



Fig. 2.3: The plot of vapour pressure and mole fraction of an ideal solution at constant temperature. The dashed lines I and II represent the partial pressure of the components. (It can be seen from the plot that p_1 and p_2 are directly proportional to x_1 and x_2 , respectively). The total vapour pressure is given by line marked III in the figure.

A plot of p_1 or p_2 versus the mole fractions x_1 and x_2 for a solution gives a linear plot (Fig 2.3). Graphs showing the variation between partial vapour pressures and the corresponding mole fraction for the components A and B for a binary solution.

- 1) Straight line (I) indicated by dotted line shows variation in vapour pressure with change in mole fraction for component 1. When, $x_1 = 1$ (Component is pure), then $p_1 = p_1^\circ$, $x_1 = p_1^\circ$. When, $x_1 = 0$ (Component is absent) then $p_1 = p_1^\circ x_1 = 0$.

- 1) ~~Straight~~ This means that the vapour pressure of component 1 is ~~at~~ maximum when $x_1 = 1$ and is zero when $x_1 = 0$.

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where P_1
ii) Straight line (II) also indicated by dotted line represents the variation in vapour pressure with change in mole fraction for component II.

when, $x_2 = 1$ (Component 1 pure), then $P_2 = p_2^\circ x_2 = p_2^\circ$

when, $x_2 = 0$ (Component 2 is absent) then $P_2 = p_2^\circ x_2 = 0$

This means that the vapour pressure of component 2 is maximum when $x_2 = 1$, and is zero when $x_2 = 0$.

iii) The total vapour pressure P of the solution is indicated by normal line (III) is the linear sum of partial vapour pressure of volatile components I and II present in solution.

$$P = P_1 + P_2 = p_1^\circ x_1 + p_2^\circ x_2$$

The minimum value of P_{total} is p_1° and the maximum value is p_2° , assuming that component 1 is less volatile than component 2, i.e., $p_1^\circ < p_2^\circ$.

4.2. Mole fraction in vapour phase: It is determined by partial pressure of components.

y_1 & y_2 = mole fractions of components 1 & 2 in vapour phase; Using Dalton's law of partial pressure

$$p_1 = y_1 p_{\text{total}} \quad \text{---} \quad \textcircled{v}$$

$$p_2 = y_2 p_{\text{total}} \quad \text{---} \quad \textcircled{v}$$

4.3. Raoult's law as a special case of Henry's law.

According to Raoult's law, the vapour pressure of a volatile component in a given solution -

$$p_1 = x_1 p_1^{\circ}$$

According to Henry's law,

$$p = K_H \cdot x$$

On comparing, partial pressure of the volatile component or gas is directly proportional to its mole fraction in solution.