

Effect of pressure on solubility of gas in liquid (Henry's Law)

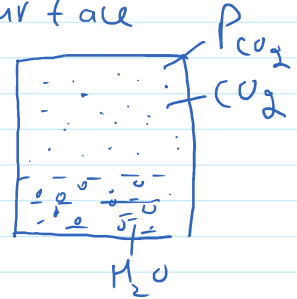
Solubility of a gas in a liquid is directly proportional to partial pressure of gas above liquid surface

$$P \propto \text{solubility}$$

Normally solubility is expressed as mole fraction

$$P \propto x$$

$x \rightarrow$ mole fraction of gas in liquid



$$P = k_H x$$

$k_H \rightarrow$ Constant of proportionality (Henry's constant)

Units of k_H

$$\text{atm} = k_H (\text{unitless})$$

$$k_H = \text{atm} / \text{bar} / \text{torr} / \text{mm Hg}$$

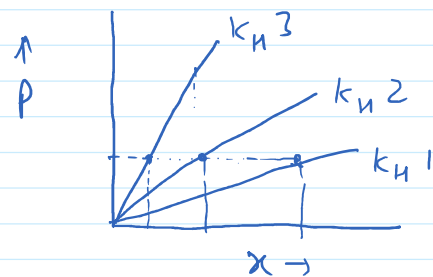
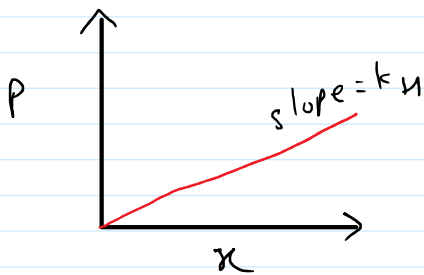
$\Rightarrow k_H$ has same units as of pressure.

But in some case units of k_H may vary depending upon solubility term used. Example:

$$P = k_H (\text{molarity})$$

$$k_H = \frac{P}{m} = \frac{\text{atm}}{\text{mol}} \text{kg}$$

Graph



Characteristics of k_H

i) Higher is value of k_H , lower is solubility of gas.

$$P = k_H x, \quad x = \frac{P}{k_H}$$

- ii) Different gases have different k_H for same solvent.
- iii) Same gas has different k_H for different solvent.
- iv) Value of k_H increases with increase of temperature

Limitations of Henry's law

- i) Pressure of the gas should not be too high or temperature of the gas should not be too low.
- ii) Gas should not be highly soluble in solvent.
- iii) Gas should not react with solvent.

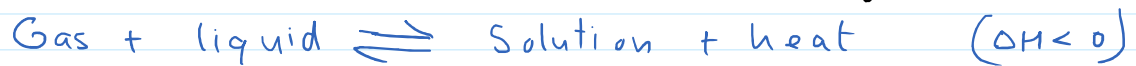
Important applications

- i) Soda water bottle is sealed under high pressure to increase solubility of CO_2 in soda water.
- ii) Scuba divers breathe at high pressure under water. Thus under water solubility of gases in blood is more. When they come out of water, solubility of gases in blood decreases as pressure is less. This releases the dissolved gases and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and create a medical condition known as bends, which are dangerous to life.

To avoid bends as well as the toxic effects of high concentrations of nitrogen in the blood, the tanks used by scuba divers are filled with air diluted with helium.

- iii) At high altitudes, the partial pressure of oxygen is less than that at the ground level. This leads to low concentration of oxygen in the blood and tissues of people living at high altitudes or climbers. Low blood oxygen causes climbers to become weak and unable to think clearly, symptoms of a condition known as anoxia.

Effect of temperature on solubility of gas



Dissolution of gas in liquid is an exothermic process.

Thus according to Le-Chatelier's principle solubility of gas decreases with increase in temperature.