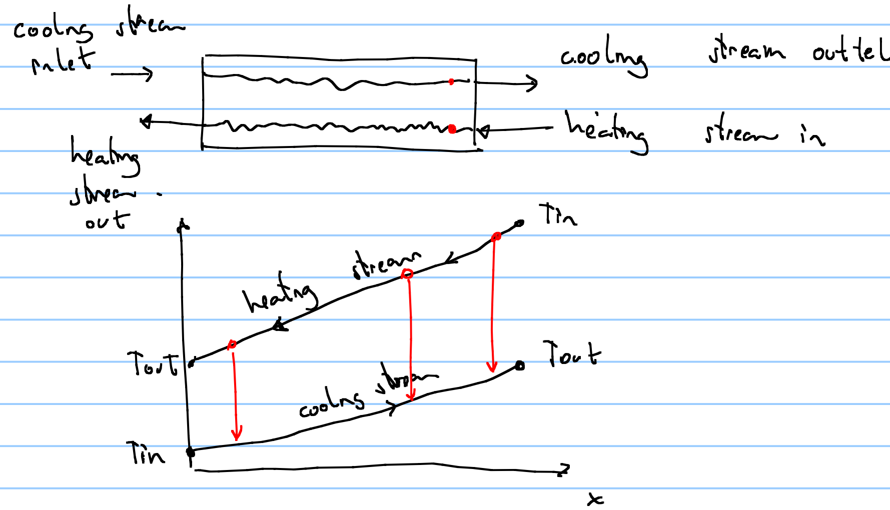
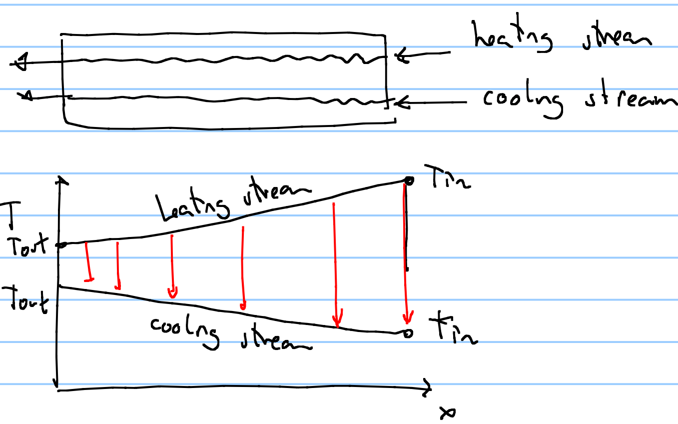
- Gas dehydration with TEG in absorption column (theory)
  ↳ triethylene glycol
- Class exercise

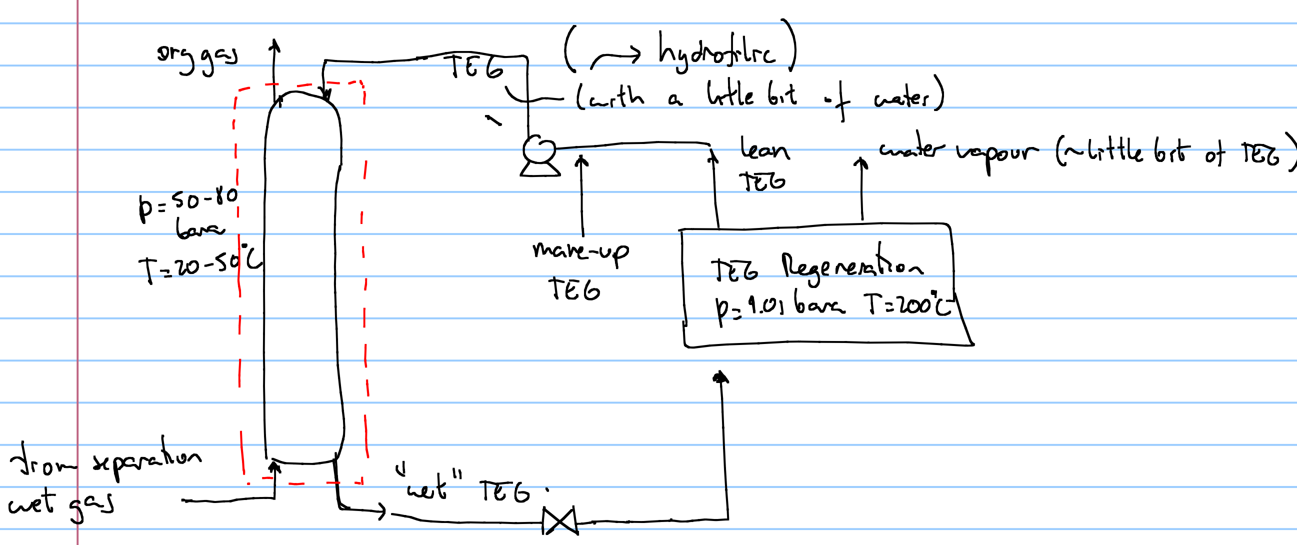
Similar to heat exchanger

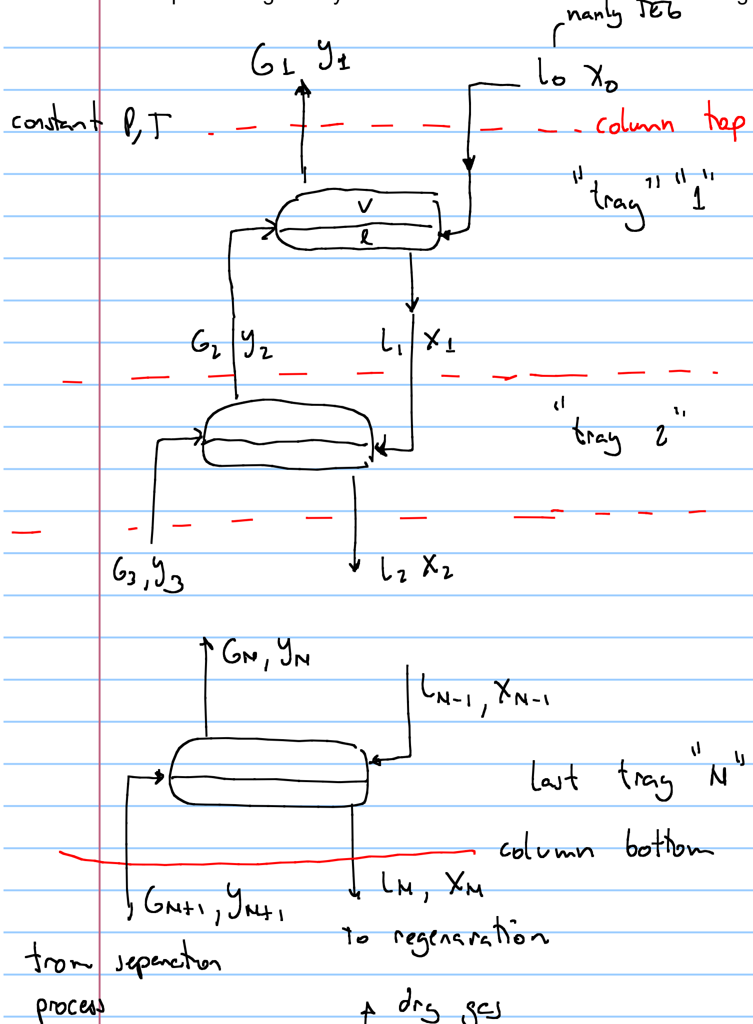


vs.



for gas dehydration (after separation - stabilization), before compression (wet gas transport) TEG columns are typically used





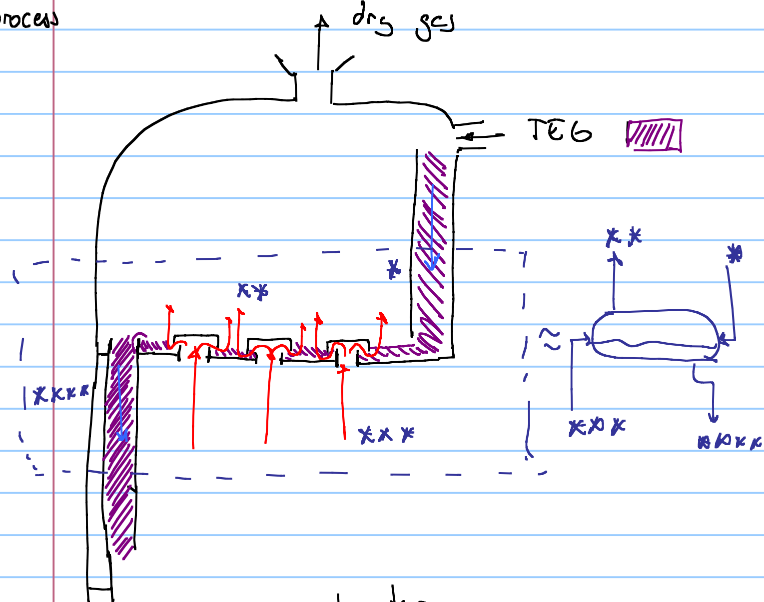
L liquid molar rate
G gas molar rate
x molar fraction of water in liquid stream
y molar fraction of water in vapor stream

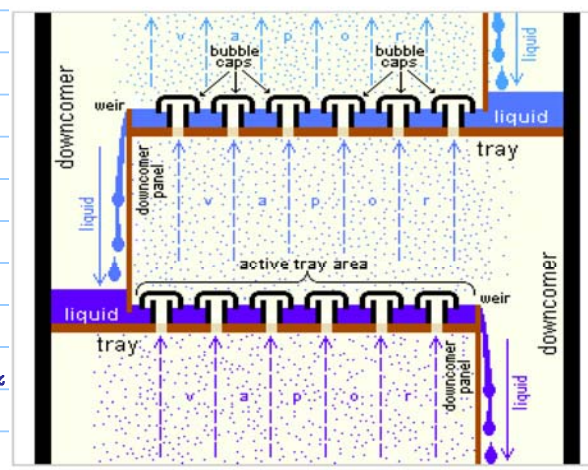
what happens in tray 1

- L_0 and G_2 are mixed
- equilibrium rates G_1, L_1 are extracted.

G_1 is sent up, L_1 is sent down

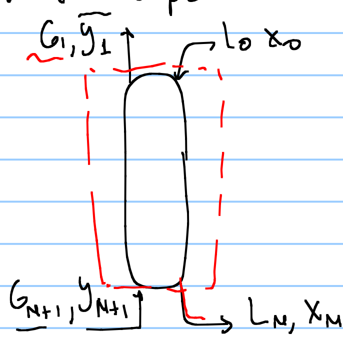
G_1 and L_1 are in equilibrium, that mean $K_1 = \frac{y_1}{x_1}$





Typical bubble cap trays used in industrial distillation columns

- mass balance of water on the complete column



very low, desired water content

$$G_{N+1} \cdot y_{N+1} + L_0 x_0 = G_1 y_1 + L_N x_N$$

G_1 is usually < G_{N+1} because water has been removed. However the amount of water is so small that

$$G_1 \simeq G_{N+1}$$

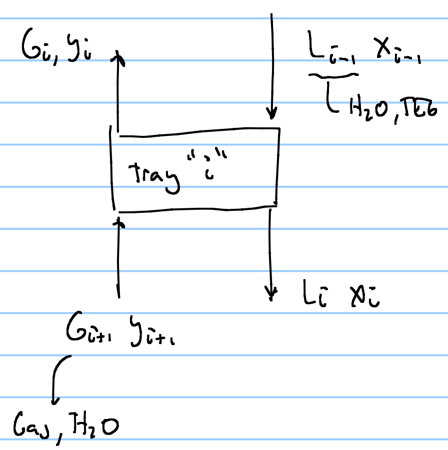
L_0, L_N and X_N are unknowns.

$L_N > L_0$ because it attracts water, however we can often have $L_0 \simeq L_N \simeq L$

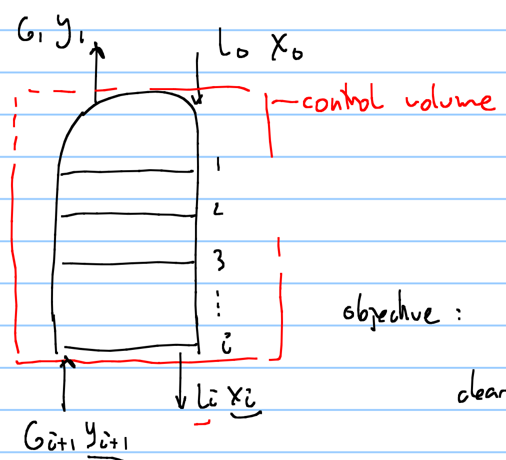
I can use the equation in two ways → ① provide L, calculate X_N ← to be used in class.

② provide X_N, calculate L

- mass balance of water in a tray "i"



$$G_i y_i + L_i x_i = L_{i-1} X_{i-1} + G_{i+1} y_{i+1}$$

- 

mole balance of water in control volume

$$G_1 y_1 + L_i x_i = L_0 x_0 + G_{i+1} y_{i+1} \quad \text{eq 1.}$$

objective: x_i y_i for each tray

clear y_{i+1} from equation (1)

$$y_{i+1} = \frac{-L_0 X_0 + L_i x_i}{G_{i+1}} + \frac{G_1 y_1}{G_{i+1}}$$

y_{i+1}: molar fraction of water entering the tray (gas)

x_i: molar fraction of water leaving the tray (liquid)

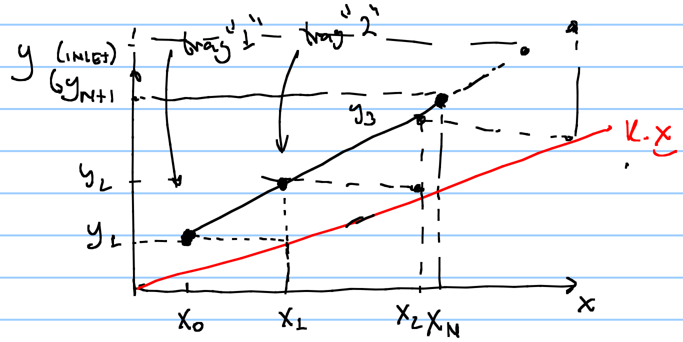
operational equation of column

assumption 1) $G_{i+1} \simeq G_1 \simeq G$:)

assumption 2) $L_i \simeq L_0 \simeq L$ not so good assumption :(!!

operational line of column

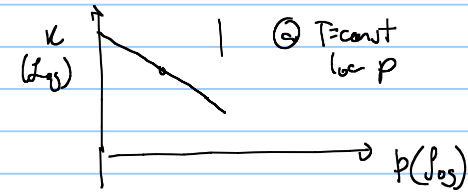
$$y_{i+1} = \frac{L}{G}(X_0 - X_i) + y_1$$



we also know column is at constant P, T

$$K_i = \frac{y_i}{x_i} \qquad K_{H_2O} = \frac{y_{H_2O}}{x_{H_2O}}$$

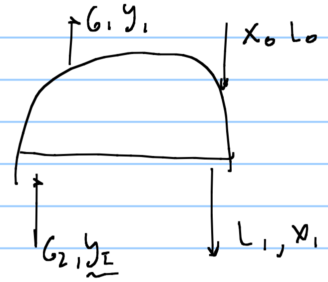
↑ component "i"



K_{H_2O} in the tower is constant

$$y_{H_2O} = K_{H_2O}\, x_{H_2O}$$

equilibrium line

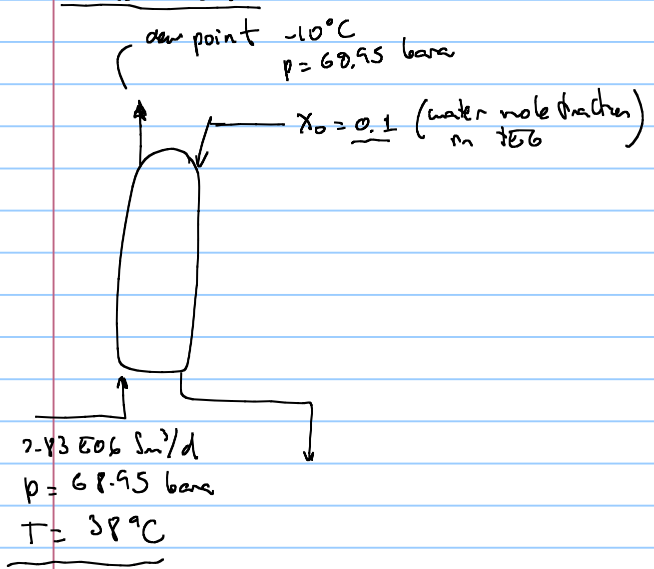


$$y_{i+1} = \frac{L}{G}(x_0 - x_i) + y_1$$

for tray 2

$$y_2 = \frac{L}{G}(x_0 - x_1) + y_1$$

Class exercise:



① determine water content in inlet gas stream

r_{sw} @ 68.95 bar, 38°C $= 1005 \frac{kg}{1E06\ Sm^3}$

② determine desired water content in outlet gas stream

r_{sw} @ 68.95 bara, -10 °C

$r_{sw} = 61.8 \frac{kg}{(1E06\ Sm^3)}$

③ water to be removed

$$\dot{m}_w = \left(r_{sw}\Big|_{68.95,\ 38} - r_{sw}\Big|_{68.95,\ -10} \right) q_g$$

$\dot{m}_w = 2670$ kg/d

④ Equilibrium line $y_{i+1} = \frac{L}{G}(x_0 - x_i) + y_1$

I have