Homework 8

Problem 2.1

Determine minimum $\frac{L'}{V'}$ using the same data as problem 1.

The minimum value of $\frac{L'}{V'} can be found with the equation$

$$L'_{min} = \frac{V'(Y_{N+1} - Y_1)}{\frac{Y_{N+1}}{Y_{N+1}(K_N - 1) + K_N} - X_0} \tag{1}$$

$

where Y_{N+1}, X_0, Y_1, and V' are used in problem 1 and $K_N = \frac{y_{N+1}}{x_N}$.

In [ ]:

```
import numpy as np
import scipy.interpolate as interp
import matplotlib.pyplot as plt
```

In [ ]:

```
Vp = .9
YNp1 = .1/.9
Y1 = .216*YNp1
XN = .08763
yNp1 = YNp1/(1+YNp1)
xN = XN/(1+XN)
KN = yNp1/xN
X0 = .04
LpMin = Vp*(YNp1-Y1)/(YNp1/(YNp1*(KN-1)+KN)-X0)

flow = LpMin/Vp
# print(flow)
```

$\frac{L'}{V'} = 1.83$

Problem 2.2

Determine the number of stages if twice the minimum flow rate is used.

The number of stages can be found graphically similarly to the process in problem 1. The equilibrium data is plotted and the operating line can be determined by X_0, Y_1, and $\frac{L'}{V'}$. The lines can then be drawn in to connect the equilibrium curve and operating line.

In [ ]:

```
X = np.array([.01,.02,.03,.04,.05,.06,.07,.08,.09,.1,.11])
Y = np.array([.003,.008,.015,.023,.032,.043,.055,.068,.083,.099,.12])


xinterp = interp.interp1d(Y,X,kind='cubic')
slope = 2*flow

def Ynp1(XN):
```

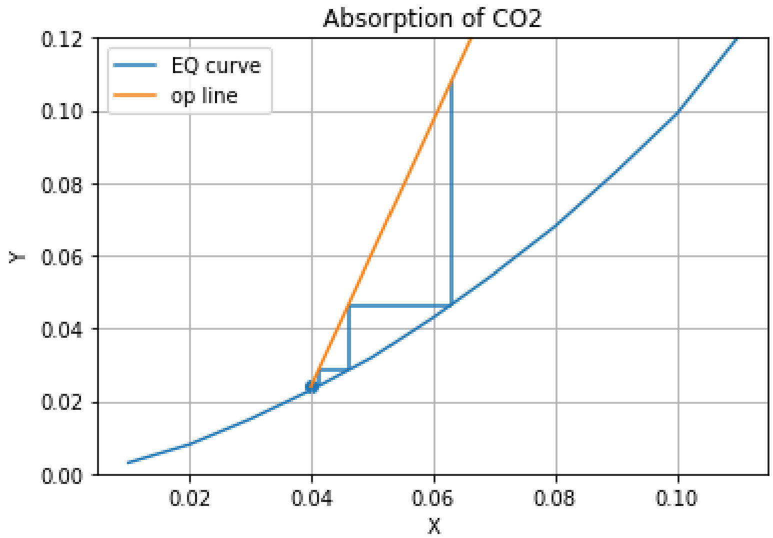
```
    return (XN-X0)*slope+Y1
dep = np.linspace(X0,.11)
# print(slope)
```

In [ ]:

```
plt.plot(X,Y,label='EQ curve')
plt.scatter(X0,Y1)
plt.plot(dep,Ynp1(dep),label='op line')
plt.grid()
plt.ylim(0,.12)

x1 = xinterp(Y1)                                                           #lines co
y1 = Ynp1(x1)
x2 = xinterp(y1)
y2 = Ynp1(x2)
x3 = xinterp(y2)
y3 = Ynp1(x3)
# x4 = xinterp(y3)
# y4 = Ynp1(x4)
# x5 = xinterp(y4)
# y5 = Ynp1(x5)
# x6 = xinterp(y5)
# y6 = Ynp1(x6)
# x7 = xinterp(y6)                                                       # only has
# y7 = Ynp1(x7)



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.title('Absorption of CO2')
plt.ylabel('Y')
plt.xlabel('X')
plt.legend()

;
```

Out[ ]:

```
''
```



3 theoretical stages are required for this process.

Problem 2.3

Determine number of actual trays needed if each stage has an efficiency of 40%

The efficiency is found by

$$E = \frac{N_t}{N_a} \tag{2}$$

which means that $N_a = \frac{3}{0.40} = 7.5$ so 8 actual trays are required.