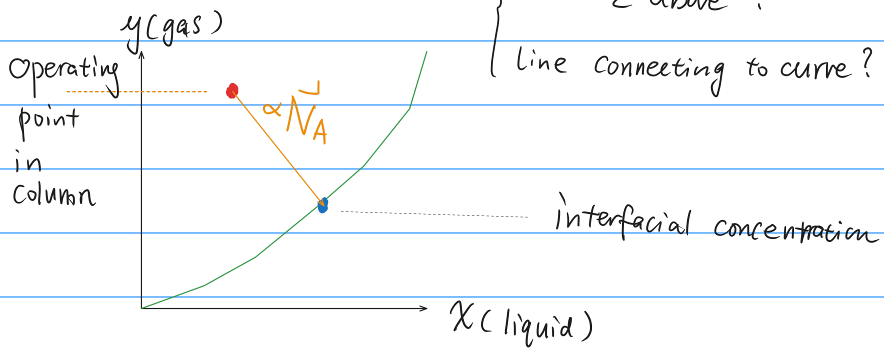
CHE318 L24

Design of packed bed absorption

Recap of last week:

① Eq diagram ? Meaning of points { on curve ? above ? line connecting to curve ?



1) For diluted (EMCD-like) system, we have

$$N_A \doteq k_y' (y_{AG} - y_{Ai}) = k_x' (x_{Ai} - x_{AL})$$

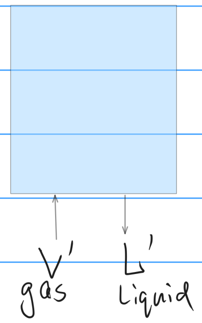
Concentrated solute through stagnant films ⇒ need to use $\frac{k_x'}{x_{Bm}}$

talked in this class

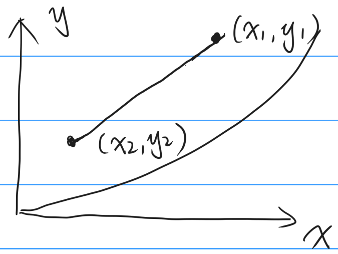
2) The series of (x, y) in tower / column forms the operating line (OL)

M.B. For operating line

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



What can it solve ?



Dilute absorption tower ⇒ $y = f(x)$ is a straight line

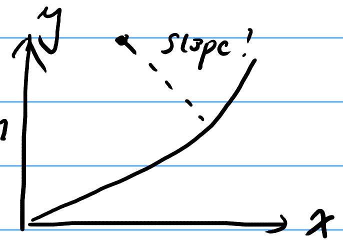
$$y = \left(\frac{L'}{V'}\right) x + [\text{const}]$$

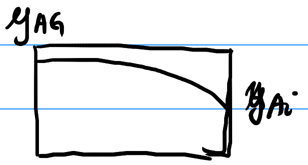
But not linear if $1 - x \neq 1$

(see assignment 6)

More accurate description for the slope

Usually, $1-x_{AL}$ & $1-y_{AG}$ is not close enough to 1 ?





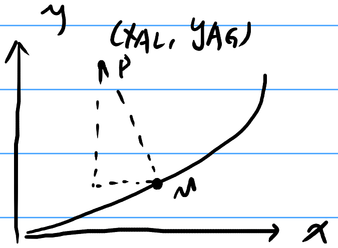
y_{AG} y_{Ai} relation is non-linear, use

$x_{Bm} = (1-y)_{im}$ correction !

(Usual description: diffusion of A through non-diffusing B)

Still, mass balance of N_A across Liq ⋮ Gas is needed

$$N_A = \frac{k_y'}{(1-y)_{im}}(y_{AG} - y_{Ai}) = \frac{k_x'}{(1-x)_{im}}(x_{Ai} - x_{AL})$$



$$\text{Slope} = \frac{y_{AG} - y_{Ai}}{x_{AL} - x_{Ai}} = -\frac{k_x'/(1-x_A)_{im}}{k_y'/(1-y_A)_{im}}$$

$(1-x_A)_{im}$ & $(1-y_A)_{im}$ depends on the actual location ⇒ { ① trial & error
② numerical

Test case: A diffusing through non-stagnant B

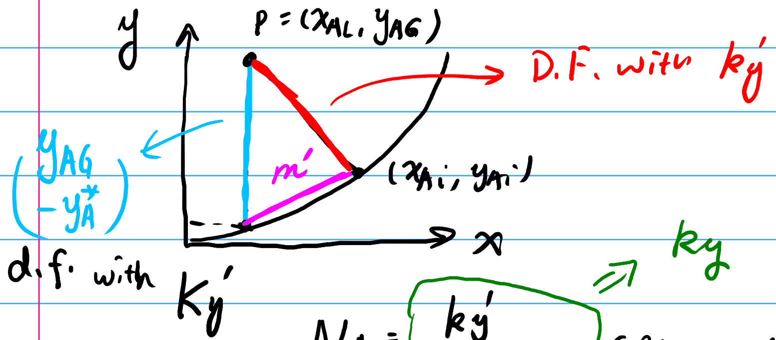
$P = (0.100, 0.380)$

find interfacial conc ? { $k_x' = 1.967 \times 10^{-3}$ kgmol/m²·s
$k_y' = 1.465 \times 10^{-3}$ kgmol/(m²·s)

Manual: $P \to$ slope $-\frac{k_x'/1}{k_y'/1}$ → (x_{i1}, y_{i1}) → update $(1-x)_{im}$, $(1-y)_{im}$ → Same slope ? $\xrightarrow{Y}$ Obtained (x_{Ai}, y_{Ai})

N → slope

Question 2. overall m.t. coefficient



$$N_A = \overbrace{\boxed{\frac{k_y'}{(1-y)_{im}}}}^{k_y}(y_{AG} - y_{Ai}) = \overbrace{\boxed{\frac{K_y'}{(1-y)_{*m}}}}^{K_y}(y_{AG} - y_A^*)$$

Relation? Geometric gives

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