Class ⇒ B.Sc. (Part-1) Hons.
Subject ⇒ Chemistry
Chapter ⇒ Physical properties of liquids.
Topic ⇒ Molar volume, vapour pressure.

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Molar volume

Molar volume of a substance is the occupied volume divided by the amount of substance at a given temperature and pressure.

Molar volume is denoted by symbol V_m and is equal to the Molar Mass (M) divided by the mass density (ρ).

$$V_m = \frac{M}{\rho}$$

For an ideal mixture containing N components, the molar volume is the weighted sum of the molar volumes of its individual components.

For a real mixture the molar volume cannot be calculated without knowing the density.

$$V_m = \frac{\sum_{i=1}^{N} x_i M_i}{\rho_{mixture}}$$

There are many liquid-liquid mixtures, for instance mixing pure ethanol and pure water, which may experience contraction or expansion upon mixing. This effect is called **excess volume**.

Units of Molar Volume

SI unit ⇒ cubic meters per mole (m^3/mol)

For gases

cubic decimeters per mole (dm^3/mol)

for liquid and solids

cubic centimeters per mole (cm^3/mol)

Vapour Pressure

The pressure exerted by the vapour in equilibrium with the liquid at that temperature is called vapour pressure of liquid.

Thus a dynamic equilibrium is established between the liquid and the vapour at the given temperature.

$$\text{Liquid} \rightleftharpoons \text{Vapour}$$

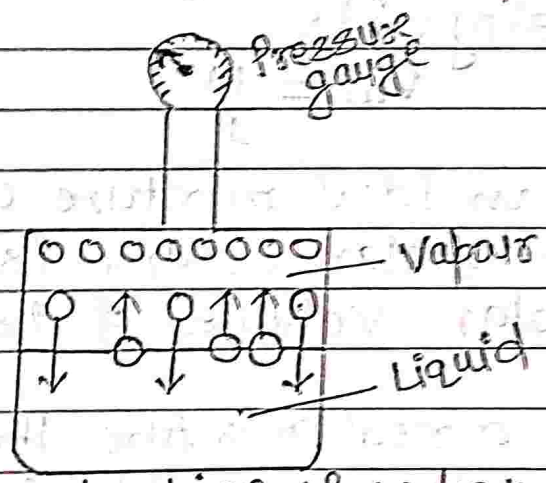

Fig: Illustration of vapour pressure.

Factors that affect the vapour pressure

1. Nature of the liquid ⇒ If the intermolecular forces of attraction in the liquids are weak, the molecules can easily leave the liquid and come into the vapour phase and hence the vapour pressure

is higher.

2. Effect of Temperature ⇒ If the temperature of the liquid is increased, the vapour pressure will increase.

This is so because at higher temperature more molecules in the liquid will have larger kinetic energy and will break away from the liquid surface. Therefore, the concentration of vapour molecules will increase before the equilibrium is re-established.

Effect of vapour pressure on Boiling points

The temperature at which the vapour pressure of the liquid is equal to the atmospheric pressure is called **Boiling point of the liquid.**

If the external pressure is higher, more heat will be required to make the vapour pressure equal to the external pressure and hence higher will be the Boiling point.

Similarly, if the external pressure is decreased, the boiling point is lowered.

Determination of vapour pressure

The vapour pressure of a given liquid is determined by two methods

(i) The static Method

(ii) The Dynamic Method

(i) The static Method ⇒ The difference in the levels of mercury in the manometer is equal to the vapour pressure of the liquid.

By adjusting the thermostat at different

temperature, the vapour pressure of the liquid at another temperature can be determined.

The static Method is used for liquids having vapour pressures up to one atmosphere.

(ii) The Dynamic Method ⇒ If V be the volume of the gas passed and m the loss in weight of the liquid, the vapour pressure is given by the expression,

$$\text{Vapour pressure} = \frac{m}{MV} \times RT$$

Where M = Molecular weight of the liquid
R = gas constant.

The Dynamic method is particularly suited for liquids of very low vapour pressure.

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