CONCEPT MAP

SURFACE CHEMISTRY

(Branch of chemistry which deals with the phenomena occurring at the surface or interface.)

Adsorption

Definition and Properties

- The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid.
- Surface phenomena.
- Spontaneous, exothermic and leads to lowering of entropy.

Terminology

- **Adsorbate :** Substance adsorbed.
- **Adsorbent :** Substance on the surface of which adsorbate is adsorbed.
- **Desorption :** Reverse of adsorption.
- **Occlusion :** Adsorption of gases on the surface of metals.
- **Sorption :** Adsorption and absorption take place simultaneously.

Types

Physisorption

- Molecules are held by weak van der Waals forces.
- Low heat of adsorption and non specific.
- No compound is formed.
- Decreases with increase in temperature.
- Forms multimolecular layer and is reversible.

Chemisorption

- Molecules are held by strong chemical bonds.
- High heat of adsorption and specific.
- Surface compounds are formed.
- Increases with increase in temperature.
- Forms unimolecular layer and is irreversible.

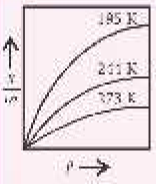
Positive adsorption

- Concentration of the adsorbate is more on the surface of the adsorbent than in the bulk.

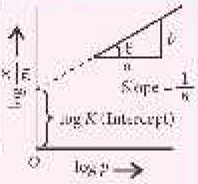
Negative adsorption

- Concentration of the adsorbate increases in the bulk after adsorption.

Adsorption Isotherms



Adsorption isotherm



Freundlich isotherm

Catalysis

Definition

- The phenomenon of enhancing the rate of a chemical reaction by using a catalyst.

Terminology

- **Promoters :** Substances that enhance the activity of a catalyst.
- **Poisons :** Substances which decrease the activity of a catalyst.
- **Activity :** Capacity to increase the speed of the chemical reaction.
- **Selectivity :** Ability of a catalyst to direct the reaction to yield a particular product.

Types

Homogeneous catalysis : When the reactants and catalyst are in the same phase e.g., oxidation of SO_2 to SO_3 in presence of NO as catalyst (lead chamber process).

Heterogeneous catalysis : When the reactants and catalyst are in different phases e.g., manufacture of NH_3 from N_2 and H_2 using Fe as catalyst. (Haber's process).

Autocatalysis : One of the products formed itself acts as a catalyst *e.g.*, titration of oxalic acid with $KMnO_4$ in presence of dil. H_2SO_4.

Induced catalysis : One reaction influences the rate of other reaction, which does not occur under ordinary conditions e.g., oxidation of sodium arsenite is induced by oxidation of sodium sulphite.

Positive catalysis : Catalyst increases the speed of a reaction.

Negative catalysis : Catalyst decreases the speed of a reaction.

Shape–Selective Catalysis

- Depends upon the pore structure of catalyst and size of reactant and product molecules.
- Zeolites are good shape selective catalysts due to honey comb-like structures.

Enzymes

- Biocatalysts
- Highly efficient and specific in nature.
- Highly active under optimum temperature and pH.
- Activity increases in the presence of activators and co-enzymes.
- Activity inhibited by inhibitors and poisons.

Colloids

Definition

- A heterogeneous system in which particle size is between 1 and 1000 nm.

Terminology

- **Dispersed phase :** Substance which is dispersed. It is a discontinuous phase.
- **Dispersion medium :** Medium in which the substance is dispersed. It is a continuous phase.

Classification

Based on physical state of dispersed phase and dispersion medium :

- **Sols :** Solids in liquids *e.g.*, paints
- **Gels :** Liquids in solids *e.g.*, cheese
- **Emulsions :** Liquids in liquids.
  - Oil in water type emulsions *e.g.*, milk.
    Water in oil type emulsions *e.g.*, butter.

Based on nature of interaction between dispersed phase and dispersion medium :

- **Lyophilic colloids :** Liquid-loving, directly formed, reversible in nature, quite stable, cannot be easily coagulated.
- **Lyophobic colloids :** Liquid-hating, prepared by special methods, readily coagulated, irreversible, not stable, and need stabilising agents for their preservation.

Based on type of particles of the dispersed phase :

- **Multimolecular colloids :** Formed by aggregation of a large number of atoms or molecules (diameter < 1 nm) held by weak van der Waals forces.
- **Macromolecular colloids :** Formed by molecules of large size.
- **Associated colloids :** Formed by substances which at low concentrations behave as normal strong electrolytes, but at higher concentrations exhibit colloidal behaviour due to the formation of aggregates (called micelles).

Important Processes and Properties

- **Tyndall effect :** Scattering of light by the colloidal particles.
- **Brownian movement :** Continuous zig-zag movement of colloidal particles.
- **Peptization :** Converting a precipitate into colloidal sol by shaking it with dispersion medium in the presence of a small amount of electrolyte.
- **Dialysis :** Separation of colloidal particles from crystalloids by diffusion through a parchment or an animal membrane.
- **Ultrafiltration :** Separation of colloidal particles from crystalloids by filtration using ultrafilter papers.
- **Coagulation :** Settling of colloidal particles.
- **Zeta potential :** Potential difference between the fixed layer and the diffused layer of opposite charges, also called electrokinetic potential.

Have a Look!

- Higher the critical temperature of a gas, more strongly it is adsorbed.
- A more strongly adsorbable substance can displace a weakly adsorbed substance from the surface of the adsorbent.
- The minimum amount of an electrolyte (millimoles) that must be added to one litre of a colloidal solution for complete coagulation is called the *coagulation* or *flocculation* or *precipitation* value of the electrolyte and smaller the value, greater is its coagulating power.
- According to Hardy-Schulze rule, greater the valency of the flocculating ion added, greater is its power to cause precipitation.