

Maximum boiling mixtures are those which show ⁽¹³⁾ negative deviation from Raoult's law. The composition have max. boiling point. eg HCl & water which boils at 108°C which is higher than that of pure water (100°C) and HCl (-85°C)

Colligative Properties: The properties of the solution which depend only on the number of solute particles but not on the nature of the solute are called colligative properties.

Four colligative properties are:

- 1) Relative lowering in vapour pressure
- 2) Elevation in boiling point.
- 3) Depression in freezing point
- 4) Osmotic pressure.

Colligative properties are useful in determining the molar mass or molecular wt of the non-volatile solute.

1) Relative lowering in vapour pressure:

$$\pi_B = \frac{P_A^\circ - P_A}{P_A^\circ}$$

$P_A^\circ - P_A$ diff in vapour pressure of pure solvent and solution.

The relative lowering in vapour pressure of an ideal solⁿ containing the non-volatile solute is equal to the mole fraction of the solute at a given temp.

Determination of Molar mass of a solute from Relative lowering in vapour pressure:

$$\frac{P_A^\circ - P_A}{P_A^\circ} = \pi_B \quad \text{where } W_A, W_B \text{ are weights of solvent and solute and } M_A \text{ \& } M_B \text{ are molar masses}$$

Mole fraction $\pi_B = \frac{n_B}{n_A + n_B}$ where n_A & n_B are moles of the solvent and solute.

$$n_A = \frac{W_A}{M_A}$$

$$n_B = \frac{W_B}{M_B}$$

$$x_B = \frac{w_B}{M_B} \div \left(\frac{w_B}{M_B} + \frac{w_A}{M_A} \right)$$

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molar con of solute is very less as it is applicable to ideal solⁿ.

$$\frac{w_B}{M_B} \ll \left(\frac{w_A}{M_A} \right)$$

$$\frac{w_A}{M_A} + \frac{w_B}{M_B} \approx \frac{w_A}{M_A}$$

$$x_B = \frac{w_B}{M_B} \div \frac{w_A}{M_A} = \frac{w_B \times M_A}{w_A \times M_B}$$

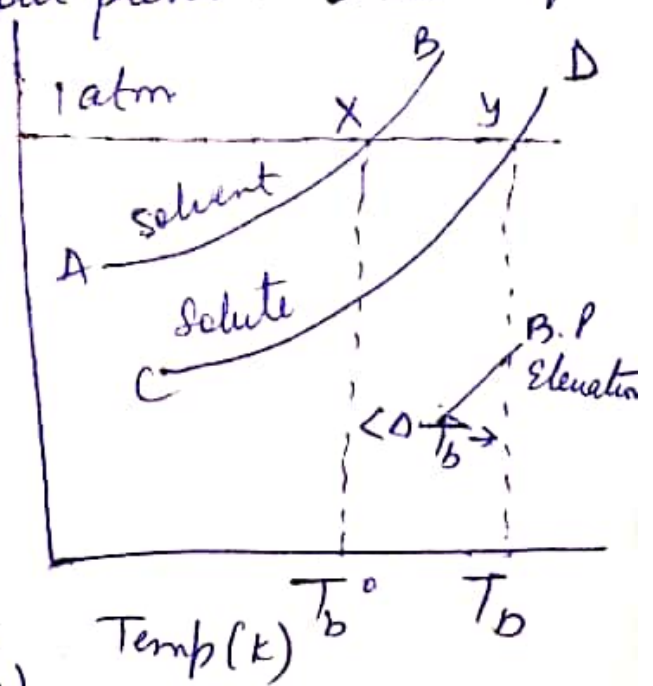
$$\frac{P_A^0 - P_A}{P_A^0} = \frac{w_B M_A}{w_A \times M_B}$$

$$M_B = \frac{w_B M_A}{w_A \left(\frac{P_A^0 - P_A}{P_A} \right)}$$

2) Elevation in Boiling point: Boiling point of a liquid is that temp at which its vapour pressure becomes equal to the atmospheric pressure.

The vapour pressure of pure solvent increase with rise in temp. V.P

The vapour pressure of pure solvent is greater than that of solution.



$$\Delta T_b = T_b - T_b^0$$

$$\Delta T_b \propto m \text{ (molality of solⁿ)}$$

$$\Delta T_b = K_b m \text{ (moles of solute in 1kg of solvent)}$$

K_b is molal boiling point elevation constant (Ebullioscopic Constant)

K_b is the elevation in B.P for 1 molal solⁿ i.e. a solution containing 1 gm mole of solute dissolved in 1000 gm of the solvent.

$$K_b = \frac{MRT_b^2}{\Delta H_{\text{vap}} \times 1000}$$

M = Molar mass of solvent
 T_b BP solvent & gas contact
 ΔH_{vap} molar enthalpy of vaporization of solvent.

Determination of molar mass of solute from elevation in B.P temp: To calculate the molar mass of an unknown non volatile compd a known amt of it is dissolved in known mass of suitable solvent & elevation in boiling point is determined.

Let W_B gm of a non volatile solute is dissolved in W_A gm of solvent and M_B is the molar mass of solute.

$$\text{molality } m = \frac{\text{moles of solute} \times 1000}{\text{wt of solvent in gm}}$$

$$\text{moles of solute} = \frac{W_B}{M_B}$$

$$m = \frac{W_B \times 1000}{M_B \times W_A}$$

$$\Delta T_b = \frac{K_b \times W_B \times 1000}{M_B \times W_A}$$

$$M_B = \frac{K_b \times W_B \times 1000}{\Delta T_b \times W_A}$$

A boiling point of pure water is 100°C . Calculate B.P of an aq solⁿ containing 0.6 gm of urea (molar mass = 60) in 100 gm of water (K_b for water = 0.52 K/m)

$$\Delta T_b = \frac{K_b \times W_B \times 1000}{M_B \times W_A}$$

$$K_b = 0.52, M_B = 60, W_B = 0.6 \text{ gm}, W_A = 100 \text{ gm}$$

$$\Delta T_b = \frac{0.52 \times 0.6 \times 1000}{60 \times 100 \times 10} \quad \Delta T_b = 0.052^\circ\text{C}$$

B.P of solⁿ = $100 + 0.052 = 100.052^\circ\text{C}$