACE OF PACKING
- LIQUID FLOWS OVER THE PACKING
- GAS FLOWS THROUGH VOIDS
- PACKING
  - RANDOM
  - STRUCTURED

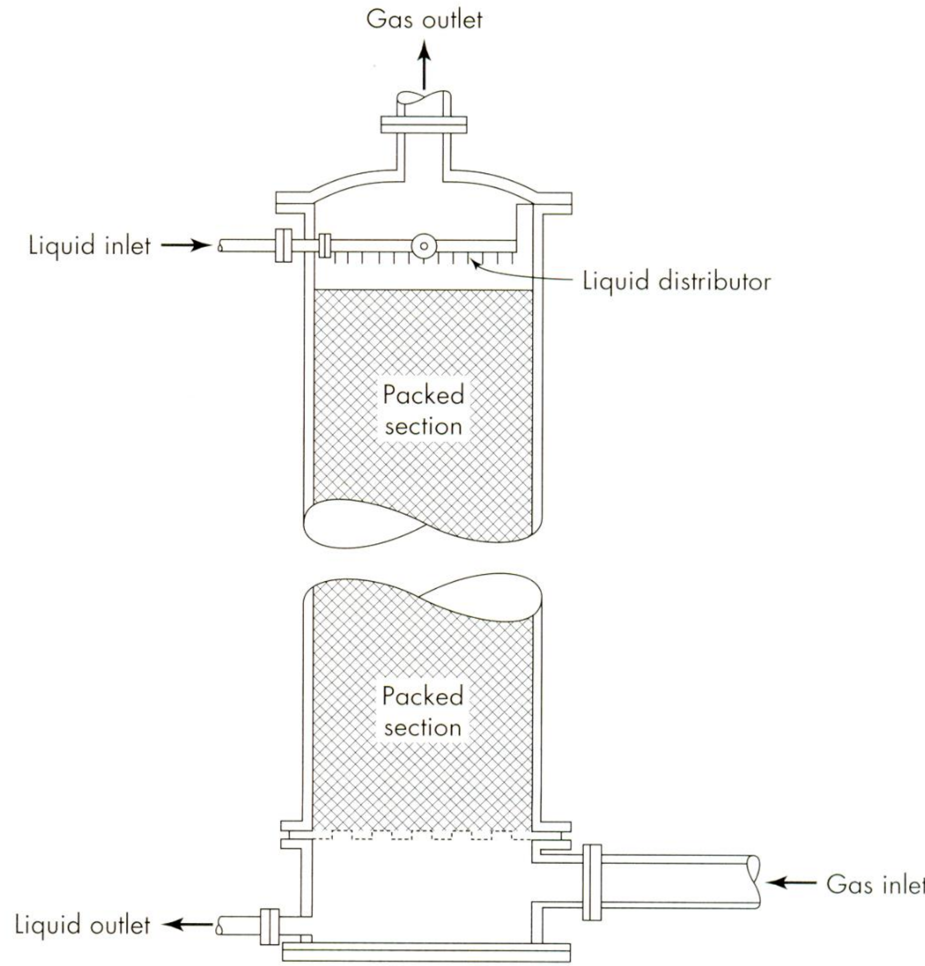
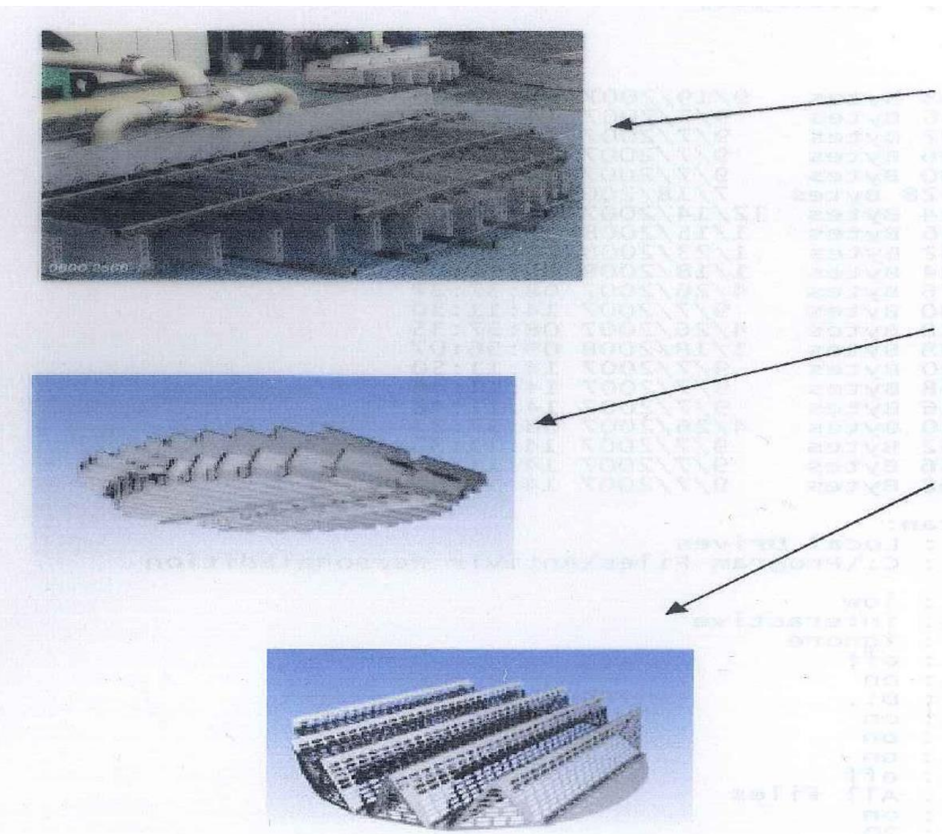
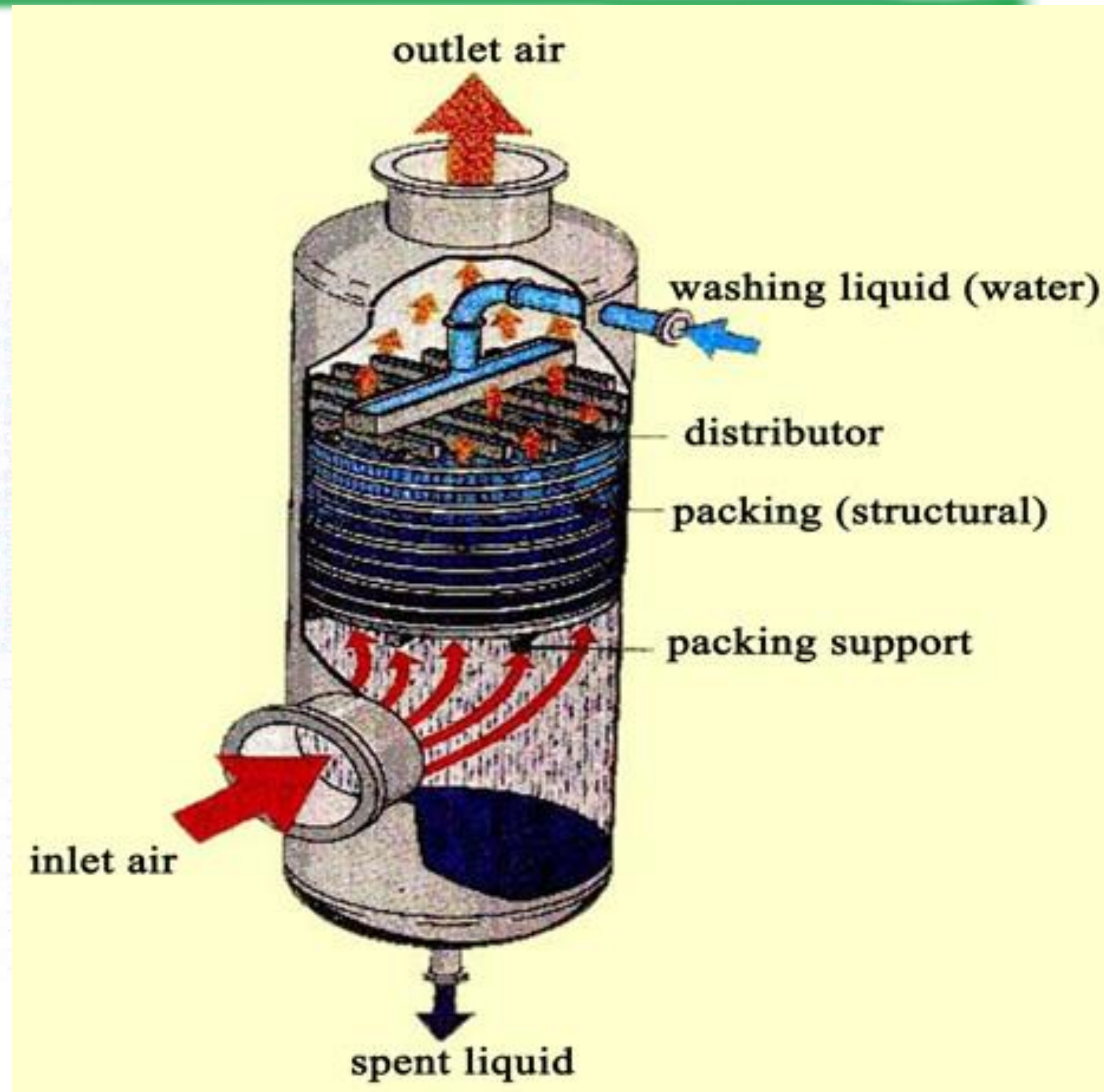


FIGURE 18.1
Packed tower.

Gas Absorption- Packed columns





Random packing

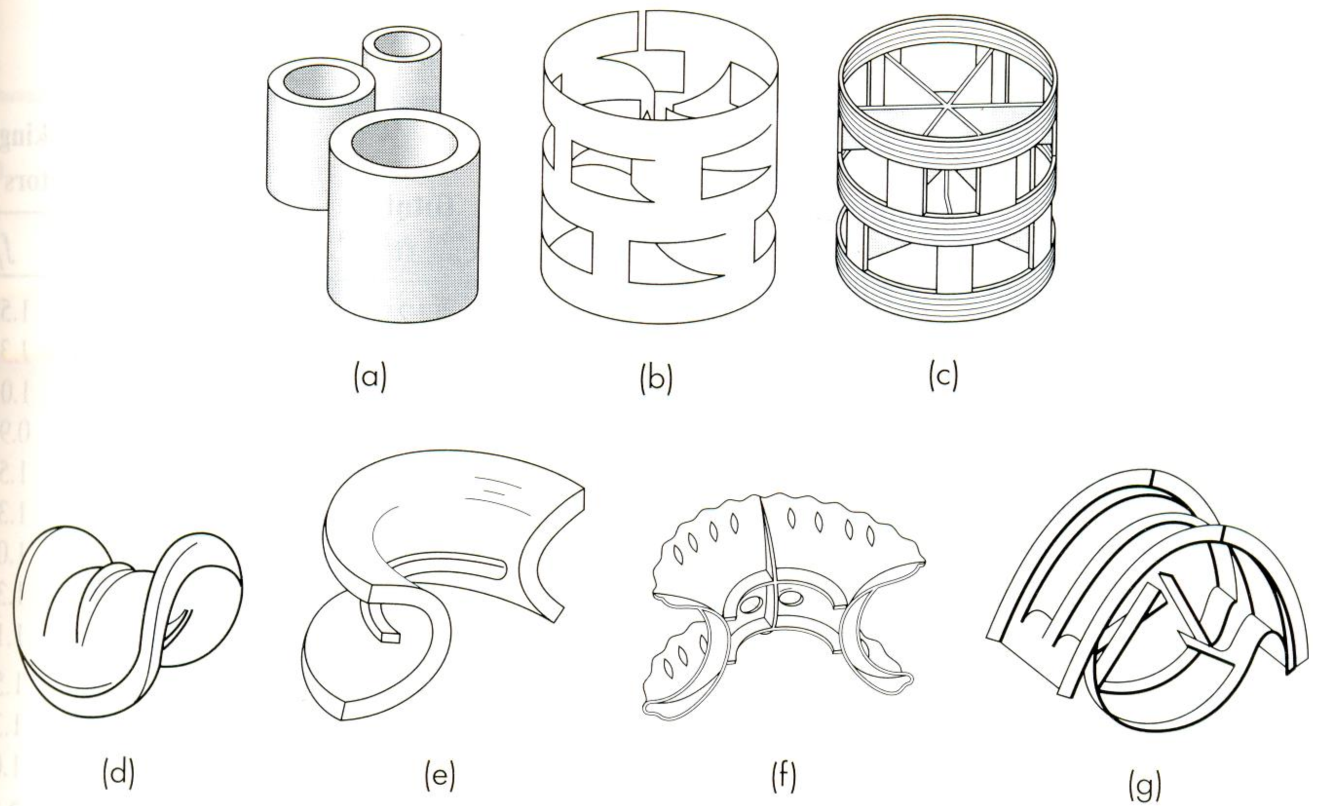
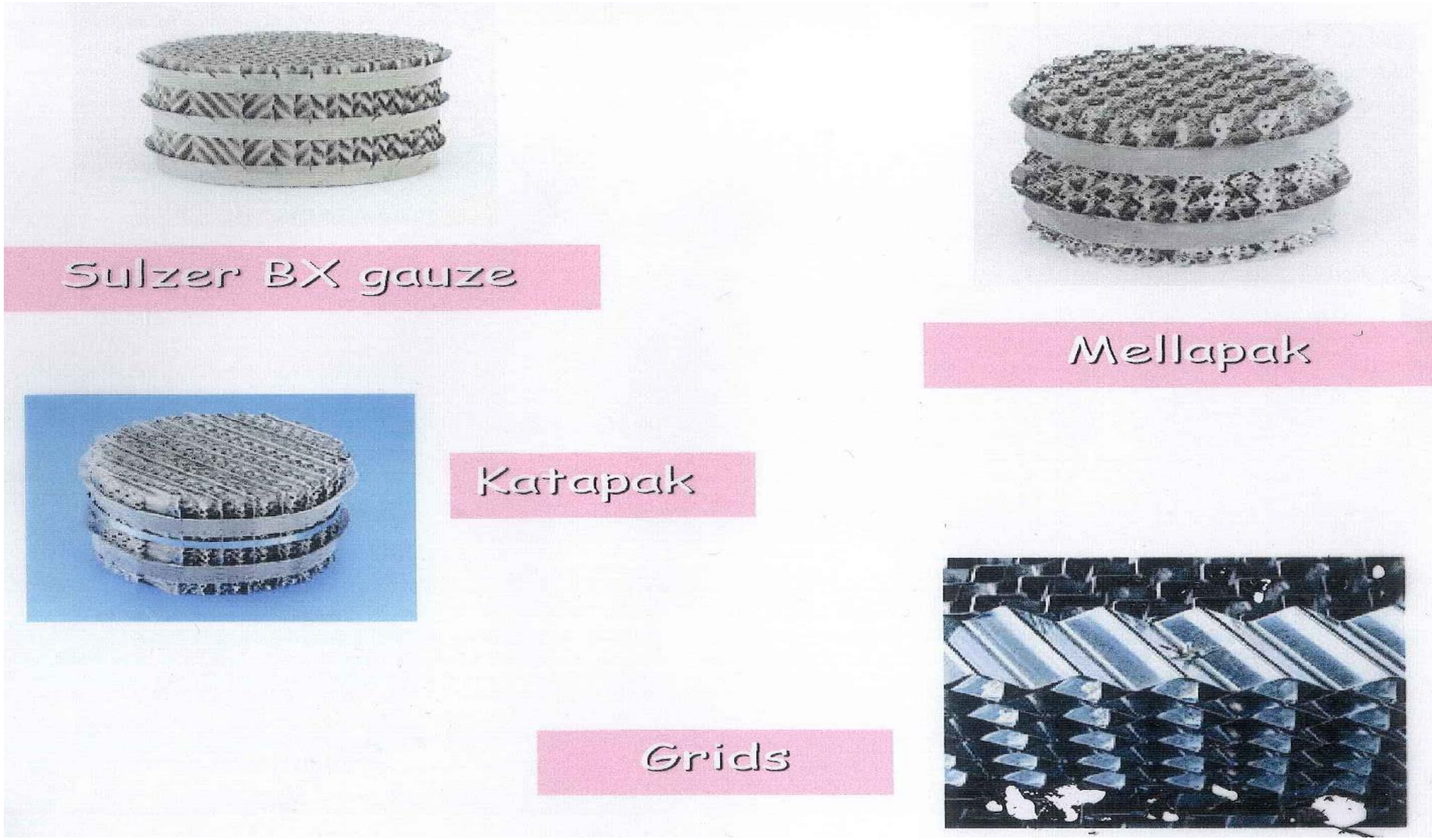


FIGURE 18.2
Common tower packings: (*a*) Raschig rings; (*b*) metal Pall ring; (*c*) plastic Pall ring; (*d*) Berl saddle; (*e*) ceramic Intalox saddle; (*f*) plastic Super Intalox saddle; (*g*) metal Intalox saddle.

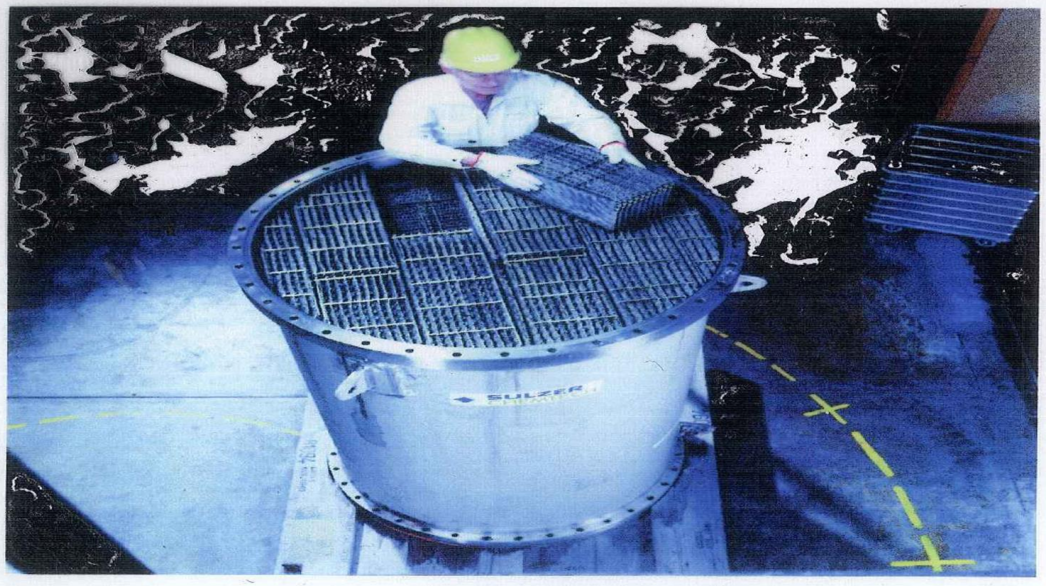
Plastic, metal or ceramics

60 – 90% porosity

Structured Packing



Structured Packing



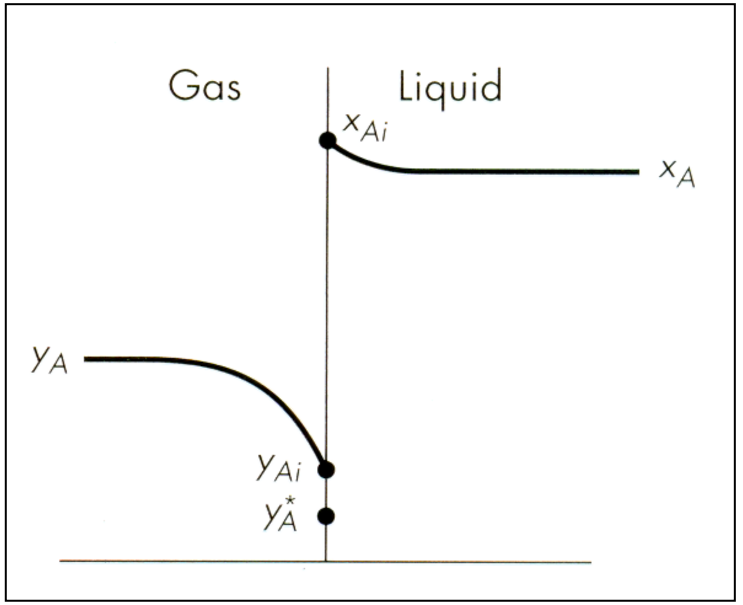
- The rate of absorption, r per unit volume of packed column is given by any of the following equations:

$$r = k_y a(y - y_i) \tag{18.7}$$

$$r = k_x a(x_i - x) \tag{18.8}$$

$$r = K_y a(y - y^*) \tag{18.9}$$

$$r = K_x a(x^* - x) \tag{18.10}$$



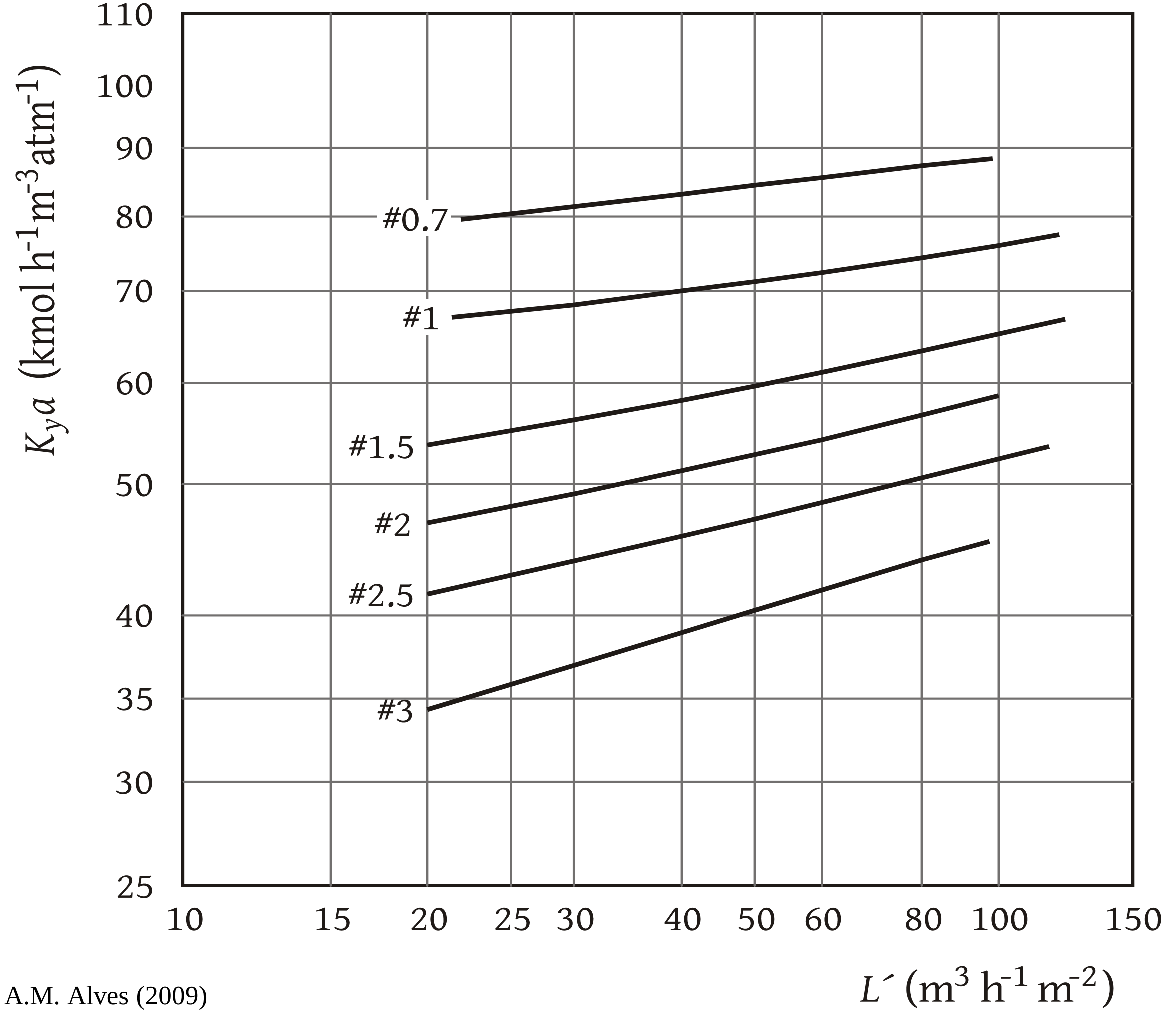
where y and x refer to the mole fraction of the component being absorbed.

Capacity coefficients

$$\frac{1}{K_y a} = \frac{1}{k_y a} + \frac{m}{k_x a}$$

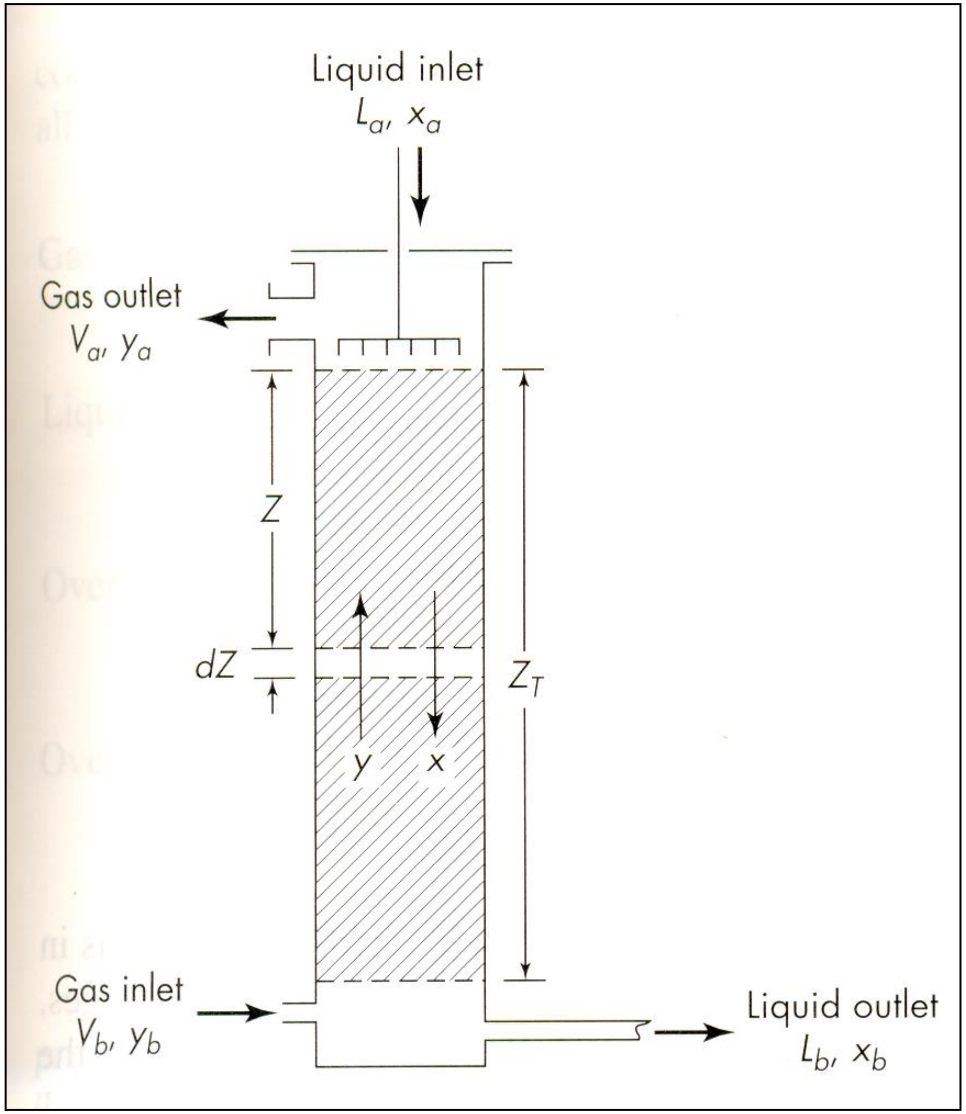
$$\frac{1}{K_x a} = \frac{1}{k_x a} + \frac{1}{m k_y a}$$

Nutter ring



Engenharia de Processos de Separação, E. G. Azevedo, A.M. Alves (2009)

Gas Absorption- Z_T ?



Mass balance A in dz

$$-V\,dy = K_y a(y - y^*)S\,dZ$$

$$\frac{K_y a S}{V}\int dZ = \frac{K_y a S Z_T}{V} = \int_a^b \frac{dy}{y - y^*}$$

$$Z_T = \frac{V/S}{K_y a}\int_a^b \frac{dy}{y - y^*}$$

Gas Absorption- Z_T ?

$$Z_T = H_{Oy} N_{Oy}$$

$$\boxed{z = H_{OG} \quad N_{OG}}$$

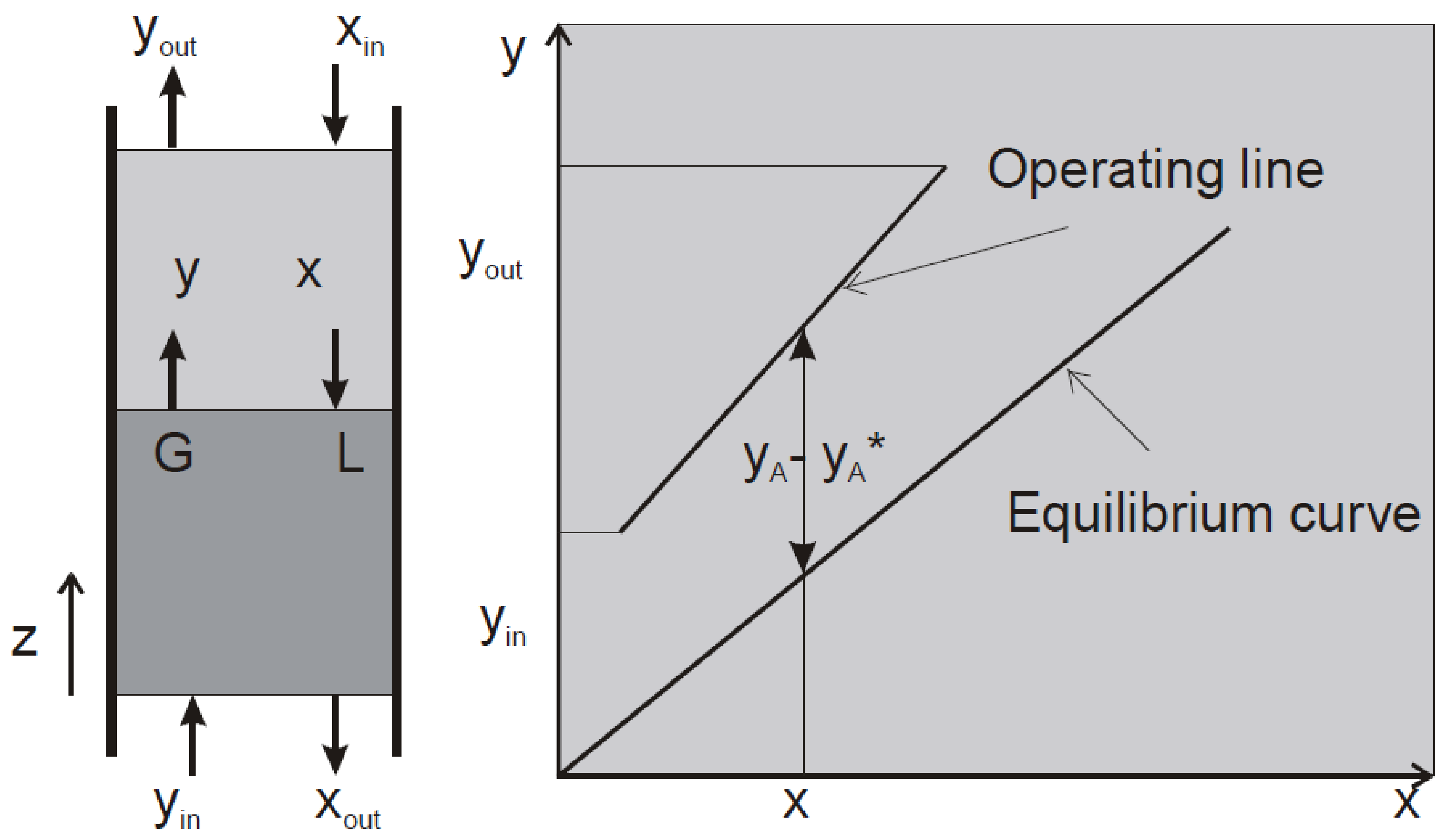
Height of transfer unit

N° of transfer units

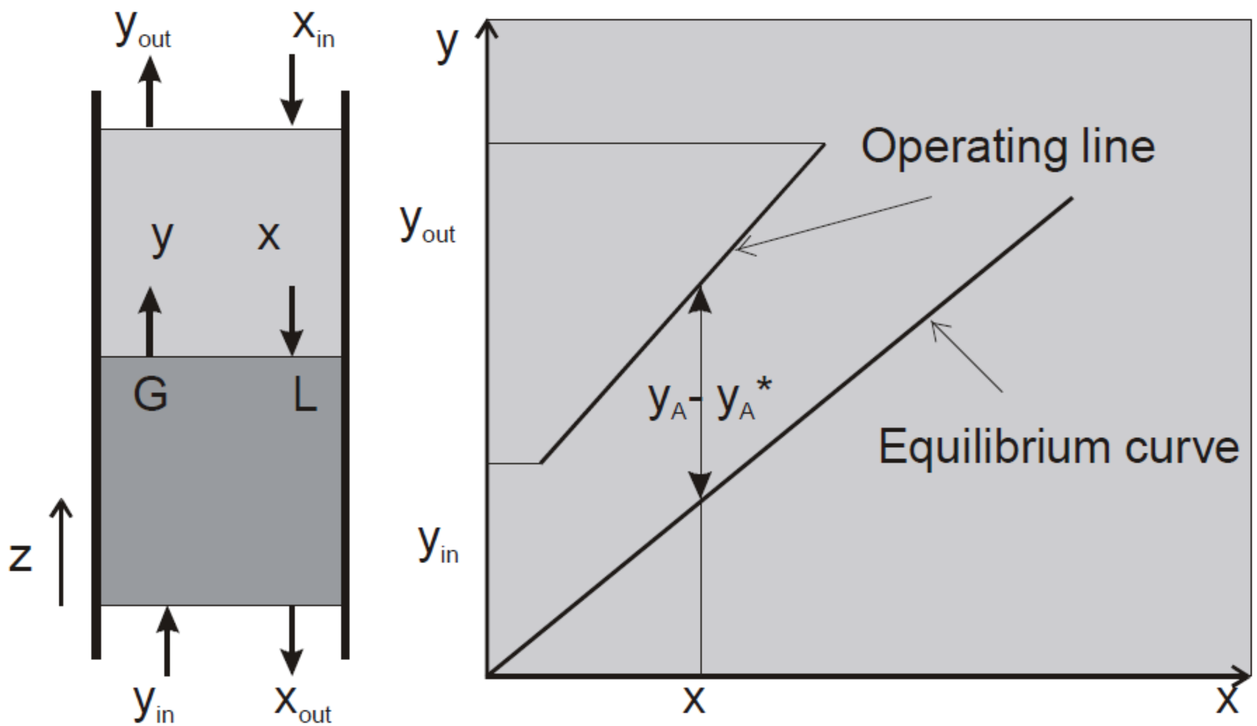
$$\frac{V/S}{K_y a},$$

$$\int_a^b \frac{dy}{y - y^*}$$

Gas absorption



Gas absorption



$$x_{in}L + yG = xL + y_{out}G$$

$$x = G/L\, y - G/L\, y_{out} + x_{in}$$

Analytical integration

$$y - y^{*} = y - mx = y - m\left(\frac{G}{L}y - \frac{G}{L}y_{out} + x_{in}\right) = \left(1 - \frac{mG}{L}\right)y + \frac{mG}{L}y_{\text{out}} - mx_{\text{in}}$$

$$n_{\text{OG}} = \int_{y_{out}}^{y_{in}} \frac{dy_A}{\left(1 - \frac{mG}{L}\right)y + \frac{mG}{L}y_{out} - mx_{in}}$$

$$n_{\text{OG}} = \frac{1}{1 - \frac{mG}{L}} \ln\left[\frac{\left(1 - \frac{mG}{L}\right)y_{in} + \frac{mG}{L}y_{out} - mx_{in}}{\left(1 - \frac{mG}{L}\right)y_{out} + \frac{mG}{L}y_{out} - mx_{in}}\right]$$

$$n_{\text{OG}} = \frac{1}{1 - \frac{mG}{L}} \ln\left[\frac{\left(1 - \frac{mG}{L}\right)y_{in} + \frac{mG}{L}y_{out} - mx_{in}}{y_{out} - mx_{in}}\right]$$

Numerical Integration

Simpson...

$$N_{Oy} = \frac{y_b - y_a}{\overline{\Delta y_L}}$$

$$\overline{\Delta y_L} = \frac{\Delta y_b - \Delta y_a}{\ln\left(\frac{\Delta y_b}{\Delta y_a}\right)}$$

$$\Delta y_a = y_a - y_a^*$$

$$\Delta y_b = y_b - y_b^*$$

It is absorbed 95% of the acetone present in a gas mixture acetone-air with 2% of acetone (% molar).

A packing column is used in countercurrent mode. The water flowrate used is 20% higher than the minimum and the gas flowrate is 1000 mol/h

The equilibrium line is $y_A^*=2{,}5\ x_A$, with A acetone and, y_A and x_A, the molar fractions of acetone in the gas and liquid phases, respectively.

a) Evaluate the minimum water flowrate

b) Evaluate the number of transfer units, N_{OG}?

$$N_{OG} = \int_{y_s}^{y_e} \frac{dy}{y - y^*}$$

with ye and ys the molar fractions of acetone in the inlet and outlet, respectively.

It is absorbed 99% of a toxic gas presente in air using H2O em countercurrent mode in a packed column.
If the water flowrate is 50% higher than the minimum, evaluate N_{OG}.
The molar fraction of the toxic gas entering the column is 0.5.
The equilibrium data is given by the equation $y = 2x$, in molar fraction.