Distillation

The separation of liquid mixtures into their various components is one of the major operations in the process industries, and distillation, the most widely used method of achieving this end, is the key operation in any oil refinery. In processing, the demand for purer products, coupled with the need for greater efficiency, has promoted continued research into the techniques of distillation. In engineering terms, distillation columns have to be designed with a larger range in capacity than any other types of processing equipment, with single columns 0.3–10 m in diameter and 3–75 m in height .

**VAPOUR–LIQUID EQUILIBRIUM**

The composition of the vapour in equilibrium with a liquid of given composition is determined experimentally using an equilibrium still. The results conveniently shown on a temperature–composition diagram as shown in Figure 7. In the normal case shown in Figure 7*a*

 

Separation of a binary mixture Multicomponent separation



**Partial pressures, and Dalton’s, Raoult’s and Henry’s laws**

The partial pressure *PA* of component **A** in a mixture of vapours is the pressure that would be exerted by component **A** at the same temperature, if present in the same volumetric concentration as in the mixture.

By Dalton’s law of partial pressures, *P* = *∑PA*, that is the total pressure is equal to the summation of the partial pressures. Since in an ideal gas or vapour the partial pressure is proportional to the mole fraction of the constituent, then:

 For an *ideal mixture*, the partial pressure is related to the concentration in the liquid phase by Raoult’s law which may be written as:

 where *P A* is the vapour pressure of pure **A** at the same temperature



Fig.8 Partial pressures of non-ideal mixtures

**Various temperatures**





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**Example**

The vapour pressures of *n*-heptane and toluene at 373 K are 106 and 73*.*7 kN/m2 respectively. What are the mole fractions of *n*-heptane in the vapour and in the liquid phase at 373 K if the total pressure is 101*.*3 kN/m2?

Solution :

