SURFACE CHEMISTRY

Adsorption

- Accumulation of molecular species at the surface rather than in the bulk of a solid or liquid.
- Surface phenomenon
- Concentration on the surface of adsorbent different from that in bulk.

ADSORBATE — Molecular species which concentrates at the surface.

SORPTION — Both adsorption & absorption takes place simultaneously

ADSORBENT — Material on the surface of which the adsorption takes place.

TYPES

Physisorption

- Adsorption when accumulation of gas on the surface of solid occurs due to weak van der Waals'forces.
- Non-specific
- Depends on nature of adsorbate
- Reversible
- Increases with increases in surface area.
- Low enthalpy of adsorption.

Chemisorption

- Adsorption when gas molecules or atoms are held to surface by chemical bonds.
- Highly specific
- Irreversible
- Increases with increase of surface area
- High enthalpy of adsorption

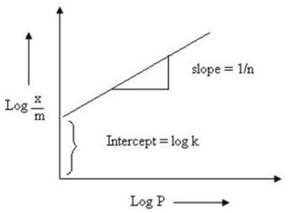
Features

- ΔG, ΔH and ΔS are all negative.
- Extent of adsorption increase with surface area

Freundlich Adsorption Isotherm

$\frac{x}{m} = kp^{1/n}$ (n> 1)

$\log \frac{x}{m} = \log k + \frac{1}{n} \log p$



Catalysis

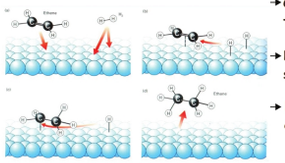
- Substances which accelerate the rate of reaction and remain chemically and quantitatively unchanged after the reaction are known as catalysts and phenomenon is know as catalysis.

Homogeneous Catalysis
Reactants and catalyst are in same phase.
(oxidation of SO_2 to SO_3 by NO as catalyst)

Heterogenous Catalyst
Reactants and catalyst are in different phases.
(Oxidation of SO_2 to SO_3 by Pt as catalyst)

Adsorption Theory

→ Diffusion of reactants to surface of catalyst
→ Adsorption of reactant molecules on the surface of catalyst.



→ Chemical reaction on the surface of catalyst through formation of intermediate.
→ Desorption of products creating surface for further reaction.
→ Diffusion of products away from catalyst surface.

Enzyme catalysis
Enzymes that catalyse many life processes in bodies of plants and animals are termed as Biochemical catalysts and phenomenon is known as Biochemical catalysis
(Inversion of sugar, Conversion of milk into curd)

Mechanism
Step 1:
Binding of enzyme to substrate to form an activated complex.
$E + S \rightarrow ES$

Step 2: Decomposition of activated complex to form product.
$ES \rightarrow E + P$

Shape Selective catalysis
Catalytic reaction that depends upon pore structure of catalyst and size of reactant and product molecules.
(Zeolites)

Activity
The reactants must get adsorbed reasonably strongly on to the catalyst to become active.

Selectivity
It is the ability to direct a reaction to yield a particular product selectively.

Uses in Industry
Manufacture of nitric acid by ostwald's process (platinised asbestos, 573 K)

Manufacture of ammonia by Haber's process (Fe + Mo, 200 bar, 723-773 K)

Colloids

Heterogeneous system where one substance is dispersed (dispersed phase) in another substance called dispersion medium. Particle size from 1-1000nm.(10^{-6} to 10^{-9} m)

Classification

Based on the type of particles of dispersed phase
Multimolecular : Large number of atoms/molecules aggregate (size 1-1000 nm)
Macromolecular :At Formed by molecules of large size.
Associated:At low concentration behave as normal range electrolytes and at high concentration behave as colloids. (associated colloidal particles are also called Micelles)

Based on nature of interaction
Lyophilic: Liquid loving (solvation of colloidal particles)
Lyophobic: Liquid-hating

Based on physical state
Sol: solids in liquids (Paints)
Gel: Liquids in solids (cheese)
Emulsion: Liquid in liquids
Aerosol: Liquid in gas

Properties

Colligative Properties:
Values of colligative properties are of small order in comparison to values shown by true solutions.

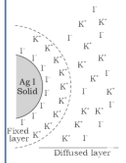
Tyndall Effect:
When a beam of light is passed & viewed perpendicular to the path of incident light, the path of beam is illuminated by a bluish light. This process is Tyndall effect.

Conditions
1) The diameter of the dispersed particle is not much smaller than the wavelength of the light
2) The refractive indices of the dispersed phase and dispersion mediun differ greatly in magnitude

Brownian Movement: Zig-zag movement of particles due to unbalanced bombardment by the molecules of dispersion medium.

Charge
Due to preferential adsorption of positive or negative ions

Helmholtz electrical double layer
The combination of the two layers of opposite charges around the colloidal particle



Electrokinetic potential or Zeta potential
The potential difference between the fixed layer and the diffused layer of opposite charges

Electrophoresis: Movement of colloidal particles toward electrode in an electric field.

Electroosmosis: Movement of dispersion medium toward electrode in an electric field.

Coagulation or Precipitation: The process of settling of colloidal particles is called coagulation or precipitation of the sol

Coagulating power $\propto \frac{1}{\text{Coagulating value}}$

Hardy schulze Rule
Coagulating power $\propto$ charge of coagulating ion

Protection of colloids
Gold number $\propto \frac{1}{\text{Protective power}}$

Purification

Dialysis: Process of removing dissolved impurities from a colloidal solution by means of diffusion through a suitable membrane

Electro-dialysis: Dialysis of impure colloidal solution of an electrolyte in the presence of electric field

Ultrafiltration: Process of separating the colloidal particles from the solvent and solute present in the colloidal solution by specially prepared filters called as ultra filter-paper

Colloidion solution
A 4% solution of nitrocellulose in a mixture of alcohol and ether

Preparation

Bredig's Arc method: For metallic colloids

Peptization: Process of converting a precipitate into colloidal sol by shaking it with dispersion medium in the presence of a small amount of electrolyte

Chemical methods
1:Oxidation
2:Reduction
3:Hydrolysis
4:Double decomposition method

Emulsions:
O/W-Milk, Vanishing cream
W/O-Butter, Cod liver oil

Emulsifying agents
Stabilise an emulsion
O/W- proteins,gums, natural and synthetic soaps, etc.,
W/O- heavy metal salts of fatty acids, long chain alcohols, lampblack, etc.

Application:
- Purification of drinking water (alum)
- Medicines
- Tanning
- Cleansing action of soaps & detergents
- Rubber industry
- Industrial Products.