HW8_3

April 11, 2022

1 Homework 8

1.1 Problem 3.a

Calculate the minimum value for $\frac{L'}{V'}$

$\frac{L'_{min}}{V'}$ is found by where the operating line intersects the equilibrium curve. In this case, the op line will be tangent with the EQ curve because the EQ curve is concave down. Assuming a dilute solute, and the liquid feed is pure water,

$$L'_{min} = V' K_N \tag{1}$$

The data first needs to be converted into mole ratios. y is related to the partial pressure by

$$y = \frac{p_i}{P}$$

where p_i is the partial pressure and P is the system pressure.

[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
from scipy.interpolate import interp1d
```

[ ]:
```
P = 101
x = np.array([0,.033,.072,.117,.171])                    #ace/water
ppAce = np.array([0,30,62.8,85.4,103])*.133322                 #kpa
y = ppAce/P
X = x/(1-x)
Y = y/(1-y)
xinterp = interp1d(Y,X)
```

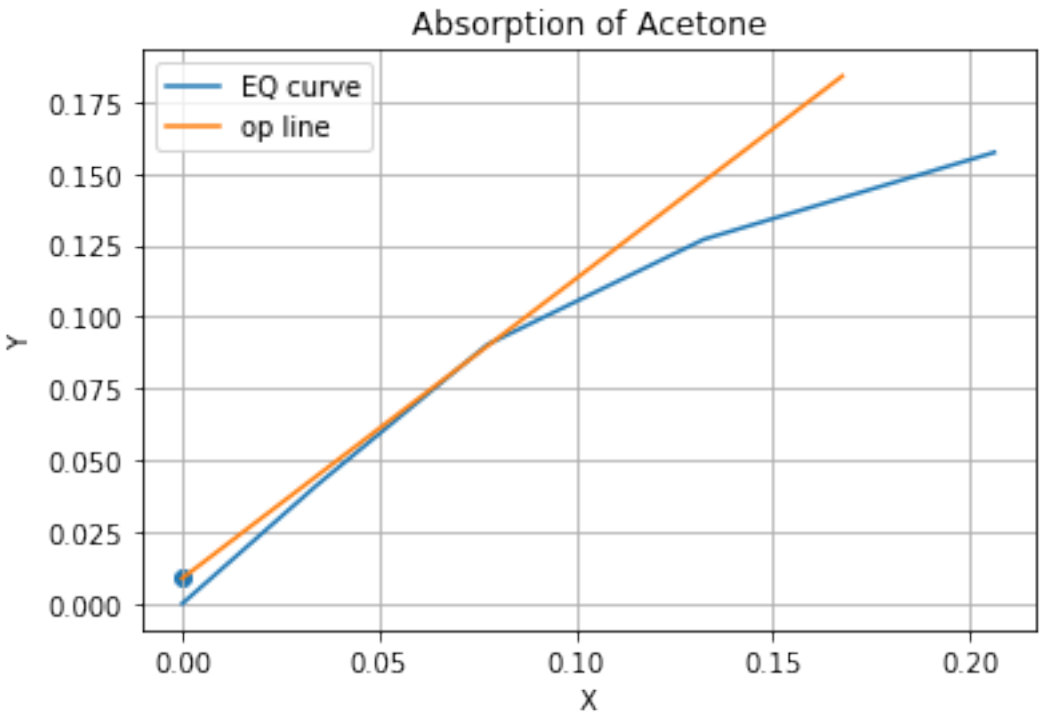
[ ]:
```
yNp1 = .15                                                      #mol␣
 ↪frac vap feed
YNp1 = yNp1/(1-yNp1)
XN = .95*YNp1                                                    ␣
 ↪#acetone absorbed in liquid exit
Y1 = .05*YNp1                                                    ␣
 ↪#acetone in vap exit
Vp = .85/.15
```

```
X0 = 0                                                          #pure␣
 ↪water
```

[ ]:
```
xN = XN/(1+XN)
KN = yNp1/xN
Lpmin = Vp*KN                                                   #assume␣
 ↪dilute

slope = Lpmin/Vp

def Ynp1(Xn,m):
    return (Xn-X0)*m+Y1
dep = np.linspace(X0,XN)
```

[ ]:
```
plt.plot(X,Y,label='EQ curve')
plt.scatter(X0,Y1)
plt.plot(dep,Ynp1(dep,slope),label='op line')
plt.grid()
plt.legend()
plt.title('Absorption of Acetone')
plt.xlabel('X')
plt.ylabel('Y')
;
```

[ ]:
```
''
```



The minimum value for $\frac{L'}{V'}$ is about 1.045.

1.2 Problem 3.b

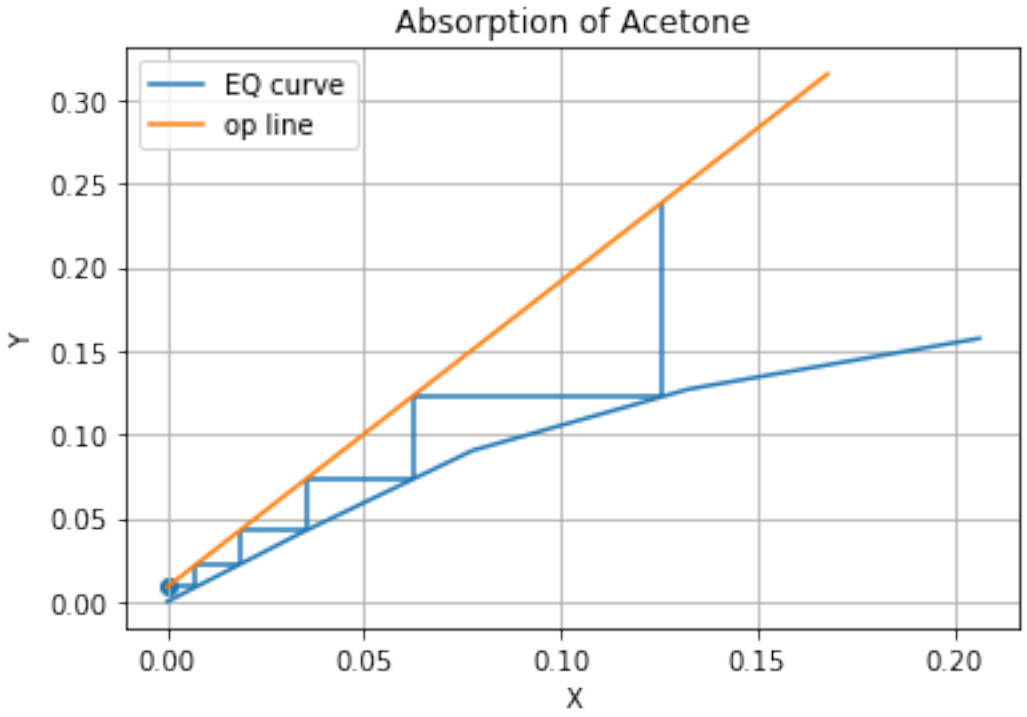
Calculate N_t if using $1.75L'_{min}$

The number of equilibrium stages can be found by plotting the EQ curve and op line and drawing in the lines to connect them.

[ ]:
```
slope2 = 1.75*slope

plt.plot(X,Y,label='EQ curve')
plt.scatter(X0,Y1)
plt.plot(dep,Ynp1(dep,slope2),label='op line')

x1 = xinterp(Y1)
 ↪#lines connecting eq and op lines
y1 = Ynp1(x1,slope2)
x2 = xinterp(y1)
y2 = Ynp1(x2,slope2)
x3 = xinterp(y2)
y3 = Ynp1(x3,slope2)
x4 = xinterp(y3)
y4 = Ynp1(x4,slope2)
x5 = xinterp(y4)
y5 = Ynp1(x5,slope2)

plt.hlines(Y1,X0,x1)
plt.vlines(x1,Y1,y1)
plt.hlines(y1,x1,x2)
plt.vlines(x2,y1,y2)
plt.hlines(y2,x2,x3)
plt.vlines(x3,y2,y3)
plt.hlines(y3,x3,x4)
plt.vlines(x4,y3,y4)
plt.hlines(y4,x4,x5)
plt.vlines(x5,y4,y5)

plt.grid()
plt.title('Absorption of Acetone')
plt.xlabel('X')
plt.ylabel('Y')
plt.legend()
print(Ynp1(XN,slope2))
print(XN)
;
```

```
0.3153308823529412
0.16764705882352943
```

```
[ ]: ''
```



6 equilibrium stages are needed for $1.75L'_{min}$

1.3 Problem 3.c

Calculate mole fraction of acetone in exit water.

x_N can be found by the relationship

$$x_N = \frac{X_N}{1 + X_N}$$

X_N is described in the problem statement to be 95% of the acetone in the vapor feed. x_N was solved for previously to be about 0.144