

Henry's Law

Solutions of Gases in Liquids

Most of gases are soluble in water or in some other liquid to a more or less extent. The

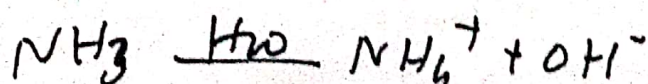
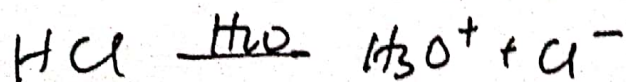
solubility of gas referred to as absorption of gas in liquid.

— Solubility of a gas in liquid depends upon following factors.

(1) Nature of gas & Nature of solvent ⇒ Gases which are easily liquified are more soluble in common solvent. $\text{CO}_2 > \text{O}_2 > \text{H}_2$

— The gases which are capable of forming ions in aqueous solution are much more soluble in water than other solvent.

e.g. HCl or NH_3 are more soluble in H_2O but not in benzene



(ii) Effect of Temperature \Rightarrow

At a given pressure, Rise of Temperature decreases inter-molecular interaction hence gas solubility decreases

(iii) Effect of Pressure \Rightarrow

Solubility of Gas in liquid at constant Temp varies with Pressure

Henry's law \Rightarrow It is Law regarding solubility of Gas in liquid

- It states that the mass of a gas dissolved per unit volume of a solvent is proportional to the pressure of gas in equilibrium with the solution at constant Temperature

$$m \propto P$$
$$m = k P$$

where k is called proportionality constant

- Henry's Law is also stated as

The pressure of a gas over a solution in which the gas is dissolved is proportional to the mole fraction of the gas dissolved in the solution at constant temperature

$$P_{\text{gas}} = K_H X$$

$X_{\text{gas}} = \frac{n_{\text{gas}}}{n_{\text{gas}} + n_{\text{H}_2\text{O}}}$

P_{gas} → Pressure of gas
 X → mole fraction of gas

where K_H = Henry's Law Constant
 Unit of K_H = atm.

- At a given pressure & temperature for a solvent, greater the solubility of gas less will be value of Henry's Law Constant

ex. $\text{H}_2 > \text{N}_2 > \text{O}_2 > \text{CO}_2$

order of K_H

solubility ← ← ←

From Dalton's law section

partial pressure of gas = mole fraction in vapour state ×

$$P_{\text{gas}} = X_{\text{gas}} \times P_{\text{atm}}$$

Total Pressure

Limitation of Henry's Law

- (i) This law not valid when pressure is too high
- (ii) This law is not valid when ~~press~~ Temp is too low
- (iii) Gas should not react with solvent. i.e. law is not applicable when gas reacts with solvent.
- (iv) It is not obeyed when gas is highly soluble due to reaction of gas with solvent. hence suitable for solubility of gas in non ionizing solvent

30 Application of Henry's law

(i) Solubility of CO_2 in water in soft drink is ~~not~~ using high pressure

Low $P \rightarrow$ low solubility
high $P \rightarrow$ high solubility

(ii) Low concentration of O_2 in blood & tissues at higher altitude due to low pressure at higher level than ground level.

\rightarrow It causes anoxia which causes thinking capacity in human

(iii) Deep sea divers (Scuba divers) uses compressed air for breathing under water. compressed air is more soluble with blood & tissue & used in metabolism ~~to~~ except ~~the~~ N_2 unreacted.

Therefore Decompression sickness or bends = muscle pain, joint pains are caused due to evolution of N_2 when comes at surface level at normal pressure.

(iv) While breathing, O_2 of air combines with haemoglobin to form oxy haemoglobin at high pressure of O_2 . In Tissue Partial pressure of O_2 is low hence released for cellular activities