JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR
Faculty of Pharmaceutical Science

Faculty Name   -   JV'n Devendra Joshi

Course   -   B.Pharm (3rdsem)

Session   -   Physical Pharmaceutics –

(Raoult's law – Part I)

Academic Day starts with–

- Greeting with saying **'Namaste'** by joining Hands together following by 2-3 Minutes Happy session, Celebrating birthday of any student of respective class and **National Anthem**

RAOULT'S LAW

In an ideal solution volume changes are negligible. Dilute solutions show colligative properties. These properties are the factors that determine how properties of a bulk solution change depending upon the concentration of the solute in it. Colligative properties are properties of a solution that depend mainly on the relative numbers of particles of solvent and solute molecules and not on the chemical properties of the molecules themselves. These can almost be referred as statistical properties because they can be understood solely based on relative number of different particles in a solution. There are four types of colligative properties namely:

1. Lowering of vapour pressure.

2. Elevation of boiling point.

3. Depression of freezing point.

4. Osmotic pressure.

Colligative properties of non-electrolyte solutions are regular. The values of colligative properties are approximately equal for equimolar concentration of drugs. It is possible to determine the number of solute particles present in the solution by measuring these properties and comparing them with the corresponding properties of the pure solvent. If mass of solute present in known, the number average molecular weight can be calculated by dividing the mass of solute by number of particles present to obtain the average mass of particles.

Osmotic pressure is the most important colligative property since it is related with physiological compatibility of parentral, ophthalmic and nasal solution. It is difficult and inconvenient to measure osmotic pressure and therefore other colligative properties are determined and related to osmotic pressure.

In the following section equations for colligative properties of ideal solution are derived and are validated for this type of solutions. These equations can be applied to real solutions with respect to limit of small concentrations. While using these equations for real (non-ideal) solutions it requires correction to be made to these ideal equations because in real solutions there exist intermolecular interactions.

Lowering of Vapour Pressure:

Lowering of vapour pressure is the simplest of the colligative properties and easiest to understand based on physical model. The pressure brought by vapour in equilibrium with its liquid at constant temperature is known as vapour pressure. It increases with temperature.

The vapour pressure of solvent is due to its escaping tendency. Temperature at which the vapour pressure of the liquid is equal to the atmospheric pressure is called as normal boiling point. The vapour pressure of pure liquid solvent depends upon the rate of escape of molecule from the surface known as escaping tendency. Solvents with greater escaping tendencies have greater vapour pressure.

The added solute is generally non-volatile which does not contribute directly to the vapour pressure of the solution. The solute interferes and prevents solvent molecules fromescaping into the atmosphere. Therefore, the vapour pressure of solution is lower than that of pure solvent.

The lowering of vapour pressure is proportional to the number of solute particles or ions. The effect of non-volatile solute on the vapour pressure may be determined in dilute solutions by applying Raoult's law. It states that in an ideal solution the partial vapour pressure of each volatile constituent is equal to the vapour pressures of pure constituent at that temperature multiplied by its mole fraction in the solution. In equation form for two volatile constituent A and B, it can be expressed as

$$P_A = P°_A \, X_A$$

$$P_A = P°_B \;\; X_B$$

where,

P_A and P_B are partial vapour pressures,

$P° \, A$ and $P° \, B$ are vapour pressures of pure constituents and

X_A and X_B are mole fractions of the constituent A and B, respectively.

The total vapour pressure of solution is sum of partial vapour pressure of each volatile constituent. Therefore

$$P = P_A + P_B$$

Limitations of Raoult's Law:

Raoult's law work only for ideal solutions over entire range of concentrations. An ideal solution obeys Raoult's law. While applying this law to real solutions it has following limitations.

Real Solutions

In real solution, the concentration of solute is high and thus intermolecular forces between solute-solute and solute-solvent are predominant that slows down the escaping of solvent molecules from the surface. This causes deviation from Raoult's law because it is applicable only to dilute solutions where the forces between solute and solvent are exactly same as those between solvent-solvent molecules.

Nature of the Solute:

Raoult's law is applicable only for solutes which are non-volatile in nature. Volatile solutes can contribute for vapour pressure above the solution which may cause the deviation from Raoult's law. Raoult's law does not apply if the added solute associates or dissociates in solvent. If association takes place the number of particles or molecules decreases causing reduction in lowering of vapour pressure. On the contrary, if solute gets dissociated more number of particles or ions are formed. For example, when 1 mole of solid sodium chloride is added to water it dissociates to produce two moles of ions as Na^+ and Cl^-.

$Na^+ Cl^-$ (solid) $\square \rightarrow Na^+$ (aq) $+ Cl^-$ (aq).
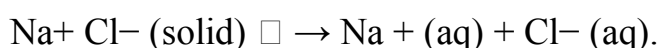
If 0.1 mole of sodium chloride is added to water its dissociation takes place to form 0.2 moles of particles in solution. Thus, it increases lowering of vapour pressure of solution.

REAL SOLUTIONS

Real solutions show change in the total volume of the solution upon mixing its

different components together. Also, there is absorption or evolution of heat during mixing and solution formation.

For example, at room temperature when 100 mL of sulfuric acid is mixed with 100 mL of water, the total volume of solution becomes 180 mL rather than 200 mL. During mixing of acid and water considerable heat is evolved causing reduction in total volume of the solution.

- **NextTopic-**

➢ Physical Pharmaceutics-I (Critical solutiontemperature and its applications – Part I)

- **Academic Day ends with-**

National song "Vande Mataram"

Reference

1.   Dr. Hajare A. Ashok A text book of physical pharmaceutics nirali prakashan first edition, july 2018