ADSORPTION

Adsorption: "Adsorption" may be defined as the process of accumulation of any substance giving higher concentration of molecular species on the surface of another substance as compared to that in the bulk. When a solid surface is exposed to a gas or a liquid, molecules from the gas or the solution phase accumulate or concentrate at the surface. The phenomenon of concentration of molecules of a gas or liquid at a solid surface is called adsorption. "Adsorption" is a well established and powerful technique for treating domestic and industrial effluents. In water treatment, the most widely method is "adsorption" onto the surface of activated carbon.

Adsorbate: The substance that concentrates at the surface is called adsorbate.

Adsorbent: The material upon whose surface the adsorption takes place is called an adsorbent. Mostly activated carbon is used as an adsorbent

- Adsorbents are used usually in the form of sphericalpellets, rods, moldings, or monoliths with hydrodynamicdiameters between 0.5 and 10 mm.
- They must have high abrasion resistance, high thermalstability and small pore diameters, which results in higherexposed surface area and hence high surface capacity foradsorption.

- The adsorbents must also have a distinct pore structurewhich enables fast transport of the gaseous vapors.

Types of Adsorption:

Depending on the type of attractions between adsorbate and adsorbent, the adsorption can be divided into two types. Forces of attraction exist between adsorbate and adsorbent. These forces of attraction can be due to Vanderwaal forces of attraction which are weak forces or due to chemical bond which are strong forces of attraction. On the basis of type of forces of attraction existing between adsorbate and adsorbent, adsorption can be classified into two types: Physical Adsorption and Chemical Adsorption.

1. Physical Adsorption or Physisorption: When the force of attraction existing between adsorbate and adsorbent are weak Vanderwaal forces of attraction, the process is called Physical Adsorption or Physisorption. Physical Adsorption takes place with formation of multilayer of adsorbate on adsorbent. It has low enthalpy of adsorption i.e. H adsorption is 20-40KJ/mol. takes place at low temperature below boiling point of adsorbate. As the temperature increases in, process of Physisorption decreases.

2.Chemical Adsorption or Chemisorptions: When the forceof attraction existing between adsorbate and adsorbent are chemical forces of attraction or chemical bond, the process is called Chemical Adsorption or Chemisorptions. Chemisorptions takes place with formation of unilayer of adsorbate on adsorbent. It has high enthalpy of adsorption. It can take place at 46 all temperature. With the increases in temperature, Chemisorptions first increases and then decreases.

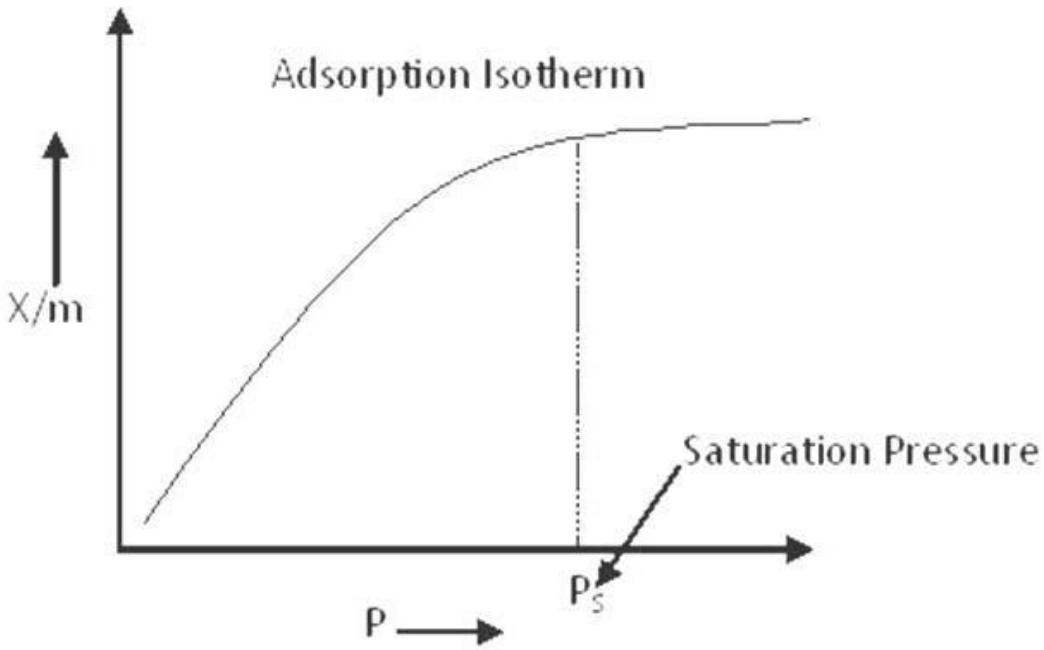
Factors influencing adsorption: Adsorption on a solid is influenced by a number of factors such as,

- Surface area
- Nature of the adsorbate
- Hydrogen ion concentration (pH) of the solution
- Temperature

- Mixed solutes and
- Nature of adsorbate

Adsorption Isotherm

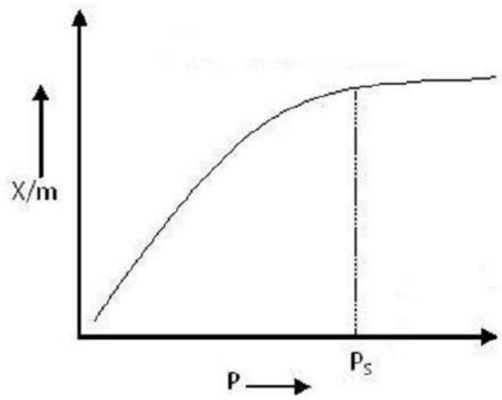
Adsorption process is usually studied through graphs known as adsorption isotherm. Adsorption is the amount of adsorbate on the adsorbent as a function if its pressure or concentration at constant temperature .The quantity adsorbed is nearly always normalized by the mass of the adsorbent to allow comparison of different materials. From the above we can predict that after saturation pressure Ps, adsorption does not occur anymore, that is there are limited numbers of vacancies on the surface of the adsorbent. At high pressure a stage is reached when all the sites are occupied and further increase in pressure does not cause any difference in adsorption process. At high pressure, adsorption is independent of pressure.



Types of Adsorption Isotherm

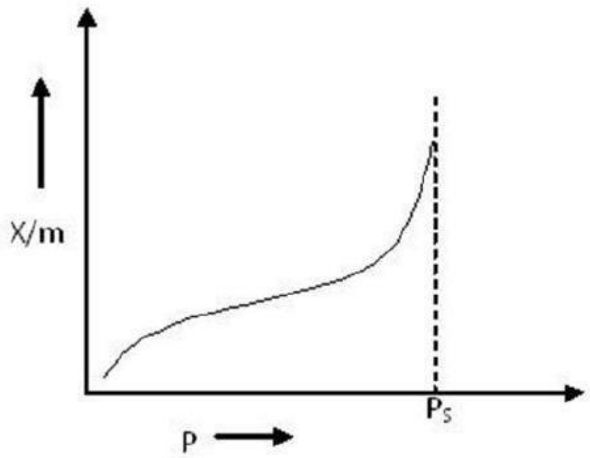
1. Type I adsorption isotherm

The above graph depicts Monolayer adsorption. This graph can be easily explained using Langmuir Adsorption Isotherm. Examples of Type-I adsorption are Adsorption of Nitrogen (N2) or Hydrogen (H) on charcoal at temperature near to -180°C.



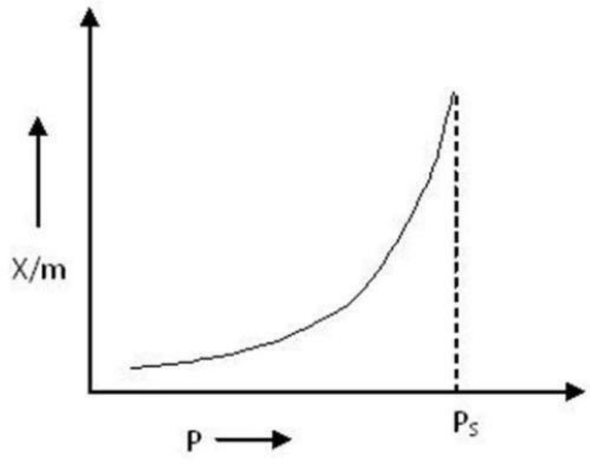
2. Type II adsorption isotherm

Type II Adsorption Isotherm shows large deviation from Langmuir model of adsorption. The intermediate flat region in the isotherm corresponds to monolayer formation. Examples of Type-II adsorption are Nitrogen (N2 (g)) adsorbed at -195°C on Iron (Fe) catalyst and Nitrogen (N2 (g)) adsorbed at -195°C on silica gel.



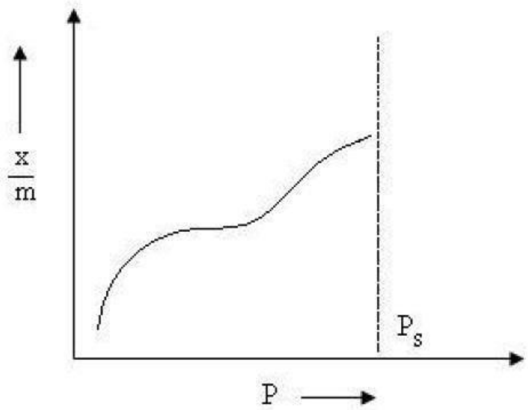
3. Type III adsorption isotherm

Type III Adsorption Isotherm also shows large deviation from Langmuir model. This isotherm explains the formation of multilayer. There is no flattish portion in the curve which indicates that monolayer formation is missing. Examples of Type III Adsorption Isotherm are Bromine (Br_2) at 790°C on silica gel or Iodine (I_2) at 790°C on silica gel.



4. Type IV adsorption isotherm

At lower pressure region of graph is quite similar to Type II. This explains formation of monolayer followed by multilayer. The intermediate flat region in the isotherm corresponds to monolayer formation. The saturation level reaches at a pressure below the saturation pressure (Ps) of the gas. Example of Type IV adsorption isotherm is adsorption of Benzene on Iron oxide at 500^{o}C and adsorption of Benzene on Silica gel at 500^{o}C.



5. Type V adsorption isotherm

Explanation of Type V graph is similar to Type IV. Example of Type V Adsorption Isotherm is adsorption of Water (vapors) at 1000°C on charcoal. Type IV and V shows phenomenon of capillary condensation of gas.