HW7_1

March 29, 2022

1 HW 7

1.1 Problem 1

Plot bubble point temperature for butanes and pentanes as a function of pressure

The bubble point temperature is found by

$$\sum_{i=1}^{C} z_i K_i = 1 \tag{1}$$

where Raoult's law can be used to find K_i

$$K_i = \frac{P_i^{sat}}{P} \tag{2}$$

and the saturated pressure can be found using the Antoine equation

$$log(P) = a - \frac{b}{c+T} \tag{3}$$

The temperature can be solved numerically by iterating T at a specified P in (2) and (3) until (1) holds true.

Component	$z_i = x_i$	a	b	c
i-Butane	0.0319	4.3281	1132.108	0.918
n-Butane	0.7992	4.35576	1175.581	-2.071
i-Pentane	0.1041	3.97183	1021.864	-43.231
n-Pentane	0.0648	3.9892	1070.617	-40.454

[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
import scipy.optimize as opt
```

[ ]:
```
def antoine(a,b,c,T):                                    #T in k
    return (10**(a-b/(T+c)))*.986923                  #return pSat in atm

p = np.linspace(.5,5)                                    #domain of pressure
```

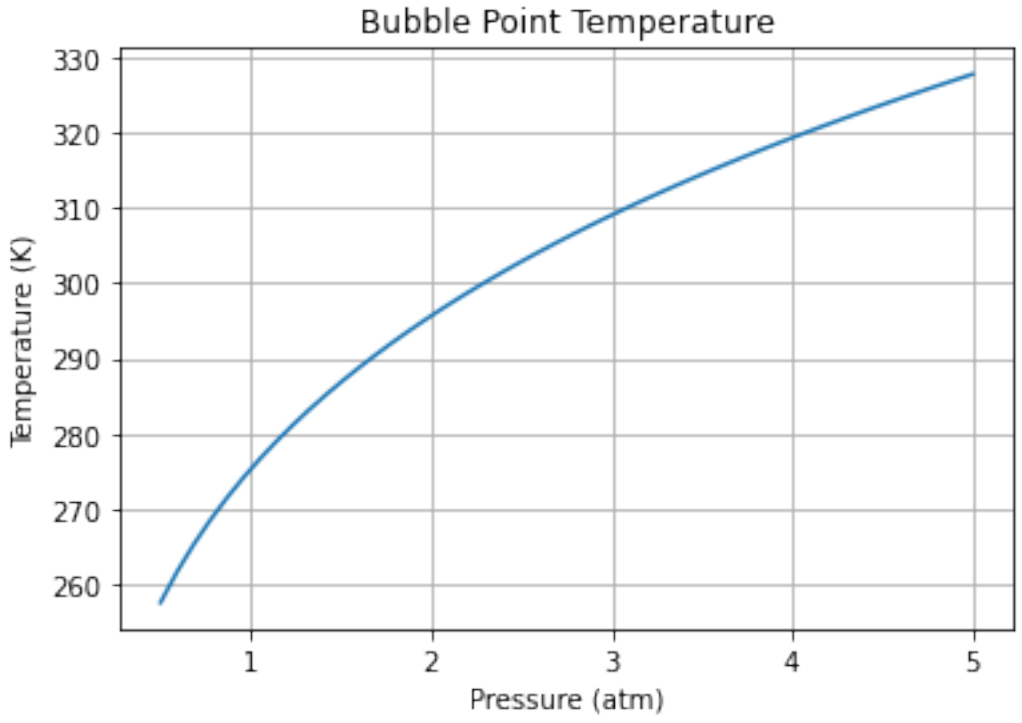
```
a = np.array([4.3281,4.35576,3.97183,3.9892])          #constants taken from
 ↪nist
b = np.array([1132.108,1175.581,1021.864,1070.617])
c = np.array([0.918,-2.071,-43.231,-40.454])

zi = np.array([.0319,.7992,.1041,.0648])
```

[ ]:
```
def resFun(T,p):                                       #using raoults law to
 ↪get ki
    Ki = antoine(a,b,c,T)/p
    kz = np.sum(Ki*zi)-1                                   #sum ki,zi
    return kz

T = []
for i in p:                                            #array of T for every p
    T.append(opt.fsolve(resFun,300,i))

plt.plot(p,T)
plt.title('Bubble Point Temperature')
plt.ylabel('Temperature (K)')
plt.xlabel('Pressure (atm)')
plt.grid();
```



The bubble point temperature increases non-linearly as pressure increases.