DALTON'S LAW OF PARTIAL PRESSURE

Dalton's law of partial pressure asserts that "at a specified temperature, the total pressure exerted by two or more non-reacting gases occupying a fixed volume is equal to the sum of the partial pressures of the individual gases."

$$P_{Total} = p_1 + p_2 + p_3 + \ldots\ldots \text{ (At constant V and T)}$$

$$= \left(\frac{n_1}{V} + \frac{n_2}{V} + \frac{n_3}{V} + \cdots\right)RT = (n_1 + n_2 + n_3 + \ldots\ldots)\frac{RT}{V} = \frac{nRT}{V}$$

Where $n = n_1 + n_2 + n_3 + \ldots\ldots$ = Total moles, V = Total volume

$$P_{Total} = \sum p_i = \frac{RT}{V}\sum n_i$$

Dalton's law of partial pressure is relevant exclusively to non-reacting gases. If two non-reacting gases, A and B, with nA and nB moles respectively, are placed in a vessel of volume V at temperature T, then...

$$PV = (n_A + n_B)\ RT \qquad \ldots(i)$$

Partial pressure may be calculated as

$$p_AV = n_ART,\ p_BV = n_BRT$$

Total pressure $(p_A + p_B)\ V = (n_A + n_B)RT \qquad \ldots..(ii)$

from (i) and (ii)

$$P = p_A + p_B$$

$$\frac{p_A}{P} = \frac{n_ART/V}{(n_A+n_B)RT/V} = \frac{n_A}{n_A+n_B} = x_A \text{ (mole fraction of A)}$$

$$p_A = x_A \times P, \text{ similarly } p_B = x_B \times P$$

Partial pressure of a component = Mole fraction × total pressure.

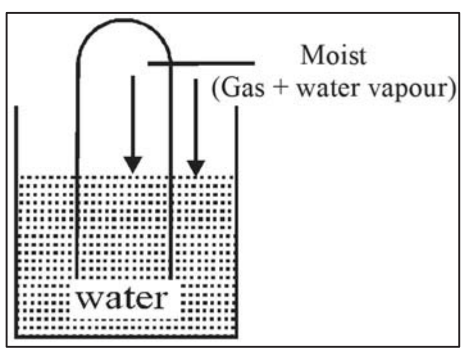
It has been observed that gases are generally collected over water and therefore are moist.

$$P_{dry\ gas} = P_{moist\ gas} - P_{water\ vapour}$$

The constant pressure exerted by water vapor when in equilibrium with water at a specific temperature is termed vapor pressure, and it directly correlates with the temperature, reaching 760 mm at 100ºC.

$$\text{Relative Humidity (RH)} = \frac{\text{Partial pressure of water in air}}{\text{Vapour pressure of water}}$$

Pressure of dry gas = Pressure of moist gas – aqueous tension.



Ex. A mixture of NO_2 & CO having total volume of 100 ml contains 70 ml of NO_2 at 1 atm, mixture is left for some time and same NO_2 get dimerized to N_2O_4 such that final volume of the mixture become 80 ml at 1 atm, calculate the mole fraction of NO_2 in final equilibrium mixture.

Sol. Initial volume of NO_2 = 70 ml

Initial volume of CO = 100 – 70 = 30 ml

Final volume of mixture = 80 ml

Let the volume of NO_2 in final mixture be x

Let 'v' ml NO_2 be converted to N_2O_4

$$2NO_2 \rightarrow N_2O_4$$
$$V \qquad \frac{V}{2}$$

Hence final volume

= volume of CO + volume of NO_2 left + volume of N_2O_4 formed

= 30 + 70 – V + V/2 = 80

V = 40 ml

Hence volume of NO_2 left = 70 – V = 30 ml

Now as: volume $\propto$ moles

$\therefore$ mole fraction = volume fraction $= \frac{30}{80} = \frac{3}{8}$