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CH18B020

CH3030 - AMT Tutorial - 1

(1) From the given data, calculate mole ratios

<u>Inlet</u> : $Y_{CO_2, \text{flue gas}} = \frac{0.15}{1-0.15} = 0.1765$

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

<u>Outlet</u> :

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

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

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

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

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

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

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

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

b) Using value of G_s calculated earlier,

$L_s = 1.2 \times 14.722 \times V_s \Rightarrow L_s = 735.866$ mol/m^3 of gas

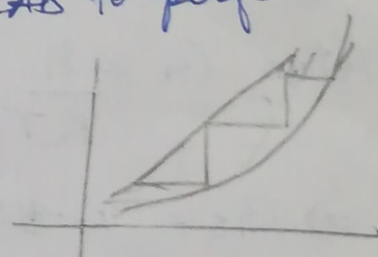
$$M.W. \text{ of liquid} = \frac{W}{\frac{0.3W}{61} + \frac{0.7W}{18}} \quad \left(\frac{\text{Weight of liquid}}{\text{total no. of moles of it}} \right)$$

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

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

$= 16.8$ kg of liquid / m^3 of gas

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



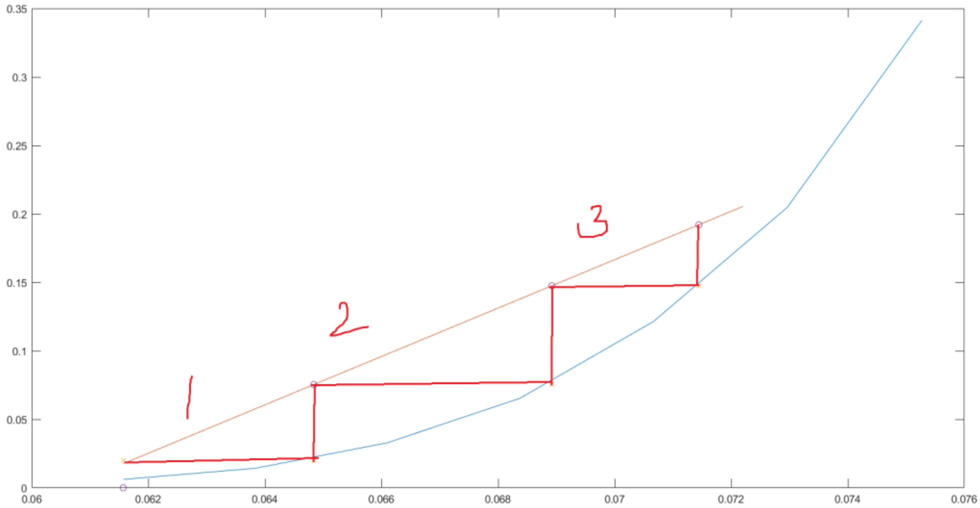
→ For a given y, find x at eqbm curve using splines.

→ For that x find y on operating line

→ Stop the iterations once y > Yentry

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

Question 1) Graph + Code




```
clear; close all;
X = [0.061571125 0.063829787 0.066098081 0.068376068 0.070663812 0.072961373 0.075268817 ];
Y = [0.006178288 0.014234875 0.032842582 0.065420561 0.121357433 0.204755614 0.341176471 ];
xl = 0.065:0.001:0.075;
yl = 0.1765.*ones(1,11);
xlol = linspace(0.06157,0.0722,10);
X_atminL = spline(Y,X,0.1765);
%determining number of trays
i = 0;
y = 0.02;
xcoords = zeros(1,4);
ycoords = zeros(1,4);
ycoords2 = ycoords;
while y <= 0.1765
   i = i + 1;
   x = spline(Y,X,y);
   xcoords(i) = x;
   ycoords(i) = y;
   y = 0.01765 + 1.2*14.722*(x-0.06157);
   ycoords2(i) = y;
end
xcoords(4)=0.06157;
ycoords(4) = 0.02;
plot(X,Y,xlol,0.01765 + 1.2*14.722.*(xlol-0.06157),xcoords,ycoords,'x',xcoords,ycoords2,'o');
a = [0.058 0.06 0.062 0.064 0.066 0.068 0.07 ];
b = [0.006140351 0.014035088 0.031798246 0.061403509 0.108223684 0.16995614 0.254385965 ];
figure();
plot(a,b);
```

(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 $x \simeq X$

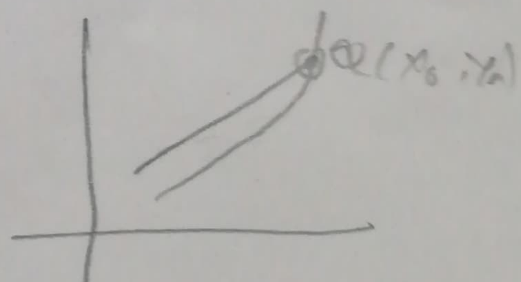
$$\Rightarrow Y P_{total} = X \gamma P_{vapor}$$

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

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

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

Using the curve equation we get,



$X_{exit} = 0.0349$.

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

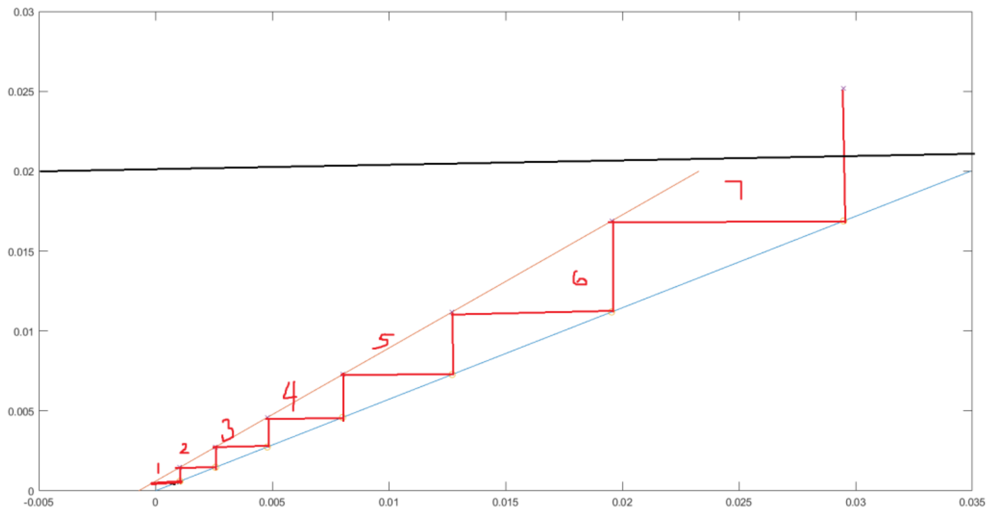
$\Rightarrow L_{s\,min} = 98$ kmol/h.

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 $\boxed{7}$.

Question 2: Graph + Code




```
close all;
Vs = 176.4;
Yentry = 0.02;
Yexit = 0.03*0.02;
Xentry = 0;
gamma = 6;
P = 110*10^3;
pvap = 10.5 * 10^3;
k = P/gamma/pvap;
X = @(Y)(k*Y);
Xexit = X(Yentry);
Lsmin = Vs*((Yentry-Yexit)/(Xexit));
Ls = 1.5*Lsmin;
m = Ls/Vs;
i = 0;
y = Yexit;
xcoords = zeros(1,3);
ycoords = zeros(1,3);
ycoords2 = ycoords;
while y <= Yentry
    i = i + 1;
    x = X(y);
    xcoords(i) = x;
    ycoords(i) = y;
    y = 0.03*0.02 + m*(x);
    ycoords2(i) = y;

end
ys = 0:0.0005:0.02;
xs = (ys - 0.03*0.02)/m;
plot(X(ys),ys,xs,ys,xcoords,ycoords,'o',xcoords,ycoords2,'x');
```