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Deg I Chem. Hons, Paper – II

Topic :– Colligative Properties

Lowering of Vapour Pressure :–

The Pressure of vapour above liquid at a given temperature at equilibrium Point is called vapour pressure.

According to GayLussac, when a non-Volatile solute is dissolved in a liquid, the vapour pressure of the solution becomes lower than the vapour pressure of the pure Solvent.

Raoult, after a series of experiments on a number of solvents such as water, benzene and ether announced the following generalisation which is now known as Raoult's Law

"The relative lowering of vapour Pressure of a solution ie [Lowering divided by the vapour Pressure of Pure solvent] is equal to the mole fraction of the Solute in solution."

Mole fraction of a solute is defined as the ratio of the number of

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moles of the solute to the total number of moles of the solvent and solute present in a solution.

If n is the number of moles of the solute dissolved in N moles of a solvent then

Mole fraction of the solute $= \frac{n}{n+N}$

where P_0 is the vapour pressure of pure solvent and P is the vapour pressure of the solution

Then according to Raoult's Law

$$\frac{P_0 - P}{P_0} = \frac{n}{n+N}$$

Theoretical Proof :-

suppose the vapour pressure of the molecules of solvent on solution is P. Then this vapour pressure will be directly proportional to the number of molecules of solvent i.e P will be directly proportional to the mole fraction of the solvent

$$P \propto \frac{N}{n+N}$$

$$\therefore P = \frac{KN}{n+N} \quad \text{--- (1)}$$ where K is a constant

For Pure solvent $n=0$

$$\therefore \frac{N}{n+N} = \frac{N}{N} = 1$$

$$\therefore P_0 = K \times 1 = K$$

Putting the value of $K = P_0$ in equation (1)

$$P = \frac{P_0 N}{n+N}$$

$$\therefore \frac{P}{P_0} = \frac{N}{n+N} \qquad \text{———} \qquad (2)$$

subtracting both side of eq (2) from 1 we get

$$1 - \frac{P}{P_0} = 1 - \frac{N}{n+N}$$

$$\frac{P_0 - P}{P_0} = \frac{(n+N) - N}{n+N} = \frac{n}{n+N}$$

$$\text{or} \quad \frac{P_0 - P}{P_0} = \frac{n}{n+N}$$

Proved.