# Langmuir Adsorption Isotherm:

In 1916, Irving Langmuir published a new model isotherm for gases adsorbed to solids, which retained his name. It is a semi-empirical isotherm derived from a proposed kinetic mechanism. This isotherm was based on different assumptions one of which is that dynamic equilibrium exists between adsorbed gaseous molecules and the free gaseous molecules.

It is based on four assumptions:
1. The surface of the adsorbent is uniform, that is, all the adsorption sites are equivalent.
2. Adsorbed molecules do not interact.
3. All adsorption occurs through the same mechanism.
4. At the maximum adsorption, only a monolayer is formed: molecules of adsorbate do not deposit on other, already adsorbed, molecules of adsorbate, only on the free surface of the adsorbent.

Langmuir suggested that adsorption takes place through this mechanism:

$$A\ (g) + B\ (s) \underset{Desorption}{\overset{Adsorption}{\rightleftharpoons}} AB$$
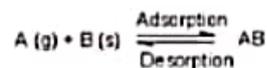
Where,
A(g) = unadsorbed gaseous molecule
B(s) = unoccupied metal surface
AB = Adsorbed gaseous molecule.

The direct and inverse rate constants are k and k^{-1}

Based on his theory, Langmuir derived an equation which explained the relationship between the number of active sites of the surface undergoing adsorption and pressure. This equation is called Langmuir Equation.

$$\theta = \frac{KP}{1+KP}$$

Where,

θ= the number of sites of the surface which are covered with gaseous molecule,

P= pressure

K =is the equilibrium constant for distribution of adsorbate between the surface and the gas phase .

The basic limitation of Langmuir adsorption equation is that it is valid at low pressure only.

At lower pressure, KP is so small, that factor (1+KP) in denominator can almost be ignored. So Langmuir equation reduces to

$$\theta = KP$$

At high pressure KP is so large, that factor (1+KP) in denominator is nearly equal to KP. So Langmuir equation reduces to
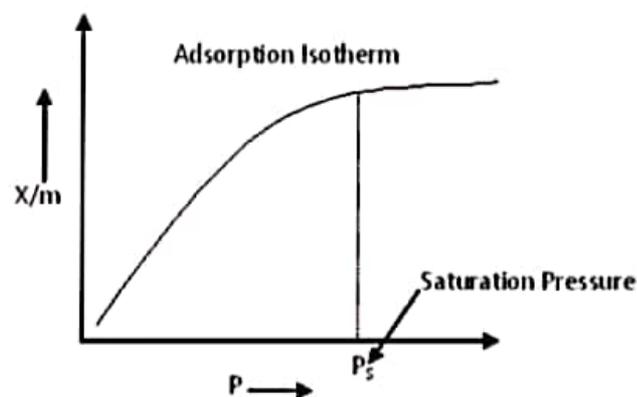
$$\theta = \frac{KP}{KP} = 1$$

Factors affecting adsorption:

The extent of adsorption depends upon the following factors:

1. Nature of adsorbate and adsorbent.
2. The surface area of adsorbent.
3. Activation of adsorbent.
4. Experimental conditions. E.g., temperature, pressure, etc.

Adsorption Isotherm:

Adsorption process is usually studied through graphs known as adsorption isotherm. That is the amount of adsorbate on the adsorbent as a function if its pressure or concentration at constant temperature .The quantity adsorbed is nearly always normalized by the mass of the adsorbent to allow comparison of different materials.