**Example**

A mixture of 100 k mole which contain 60% mole percent n-pentane and 40% n-heptane are vaporized at 101.32 kpa pressure under different conditions unitl 60 k mole is distilled .

1. what is the average composition of total vapour distillated (Xd) and composition of the liquid (Xw), the equilibrium is given as:

xA 1 0.86 0.59 0.398 0.25 0.195 0.059

yA 1 0.98 0.925 0.856 0.701 0.521 0.271

1. Repeat (a), if the equilibrium data is given by the yA =1.8 xA
2. Repeat (a), if the relative volatility αAB = 5.8

**Solution**

1. Let A n-pentane , F =100 k mole , Xf =60%= 0.6 , D = 60 k mole

W=F-D W = 100-60 =40 k mole

xA yA  1 / (xA - yA)

0.6 0.92 3.125

0.5 0.89 2.56

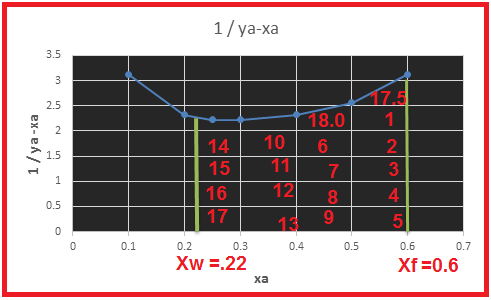
0.4 0.83 2.32

0.3 0.75 2.22

0.25 0.7 2.22

0.2 0.63 2.32

0.1 0.42 3.12



Area under the curve = 18 \* 0.1 \* 0.5 = 0.9

From the curve Xw = 0.22

DXd =FXf – W Xw , Xd = 100(0.6) – 40(0.22) / 60 = 0.853

1. If the eq. data is given y = mx+C , yA =1.8 xA

**ln F / W = -1 / m-1 ln[ (m-1) xm +c / (m-1) xf +c ] , mx 1.8 , c=0**

ln 100/ 40= -1 / 0.8 ln 0.8 Xw / 0.8 Xf , Xw =0.288

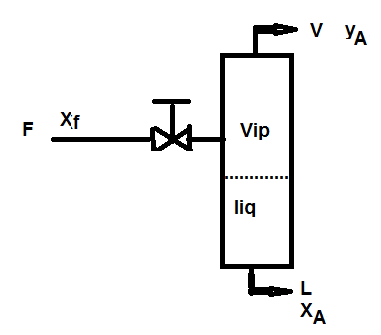
Xd= FXf-WXw / D = 100(0.6)-40(0.288) / 60 =0.808

1. If the αAB is given αAB = 5.8

**-0.916=1 / 5.8-1 ln [ xw(1-0.6) / 0.6(1-xw)]+ ln [ (1-0.6) / (1-xw)]**

**Xw = 0.26 by try and error , assume the Xw less than Xf**

**Continuous / Flash distillation (Equilibrium distillation) :**



F = V + L , F Xf = V yA + L XA , where

F = mole per unit time of feed of mole fraction Xf of A

V = mole per unit time of vapour formed with yA , the mole fraction of A

L = mole per unit time of liquid with XA, the mole fraction of A

**Example /** Amixture of 100 kmole which contain 60% mole percent n-pentaine and 40% n-heptane is vaporized at 101.32 kpa pressure in an equilibrium or / flash distillate and 40 kmole are distillated , what is the composition of the vapour distillated yA and of the liquid left XA, U.L.E is as in α

XA  1` 0.86 0.59 0.398 0.25 0.145 0.059

yA 1 0.98 0.925 0.836 0.701 0.521 0.271

**Solution**

Flash equilibrium distillation single stage distillation . F= 100 kmole , D= 40 kmole

F = W+D , F Xf = V yA + L XA , then 100(0.6)= 60(Xw)+ 40 (Xd)

Let Xw= 0.43 less than 0.6 Xf

100(0.6)= 60(0.43) + 40(Xd) , then Xd = 0.855 ≈ 0.86 in the table

60 = 25.8+ 34.2 because Xd ≈ 0.86 and Xw= 0.43

**Continuous distillation**

Rectification can be classified in to two parts

1. Binary ( two components) 2- Multi components

The operation of a typical fractionating column may be followed by reference to Figure 9. The column consists of a cylindrical structure divided into sections by a series of perforated trays which permit the upward flow of vapour. The liquid reflux flows across each tray, over a weir and down a downcomer to the tray below. The vapour rising from the top tray passes to a condenser and then through an accumulator or reflux drum and a reflux divider, where part is withdrawn as the overhead product D, and the remainder is returned to the top tray as reflux R.



**Fig .9 Continuous fractionating column with rectifying and stripping sections**

**Number of plates required in a distillation column :**

There are two basic methods for determining the number of plates required. The first is due to SORELand later modified by LEWIS*,* and the second is due to MCCABE and THIELE*.* The Lewis method is used here for binary systems. This method is also the basis of modern computerised methods. The McCabe–Thiele method is particularly . important since it introduces the idea of the operating line which is an important common concept in multistage operations.

1. LEWIS –SOREL ( equations)
2. McCabe–Thiele method ( charts)
3. **McCabe–Thiele method ( charts)**
4. **Top operating line**



At top , the materials balance the above number of plats (n): Vn = L n+1 + D

yn Vn= Xn+1 L n+1 Xd D then yn=( Ln+1 / Vn ) Xn+1 +( D / Vn)Xd  , since the molar liquid over flow is constant, then ( Ln = Ln+1) , therefore yn=( Ln / Vn ) Xn+1 +( D / Vn) Xd , if Xn+1 = Xd Then yn=( Ln / Vn ) Xd +( D / Vn) Xd

first point (Xd , Xd) , second point ( 0, Xd / Rt ) or (0, D Xd / Vn)