Chemistry Study Materials for Class 12 (NCERT Based Notes of Chapter -02)

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1. Osmosis and Osmotic Pressure

Osmosis is the process of flow of solvent molecules from pure solvent to solution through a semi-permeable membrane. Or, it is the flow of solvent molecules from lower concentration side to a higher concentration side through a semi-permeable membrane (SPM).

A membrane that allows the passage of solvent molecules only is called a semi-permeable membrane. E.g. egg membrane, all animal and plant membrane. Cellulose acetate is an example for artificial SPM.

Osmotic pressure is defined as the excess pressure that must be applied on solution side to stop osmosis. Or, it is the pressure that just stops the flow of solvent molecules. It is denoted by π. It is a colligative property, since it depends on the number of solute molecules and not on their nature.

For dilute solutions, osmotic pressure is proportional to the molarity (C) and temperature (T).

i.e. $\pi = CRT$

Here R is the universal gas constant. (R= 0.0821 Latm/K/mol or R = 0.083Lbar/K/mol).

But $C = n_2/V$, the concentration of the solution.

Therefore, $\pi = n_2.\frac{RT}{V}$

Or, $\pi V = n_2RT$

Or, $\pi V = \frac{w_2RT}{M_2}$

Where V is the volume of the solution, w_2 is the mass of solute and M_2 is the molar mass of solute.

Thus by knowing all other values, we can calculate the molar mass of the unknown solute by the equation:

$$M_2 = \frac{w_2RT}{V}$$

Advantages of osmotic pressure measurement over other colligative property measurement

1. Osmotic pressure measurement can be done at room temperature.
2. Here molarity of the solution is used instead of molality, which can be determined easily.
3. The magnitude of osmotic pressure is large even for very dilute solutions.
4. This method can be used for the determination of molar masses of Biomolecules (which are generally not stable at higher temperatures) and for polymers (which have poor solubility).

Examples for osmosis:

a) Raw mango placed in concentrated salt solution loses water and shrink.
b) Wilted flowers revive when placed in fresh water
c) Blood cells collapse when suspended in saline water.
d) The preservation of meat by salting and fruits by adding sugar protect against bacterial action. Through the process of osmosis, a bacterium on salted meat or candid fruit loses water, shrinks and dies.

Isotonic, hypertonic and hypotonic solutions

Two solutions having same osmotic pressure at a given temperature are called isotonic solutions.

When such solutions are separated by a semi-permeable membrane, *no* osmosis occurs.

For e.g. our blood cells are isotonic with 0.9% (mass/volume) sodium chloride solution, called ***normal saline solution***. So it is safe to inject intravenously.

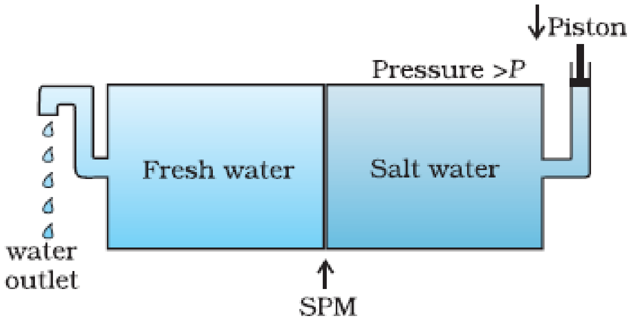
A solution having higher osmotic pressure than another is called hypertonic solution. While a solution having lower osmotic pressure than another is called hypotonic solution.

If we place our blood cells in a solution containing more than 0.9% (mass/volume) sodium chloride solution, water will flow out of the cells and they would shrink. On the other hand, if they are placed in a solution containing less than 0.9% (mass/volume) NaCl, water will flow into the cells and they would swell.

Reverse osmosis and water purification

The direction of osmosis can be reversed if a pressure larger than the osmotic pressure is applied to the solution side. Now the pure solvent flows out of the solution through the semi permeable membrane. This phenomenon is called reverse osmosis and is used in desalination of sea water.

When pressure more than osmotic pressure is applied, pure water is squeezed out of the sea water through the membrane. Commonly used SPM is cellulose acetate. A schematic representation of reverse osmosis is as follows:



ABNORMAL MOLARMASS

The molar mass obtained by colligative property measurement is incorrect, if there is association or dissociation of particles. Such molar masses are called abnormal molar masses.

For e.g. acetic acid dimerises in benzene due to hydrogen bonding. So the number of molecules in solution decreases and hence the colligative property decreases and molecular mass increases.

In order to correct the abnormal molar masses, van't Hoff introduced a factor called ***van't Hoff factor (i)***. It is defined as:

$$i = \frac{\text{Normal Molar mass}}{\text{Abnormal molar mass}}$$

Or, $$i = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

Or, $$i = \frac{\text{Total number of moles of particles after association/dissociation}}{\text{Number of moles of particles before association/dissociation}}$$

In the case of association, the value of $i < 1$ and in dissociation, the value of $i > 1$.

Thus for NaCl, i = 2, for K_2SO_4, i = 3, for $CaCl_2$, i = 3 and for acetic acid in benzene, i = ½

Inclusion of van't Hoff factor modifies the equations for colligative properties as follows:

1. Relative lowering of vapour pressure, $\frac{\Delta P}{P_1^0} = i \times \frac{w_2 \times M_1}{w_1 \times M_2}$
2. Elevation of Boiling point (ΔT_b) = $i.K_b.m$
3. Depression of freezing point (ΔT_f) = $i.K_f.m$
4. Osmotic Pressure (π) = i.CRT

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