

Surface Chemistry

It deals with phenomenon occurring at the surface or interface.

Adsorption

Accumulation of particles at surface is known as adsorption. It is classified as physisorption & chemisorption.

Physisorption & Chemisorption

In physisorption, adsorbate is held by adsorbent by weak van der Waal's forces and in chemisorption, adsorbate is held by the adsorbent by strong chemical bond.

Sorption

When both the phenomenon of adsorption & absorption occur simultaneously, then it is termed as sorption.

Factors affecting Adsorption:

1. Nature of gas (adsorbate)
2. Nature of solid (adsorbent)
3. Specific area of solid (adsorbent)
4. Pressure of gas
5. Temperature
6. Activation energy of solid.

Adsorption Isotherms

1. Freundlich Adsorption Isotherm:

$$\frac{x}{m} = kp^n ; n > 1$$

2. Langmuir Adsorption Isotherm

$$\frac{x}{m} = \frac{k_1 P}{1 + k_1 P}$$

Catalysis

Catalysis is the phenomenon, by which the rate of a reaction is altered (accelerated or retarded) by the presence of a substance, which itself remains unchanged, chemically in the process. The substance altering the rate of the reaction is called a catalyst.

Types of Catalysis

1. Positive catalysis
2. Negative catalysis
3. Auto catalysis
4. Homogeneous catalysis
5. Heterogeneous catalysis
6. Induced catalysis

Comparison of Physisorption and Chemisorption

	Physical Adsorption	Chemical Adsorption (Activated ad.)
1.	It is caused by intermolecular vander waal's forces.	It is caused by chemical bond formation.
2.	It is not specific.	It is highly specific.
3.	It is reversible.	It is irreversible.
4.	Heat of adsorption is low. (20–40) KJ/mol	Heat of adsorption is high. (80–240 kJ/mol)
5.	No appreciable activation energy is involved.	High activation energy is involved.
6.	It forms multimolecular layers on adsorbent surface.	If forms unimolecular layer under high pressure.

Critical temperature increases

Ease of liquifaction increases

Extent of adsorption increases (true for physisorption)

Comparison of Lyophobic and Lyophilic Sols

	Property	Lyophilic sol (Emulsoid)	Lyophobic sol (suspensoid)
1.	Preparation	Can be easily prepared by shaking or warming the substance with solvent	Cannot be prepared easily, special methods are required
2.	Stability	are more stable	are less stable
3.	Reversibility	are reversible	are irreversible
4.	Viscosity	Viscosity is much higher than that of solvent	Viscosity is nearly same as that of the solvent

Property		Lyophilic sol (Emulsoid)	Lyophobic sol (suspensoid)
5.	Surface tension	Surface tension is usually low	Surface tension is almost same as that of solvent
6.	Hydration or solvation	These are highly solvated as the particles have great affinity for solvent	These are less solvated as the particles have less affinity for the solvent
7.	Charge	The particles have little charge or no charge at all	The particles carry a characteristic charge either positive or negative
8.	Visibility	Particles can not be seen under microscope	Particles can be seen under microscope
9.	Coagulation or precipitation	Precipitated by high concentration of electrolytes	Precipitated by low concentration of electrolytes
10.	Tyndall effect	Less Scattering	More Scattering
11.	Migration in electric field	May or may not migrate as they may or may not carry charge.	Migrate towards anode or cathode as these particles carry charge.

Property		Lyophilic sol (Emulsoid)	Lyophobic sol (suspensoid)
12.	General Ex.	Mostly of organic nature Ex. Gelatin, Starch, Gum, Albumin & Cellulose Solution	Mostly of inorganic nature Ex. Transition metal salt in water like Gold, As etc.

Types of Colloids According to Their Size

Multimolecular	Macromolecular	Associated colloids
Formation by aggregation of a large number of atoms or smaller molecules of substance.	Formation by aggregation of big size molecules. These are polymer with high molecular mass.	These are the substances which behave as normal electrolytes at low concentration but get associated at higher concentration and behave as colloidal solutions. These associated particles are also called micelles.
Ex. → Gold Sol (Au) Sulphur sol (S_8)	Ex. → Starch, Cellulose, Protein etc.	Ex. → Soap & Detergent

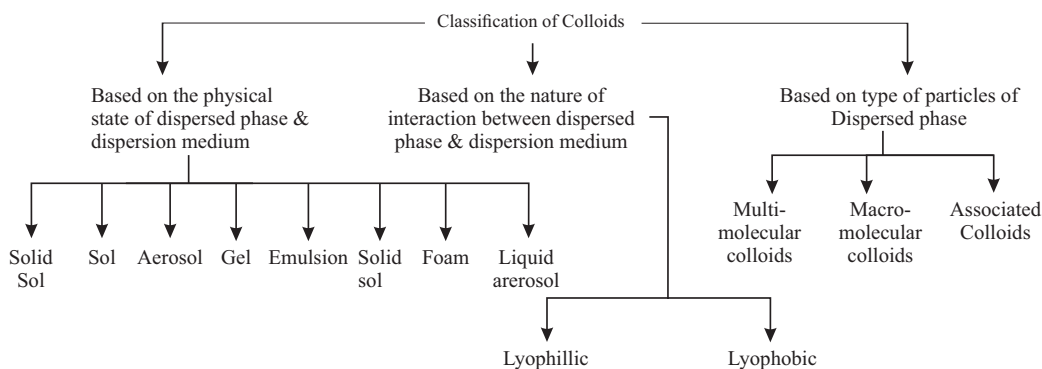
Positively and Negatively Charged Sols

Positively Charged Sols	Negatively Charged Sols
Hydrated metallic oxides. e.g., $Al_2O_3 \cdot xH_2O$, $Fe_2O_3 \cdot xH_2O$, metal hydroxides, e.g., $Fe(OH)_3$, $Al(OH)_3$, basic dye stuff like Prussian blue, haemoglobin.	Metals, e.g., Cu, Ag, Au, Metallic sulphides – e.g., As_2S_3 , CdS, acidic dyes like eosin, congo red, etc., sols of gelatin, gum, starch, blood, etc.

Colloidal System

Colloidal system is a two phase system, consisting of a dispersion medium, in which extremely minute particles are lying within colloidal range (1-1000) nm and second substance is termed as dispersed phase.

Classification of Colloids

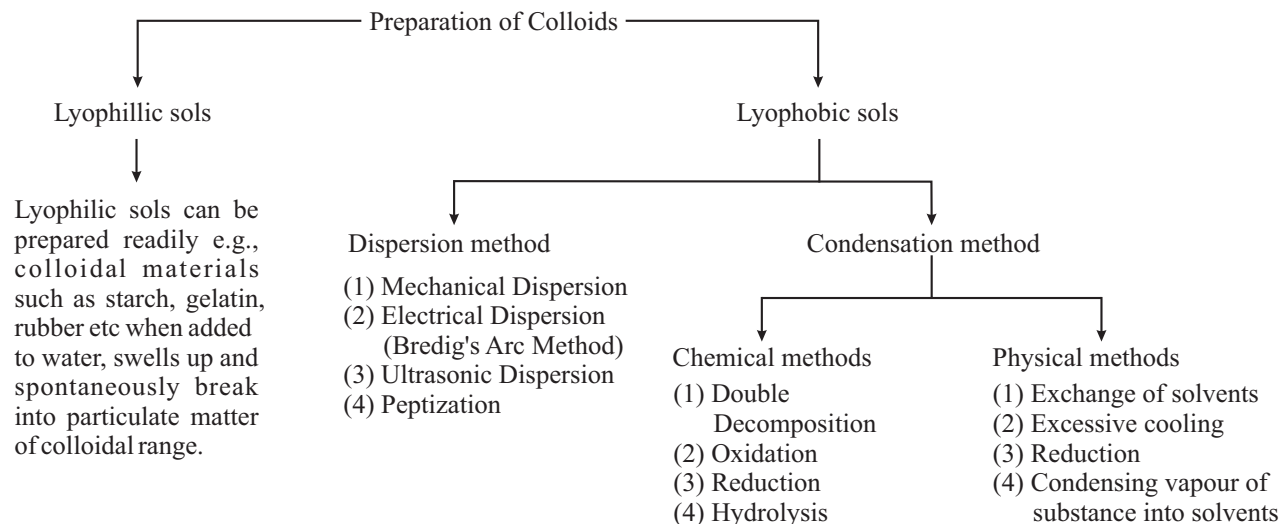


Micelles

Micelles are aggregated spherical structures of many smaller entities (amphiphilic molecules) giving rise to a colloidal system.

1. **Kraft temperature:** The formation of micelles takes place only at a particular temperature, that temperature is known as kraft temperature.
2. **CMC (Critical Micelle Concentration):** The concentration above which micelle formation becomes appreciable is termed as the critical micelle concentration. Its value depends on the nature of dispersed phase and the dispersion medium.

Preparation of Colloids



Purification of Colloidal System

The colloidal sols obtained by various methods are impure and contain impurities of electrolytes and other soluble substances, these impurities may destabilise the sol. Hence, they have to be removed.

1. **Dialysis:** It is a process of removing dissolved substance from colloidal solution by means of diffusion through a suitable membrane.
2. **Ultrafiltration:** Ultrafiltration is the process of separating the colloidal particles from the solvent and soluble solutes present in the colloidal solution by specially prepared filters, which are permeable to all substances except the colloidal particles.

Properties of Colloidal Sols

1. Optical property:

Tyndall effect: If a strong beam of light is passed through a colloidal sol placed in a dark place, the path of the beam gets illuminated. This phenomenon is called Tyndall Effect, Which is due to the scattering of light by the colloidal particles.

2. Electrical property:

Electrophoresis: The movement of colloidal particles under an applied electric potential is called electrophoresis. Depending upon the direction a movement of particle towards cathode or anode, electrophoresis can be termed as cataphoresis or anaphoresis

3. Mechanical property:

- + **Brownian motion:** The phenomenon of random movement of colloidal particles in zig-zag directions is known as Brownian motion.

+ **Sedimentation potential or Dorn potential:** When the charged colloidal particles are made to settle down under centrifugal field, there occurs a charge separation and a potential difference is developed. This effect is called **Dorn effect** and the potential difference thus developed is called Dorn potential or sedimentation potential. This process is **reverse of electrophoresis**.

4. Eletro-osmosis:

When movement of colloidal particles is prevented by some suitable means (porous diaphragm or semi-permeable membrane), it is observed that the dispersion medium begins to move in an electric field. This phenomenon is termed electro-osmosis.

5. Isoelectric point:

The H^+ concentration, at which the colloidal particles have no charge is known as the isoelectric point. At this point, stability of colloidal particles becomes very less & particles do not move under influence of electric field.

6. Streaming potential:

A potential difference is developed across a porous partition when the dispersion medium of a charged colloid is forced through it. This is called Streaming potential. This process is reverse of electro-osmosis.

Coagulation/Flocculation

The process of aggregation of colloidal particles into an insoluble precipitate by the addition of some suitable electrolyte is known as coagulation.

$$\text{Coagulation value} = \frac{\text{Millimoles of an electrolyte added}}{\text{Volume of sol in Litre}}$$

1. Factors affecting Coagulation:

- (a) Nature of Sols
- (b) Nature of electrolytes

2. Hardy-Schulze rule:

According to this rule, greater is the valency of coagulating ion, greater is its power to cause precipitation.

3. Gold Number:

“The minimum amount of the protective colloid in milligrams which when added to 10 ml of a standard gold sol is just sufficient to prevent a colour change from red to blue on the addition of 1 ml of 10% sodium chloride solution. Smaller is the gold number, greater will be protecting power of the protective colloid.

$$\text{Protective power} \propto \frac{1}{\text{gold number}}$$

$$\text{Gold Number} = \frac{\text{Weight of lyophilic sol in mg} \times 10}{\text{Volume of gold sol in mL}}$$