CHE 305 – Separation Processes
Spring 2010 - Exercise on Absorber Height

BASED ON GAS ⇒ LIQ WELL MIXED

Given:

- $K_y a = 10$ mol/ft^3 hr
- $K_x a = 8$ mol/ft^3 hr
- $L = 400$ mol/hr
- $V = 300$ mol/hr
- $S = 9$ ft^2
- EQ Curve: $y^* = 0.8x^*$

$y_b^* = 0.8(0.18) = 0.144$

$y_a^* = 0.8(0) = 0$

$$\overline{\Delta y}_L = \frac{(0.01-0)-(0.25-0.144)}{\ln\left(\frac{0.01-0}{0.25-0.144}\right)} = 0.0407$$

$$N_{Oy} = \int \frac{dy}{y-y^*} = \frac{\Delta y}{\overline{\Delta y}_L} = \frac{0.25-0.01}{0.0407}$$

$N_{oy} = 5.90$ stages

$$N_{Ox} = \int \frac{dx}{x^*-x} = \frac{\Delta x}{\overline{\Delta x}_L}$$

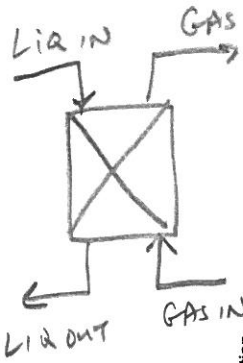
$$H_{Oy} = \frac{V/S}{K_y a} = \frac{300 \text{ mol}}{\text{hr}} \left| \frac{1}{9 \text{ ft}^2} \right| \frac{\text{ft}^3 \cdot \text{hr}}{10 \text{ mol}} = 3.33 \text{ ft/stage}$$

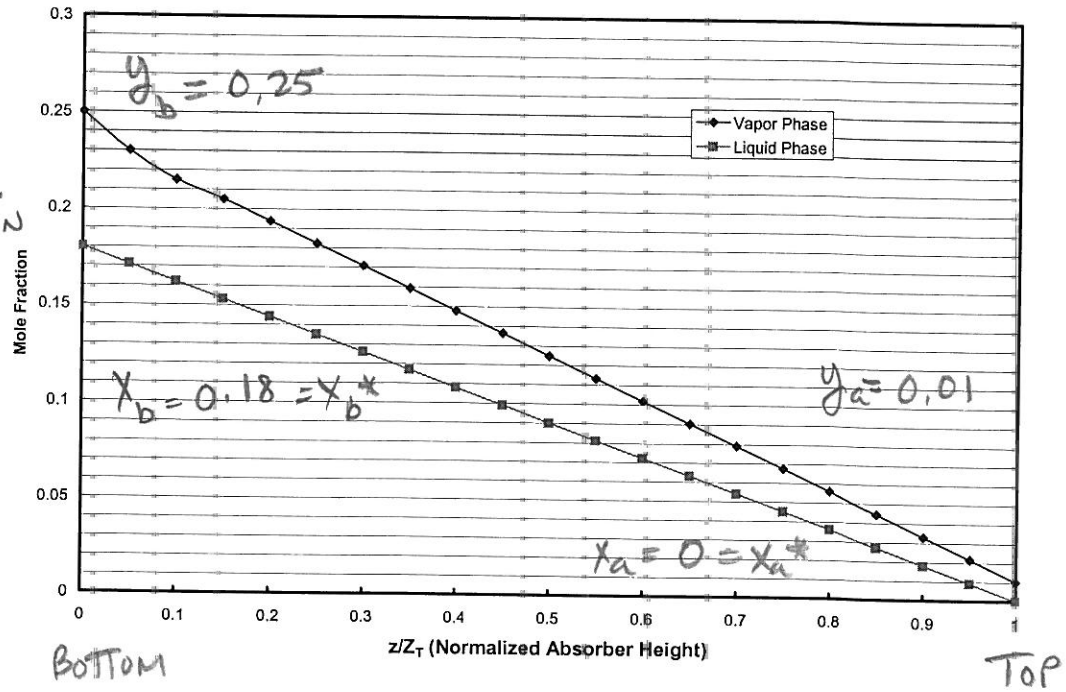
$$H_{Ox} = \frac{L/S}{K_x a}$$

$$\overline{\Delta Q}_L = \frac{(Q-Q^*)_{Top}-(Q-Q^*)_{Bottom}}{\ln\left(\frac{(Q-Q^*)_{Top}}{(Q-Q^*)_{Bottom}}\right)} = \frac{(Q^*-Q)_{Top}-(Q^*-Q)_{Bottom}}{\ln\left(\frac{(Q^*-Q)_{Top}}{(Q^*-Q)_{Bottom}}\right)}$$

Determine the column height (Z_T) given the following mole fraction gradients in the gas and liquid phases.

$$\Rightarrow Z_T = (5.90 \text{ stages})(3.33 \text{ ft/stage}) = 19.6 \text{ ft} = Z_T$$





BOTTOM

TOP

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- S = 9 ft^2
- EQ Curve: y* = 0.8x*

$X_a^* = \frac{1}{0.8}(0.01) = 0.0125$

$X_b^* = \frac{1}{0.8}(0.25) = 0.3125$

$$\overline{\Delta X}_L = \frac{(0.0125-0)-(0.3125-0.18)}{\ln\left(\frac{0.0125-0}{0.3125-0.18}\right)} = 0.0508$$

$$N_{Oy} = \int \frac{dy}{y-y^*} = \frac{\Delta y}{\overline{\Delta y}_L} \qquad N_{Ox} = \int \frac{dx}{x^*-x} = \frac{\Delta x}{\overline{\Delta x}_L} = \frac{(0.18-0)}{0.0508}$$

$N_{Ox} = 3.54$ stages

$$H_{Oy} = \frac{V/S}{K_y a} \qquad H_{Ox} = \frac{L/S}{K_x a}$$

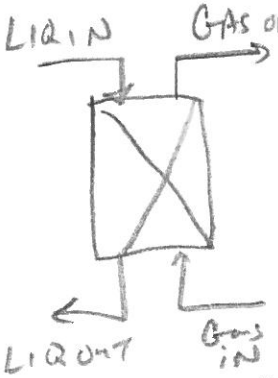
$H_{Ox} = \frac{400 \text{ mol}}{\text{hr}} \left| \frac{1}{9 \text{ ft}^2} \right| \frac{\text{ft}^3 \cdot \text{hr}}{8 \text{ mol}}$

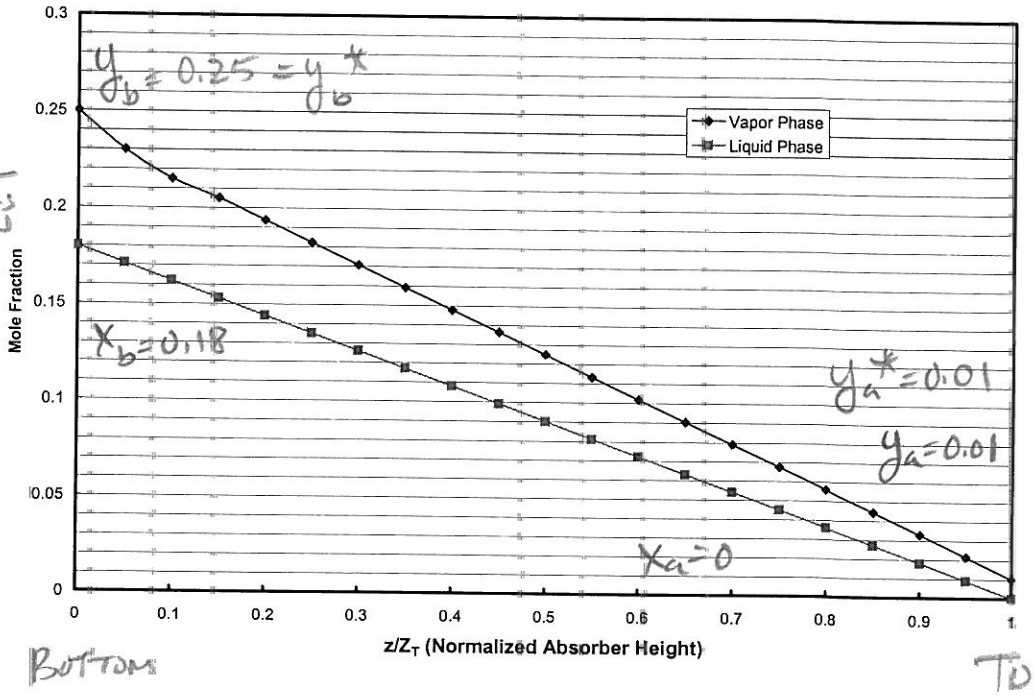
$$\overline{\Delta Q}_L = \frac{(Q-Q^*)_{Top}-(Q-Q^*)_{Bottom}}{\ln\left(\frac{(Q-Q^*)_{Top}}{(Q-Q^*)_{Bottom}}\right)} = \frac{(Q^*-Q)_{Top}-(Q^*-Q)_{Bottom}}{\ln\left(\frac{(Q^*-Q)_{Top}}{(Q^*-Q)_{Bottom}}\right)}$$

$H_{Ox} = 5.56$ ft/stage

Determine the column height (Z_T) given the following mole fraction gradients in the gas and liquid phases.

$Z_T = (3.54 \text{ stages})(5.56 \text{ ft/stage}) = \boxed{19.7 \text{ ft} = Z_T}$





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