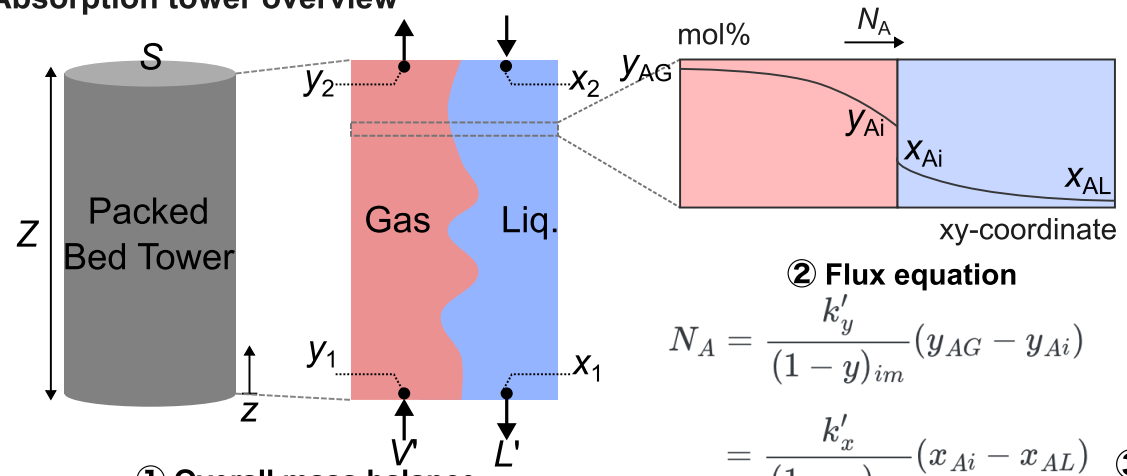
Cheatsheet: Absorption /Stripping Tower

Absorption tower overview



① Overall mass balance

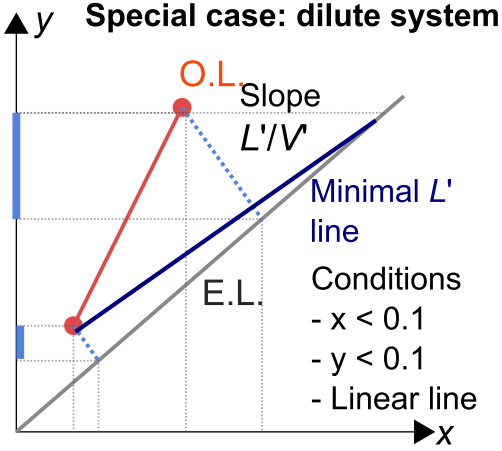
$$L'\left(\frac{x_2}{1-x_2}\right)+V'\left(\frac{y_1}{1-y_1}\right)=L'\left(\frac{x_1}{1-x_1}\right)+V'\left(\frac{y_2}{1-y_2}\right)$$

② Flux equation

$$N_A=\frac{k'_y}{(1-y)_{im}}(y_{AG}-y_{Ai})$$

$$=\frac{k'_x}{(1-x)_{im}}(x_{Ai}-x_{AL})$$

Special case: dilute system



③ Operating line slope (dilute)

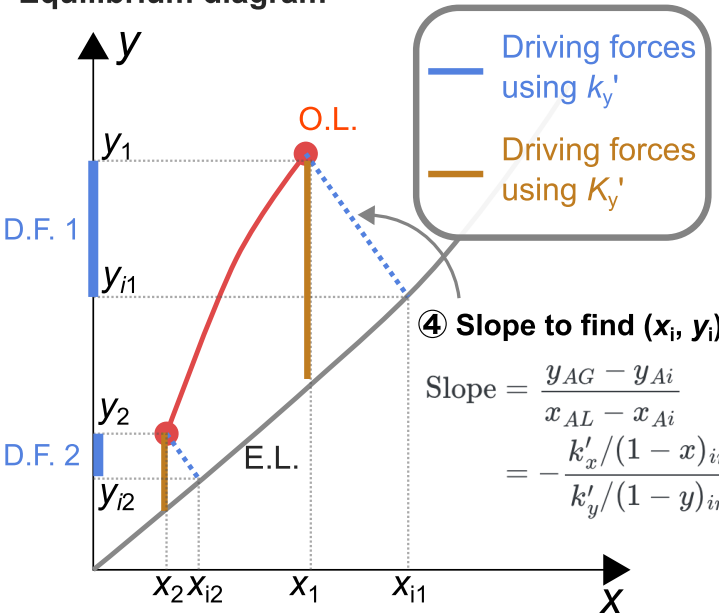
$$y=\left(\frac{L'}{V'}\right)x+\left[y_1-\left(\frac{L'}{V'}\right)x_1\right]$$

Relations for flow rates

$$L=L'+L_x \qquad V_y=V\cdot y=V'\frac{y}{1-y}$$

$$V=V'+V_y \qquad L_x=L\cdot x=L'\frac{x}{1-x}$$

Equilibrium diagram



④ Slope to find (x_i, y_i)

$$\text{Slope}=\frac{y_{AG}-y_{Ai}}{x_{AL}-x_{Ai}}=-\frac{k'_x/(1-x)_{im}}{k'_y/(1-y)_{im}}$$

⑤ Height of tower

Gas

$$Z=\int_{y_2}^{y_1}\frac{V\,dy}{\frac{k'_y aS}{(1-y)_{im}}(1-y)(y-y_i)}$$

Liq.

$$Z=\int_{x_2}^{x_1}\frac{L\,dy}{\frac{k'_x aS}{(1-x)_{im}}(1-x)(x_i-x)}$$

Gas (dilute)

$$\frac{V}{S}(y_1-y_2)=k'_y aZ(y-y_i)_m$$

Liq. (dilute)

$$\frac{V}{S}(x_1-x_2)=k'_x aZ(x_i-x)_m$$

Height of tower: using transfer units

$$H_G=\frac{V}{k'_y aS} \qquad N_G=\int_{y_2}^{y_1}\frac{(1-y)_{im}}{(1-y)(y-y_i)}\,dy$$

Dilute system

$$Z=H_G N_G=H_G\frac{y_1-y_2}{(y-y_i)_m}$$

⑥ Use of log-mean forms

$$(1-y)_{im}=\frac{(1-y_{AG})-(1-y_{Ai})}{\ln\frac{1-y_{AG}}{1-y_{Ai}}} \qquad (y-y_i)_m=\frac{(y_1-y_{i1})-(y_2-y_{i2})}{\ln\frac{y_1-y_{i1}}{y_2-y_{i2}}}$$

Adaptations

Pairs of symbols

k'_y	H_G	N_G	y_i
k'_x	H_L	N_L	x_i
K'_y	H_{OG}	N_{OG}	y^*
K'_x	H_{OL}	N_{OL}	x^*

1. **Absorption tower:**
- O.L. **above** E.L
- Minimal L'

Absorption

$y-y_i$
x_i-x
$y-y^*$
x^*-x

2. **Stripping tower:**
- O.L. **below** E.L
- Minimal V'

Stripping

y_i-y
$x-x_i$
y^*-y
$x-x^*$