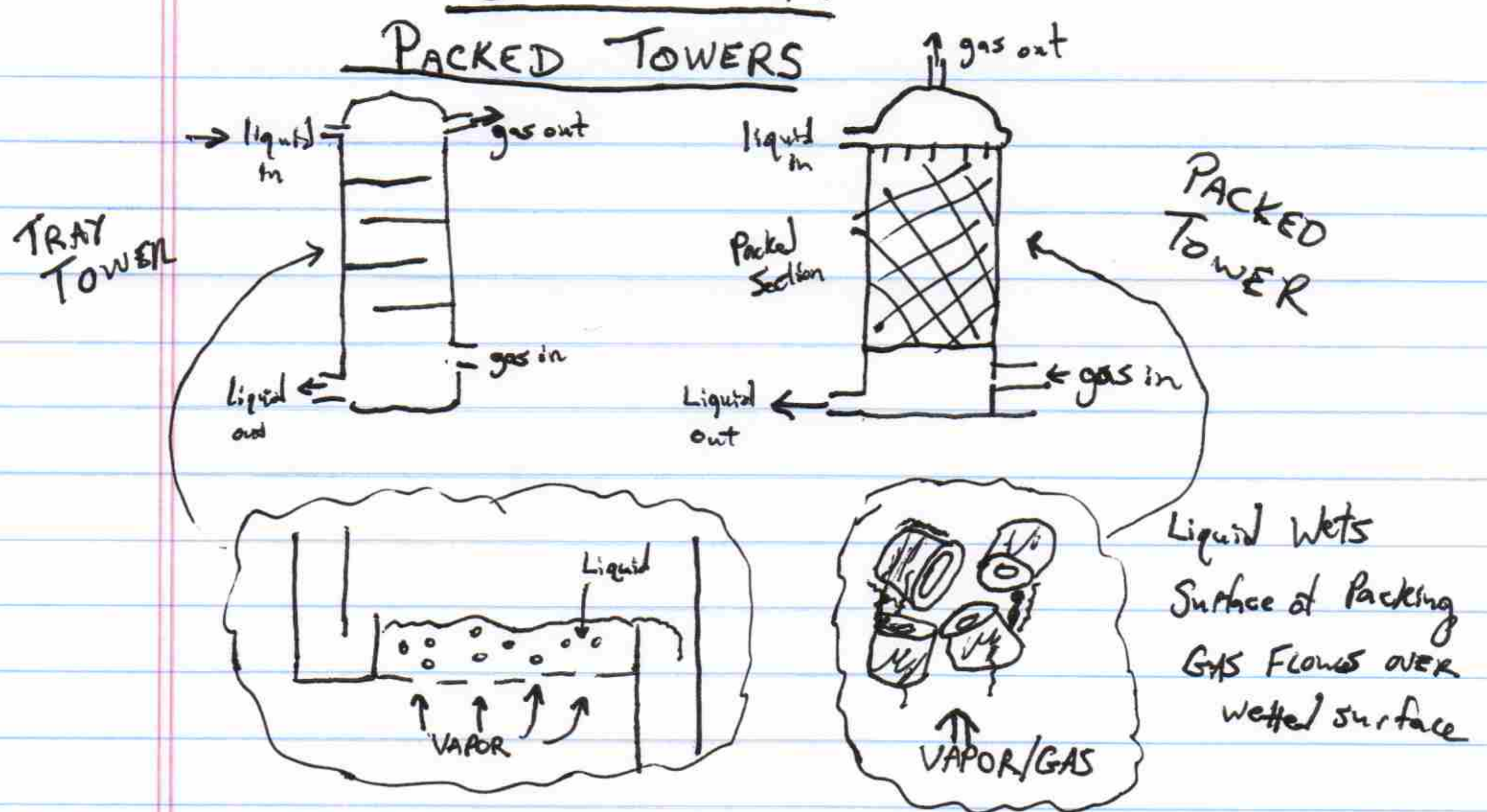
CE 407 11/2/17

PACKED TOWERS



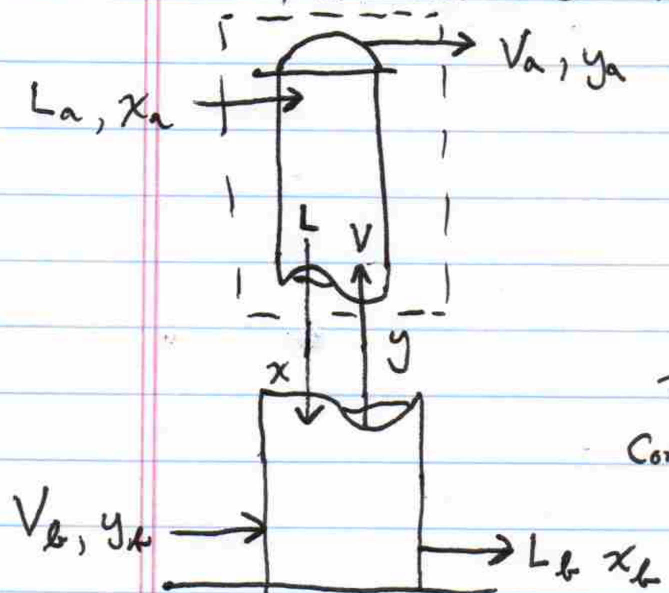
- GAS CONTACTS LIQUID, MASS TRANSFER OCCURS
- WE NEVER DISCUSSED MASS TRANSFER RATES WHEN DEALING WITH TRAY TOWERS BUT WILL GO ON AND ON ABOUT IT IN PACKED TOWER - WHAT'S UP WITH THAT?
- IDEAL PLATES ASSUMED MASS TRANSFER RATE UNDER PROCESS CONDITIONS WAS FAST ENOUGH THAT EQUILIBRIUM BETWEEN LIQUID AND GAS STREAMS WAS REACHED AT EACH PLATE
- PLATE EFFICIENCY IS AN INDICATION OF HOW MASS TRANSFER RATES LIMIT THE ABILITY TO REACH EQUILIBRIUM AT EACH STAGE

IN PACKED TOWER .. THERE ARE NO DISCRETE INTERVALS TO ASSUME AN EQUILIBRIUM HAS BEEN REACHED

SO WE NEED TO DETERMINE MASS TRANSFER RATES AND INTEGRATE ~~THE~~ ~~EX~~PRESSIONS.
(LISTEN CLOSELY AND YOU CAN HEAR ELROY SIGHING...)

MATERIAL BALANCES

IN MOLES



Total $L_a + V = L + V_a$

Component A $L_a x_a + V y = L x + V_a y_a$

↑ FOR CONTROL BOX ↑

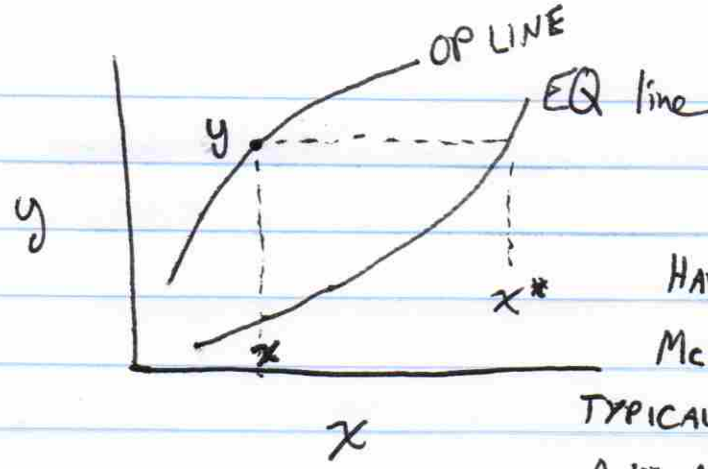
BALANCE AROUND ENTIRE TOWER

TOTAL $L_a + V_b = L_b + V_a$

Comp A $L_a x_a + V_b y_b = L_b x_b + V_a y_a$

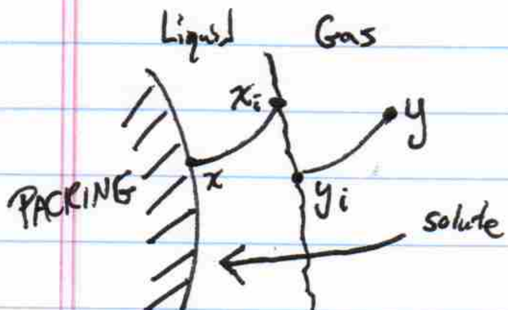
CAN REARRANGE COMPONENT A BALANCE TO GET OPERATING LINE (SIMILAR TO WHAT WE HAVE AREADY SEEN)

$$y = \frac{L}{V} x + \frac{V_a y_a - L_a x_a}{V}$$



BECAUSE WE DON'T HAVE DISCRETE STAGES McCABE-THIELE STEPS TYPICALLY DON'T HAVE ANY MEANING

ANALYSIS CAN BE DONE WITH ANY OF THE FOUR RATE EQUATIONS



$$r = k_y a (y - y_i)$$

Gas Phase
Flow in gas phase bulk to interface

$$r = k_x a (x_i - x)$$

Liquid Phase
Flow in liquid phase interface to bulk

$$r = K_y a (y - y^*)$$

Overall flow GAS SIDE

y = bulk gas composition

y^* = gas composition which is in EQ w/ bulk liquid composition x

$$r = K_x a (x^* - x)$$

Overall Flow Liquid Side

x^* = liquid composition which is in EQ w/ BULK gas composition y

x = bulk liquid composition

$$a = \frac{\text{surface area}}{\text{volume}} = \frac{l^2}{l^3}$$

$$r = \frac{\text{rate of absorption}}{\text{unit volume}} = \frac{mol}{l^3 t}$$

$$Ka \quad \frac{mol}{l^3\, t\ \text{mol fraction}}$$

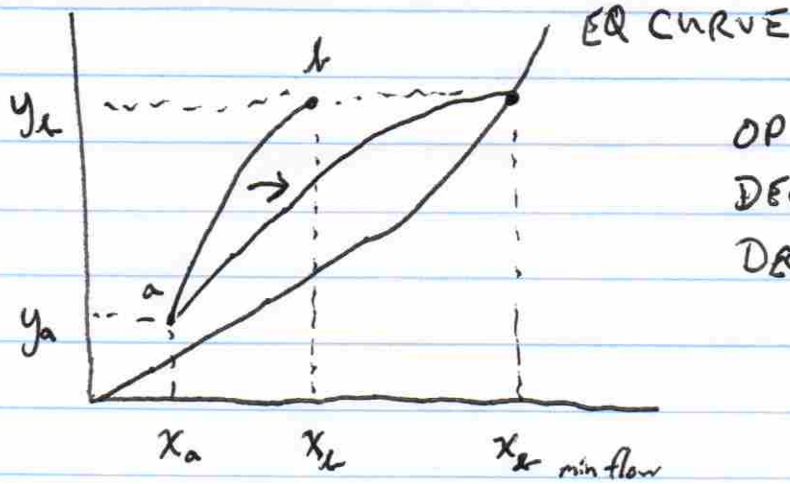
$$ka \quad \frac{mol}{l^3\, t\ \text{mol fraction}}$$

$$k \quad \frac{mol}{l^2\, t\ \text{mol fraction}}$$

UNITS

Note: for gas and liquid phase we need to calculate y_i or x_i

MINIMUM FLOW REQUIRED



OP LINE SLOPE DECREASES WITH DECREASING L

$$y_b = y^*(x_{b\,\text{min flow}})$$

or $$x_{b\,\text{min}} = x^*(y_b)$$

④ 11/2