

Mass Transfer – I (CH21202)
Tutorial Sheet No.: MT-I/NCP/2023/3

1. A liquid mixture containing 60 mol% n-pentane and 40 mol% n-heptane is vaporized at 1 std atm pressure under differential distillation condition until 40 mol% of the mixture is distilled. What is the average composition of the total vapour distilled and the composition of the liquid left?

If the same amount of vaporization is done in an equilibrium or flash distillation, what will be the composition of the vapour distilled and the composition of the liquid left?

Equilibrium Data:

x	0.0	0.059	0.145	0.254	0.398	0.594	0.867	1.00
y	0.0	0.271	0.521	0.701	0.836	0.925	0.984	1.00

Ans. For DD, $x_W = 0.40$, $y_{D,avg} = 0.90$; For FD, $x_W = 0.437$, $y_D = 0.86$

2. A liquid mixture containing 40 mol% n-heptane (A), 60 mol% n-octane (B), at 30°C, is to be continuously flash vaporized at 1 std atm pressure to vaporize 50 mol % of the feed. What will be the composition of the vapour and liquid?

If the same liquid mixture is subjected to differential distillation at atmospheric pressure with 50 mol% of the liquid distilled, what will be the composition of the composited distillate and the residue?

Temperature-Vapour pressure Data:

Temp.(°C)	98.4	105	110	115	120	125.6
P _A (mm Hg)	760	940	1050	1200	1350	1540
P _B (mm Hg)	333	417	484	561	650	760

Ans. For FD, $x_W = 0.31$, $y_D = 0.48$; For DD, $x_W = 0.272$, $y_{D,avg} = 0.528$

3. 100 moles of n-heptane and n-octane mixture containing 50% (mole) n-heptane is subjected to a differential distillation at atmospheric pressure till 50 mol % of the feed is distilled. Assuming the average relative volatility as 2.16, what will be the average concentration of n-pentane in the distillate?

Ans. $y_{D,avg} = 0.63$

4. 100 moles of acetonitrile-nitromethane mixture is differentially distilled in a batch still at a pressure of 75 kPa. The feed contains 60 mole% acetonitrile. Distillation is continued till the liquid left behind in the still contains 30 mole% acetonitrile. The vapour-liquid equilibria for the system at this pressure are correlated as follows:

$$y^* = 1.12x + 0.15 \text{ for } 0.2 \leq x \leq 0.4 \text{ and}$$

$$y^* = 0.76x + 0.25 \text{ for } 0.4 \leq x \leq 0.7,$$

where x and y^* refer to the mole fractions of acetonitrile in the liquid and equilibrium vapour, respectively. Find the average composition of the distillate collected.

Ans. $y_{D,avg} = 0.643$

5. An ideal solution containing 10% methanol (A), 80% ethanol (B) and 10% n-propanol (C) is flash vaporized at 80°C and 1 atm pressure. Compute the amount of liquid and vapour products and their composition. Given the vapour pressures of A, B and C at 80°C as 1302 mm Hg, 787 mm Hg and 364 mm Hg, respectively.

Ans. D = 60.0%, W = 40.0%, $x_{A,W} = 0.0701$, $x_{B,W} = 0.7833$; $x_{C,W} = 0.1456$; $y_{A,D} = 0.1193$; $y_{B,D} = 0.8111$, $y_{C,D} = 0.0696$.

