BY: S. VISHAL
CH18B020

CH3030 - AMT Tutorial - 1

(1) From the given data, calculate mole ratios

Inlet: $Y_{CO_2, \text{flue gas}} = \dfrac{0.15}{1-0.15} = 0.1765$

CO_2 in solution, $X_0 = \dfrac{0.058}{1-0.058} = 0.06157$

Outlet:

$Y_{CO_2, \text{gas}} = Y_1 = \dfrac{2}{98} = 0.02.$

X_n (CO_2 in solution) = ? (depends on L_s)

Also $G = \dfrac{P_1}{RT} = \dfrac{1.2 \times 10^5 \times 1.01}{8.314 \times 298} = 49$ mol/m³ of gas

$\Rightarrow G_S = 0.85 \times G = 41.65$ mol/m³

The x eqbm data is converted to X by $X = \dfrac{x}{1-x}$.
and partial pressure is also converted to corresponding mole ratio $\Rightarrow Y = \dfrac{\frac{p}{1.2 \times 760}}{1 - \frac{p}{1.2 \times 760}}$

Thus X_{eqbm} vs Y_{eqbm} data is obtained.

Using spline interpolation, X_0 is found to be 0.0722
($\because$ (X_0, Y_n) is a point on the eqbm curve at $L_{s\,min}$)

a) $\dfrac{L_{s\,min}}{V_s} = \dfrac{Y_{entry} - Y_{exit}}{X_{exit} - X_{entry}} \Rightarrow \dfrac{L_{s\,min}}{V_s} = 14.722$

b) Using value of G_s calculated earlier,

$L_s = 1.2 \times 14.722 \times V_s \Rightarrow L_s = 735.866$ mol/m³ of gas

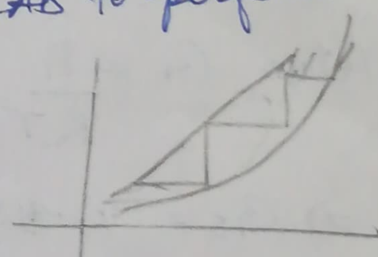
$$M.W. \text{ of liquid} = \frac{W}{\frac{0.3W}{61} + \frac{0.7W}{18}} \quad \left(\frac{\text{Weight of liquid}}{\text{total no. of moles of it}} \right)$$

$\Rightarrow M.W. = 22.827 \text{ g mol}^{-1}$

$\Rightarrow L_s = 735.866 \times 22.827$ g.

$= 16.8$ kg of liquid / m³ of gas.

c) → A loop has been set in MATLAB to perform the stepping process.



→ For a given y, find x at eqbm curve using splines.

→ For that x find y on operating line

→ Stop the iterations once y > Y entry

Using the above process the number of trays was found to be 3.

(2) Given that molar gas flow rate, $V = 180$ kmol/h.

$V_s = 0.98 \times V = 176.4$ kmol/h.

$Y_{n+1} = \frac{2}{98} \simeq 0.02$

$Y_1 = 0.03 \times \frac{2}{98} \simeq 6.12 \times 10^{-4}$.

and $X_0 = 0$ (entry feed is pure)

Modified Raoult's law : $y P_{total} = x \gamma P_{saturation}$.

For dilute solutions $y \simeq Y$ and $x \simeq X$

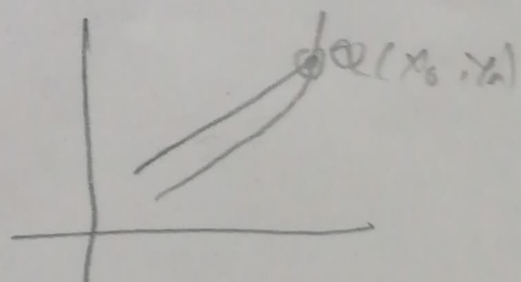
$\Rightarrow Y P_{total} = X \gamma P_{vapour}$

$\Rightarrow X = \frac{P_{total} (Y)}{\gamma P_{vapour}}$ will be the equilibrium curve.

$P_{total} = 110$ kPa, $P_{vapour} = 10.5$ kPa, $\gamma = 6$

At $L_{s\,min}$, we know that X_0, Y_n lies on eqbm curve

Using the curve equation we get,



$X_{exit} = 0.0349$.

$\therefore \frac{L_{s\,min}}{V_s} = \frac{0.02 - 6.12 \times 10^{-4}}{0.0349 - 0} \Rightarrow L_{s\,min} = 97.99$

$\Rightarrow L_{s\,min} = 98$ kmol/h.

Let $L_s = 1.5 L_{s\,min}$

$\Rightarrow L_s = 146.997 \Rightarrow L_s = 147$ kmol/h

Using the stepping process similar to q 1).
we get the number of trays to be $\boxed{7}$.