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"Colloid"

Colloidal solution: When the diameter of the particles of a substance dispersed in a solvent ranges from about 10Å to 2000Å, the system is termed a colloidal solution, colloidal dispersion or simply a colloid.

Types of colloidal system

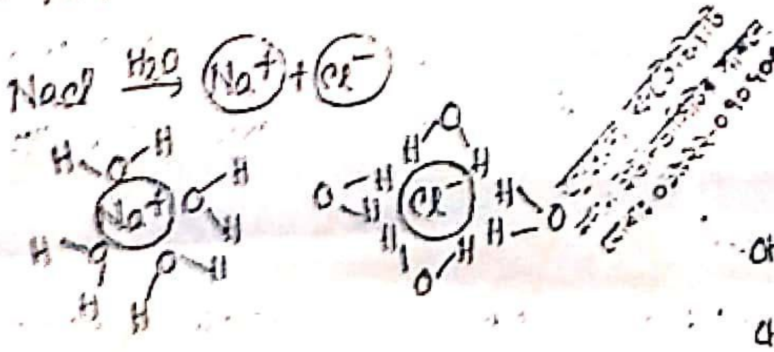
A colloidal system is made of **two** phases

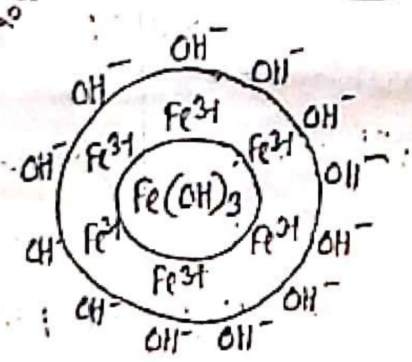
(I) **Dispersed phase:** The substance distributed as the colloidal particles is called the dispersed phase.

(II) **Disperse medium:** The medium in which dispersion of the particles take place is called disperse medium.

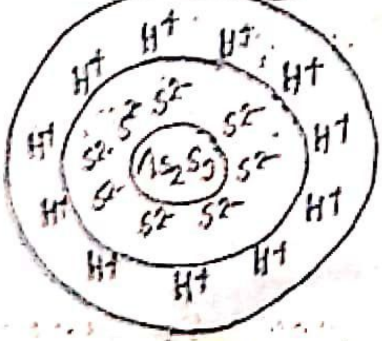
$NaCl \xrightarrow{H_2O} Na^+ + Cl^-$

$Fe^{3+} + NH_4OH \rightarrow Fe(OH)_3$





$As_2O_3 + 3H_2S \xrightarrow{H^+} As_2S_3 + 3H_2O$



□ Classification based on the nature of disperse phase and medium

Type Name	Dispersed Phase	Dispersed medium	Examples.
Foam	gas	liquid	whipped cream, shaving cream
Solid foam	gas	solid	tooth cork, foam rubber
No sols available	gas	gas	✗
Aerosol	liquid	gas	fog, mist, clouds
Emulsion	liquid	liquid	milk, hair cream
solid emulsion (gel)	liquid	solid	butter, cheese
Smoke	solid	gas	dust, soot in air
Sol	solid	liquid	paint, ink, colloidal gold
solid sol	solid	solid	ruby glass, alloys.

□ Properties of colloid:

(I) They show tyndal effect when viewed with proper illumination.

(II) They can't pass through a semipermeable membrane under suitable electrode potential.

(III) They show brownian movement

(IV) They can be separated from the dispersion medium when an electrolyte is applied.

N.B True solute do not show these properties.

Classification of colloids

① **Lyophobic colloids** Lyophobic sols are those in which the dispersed phase has no attraction for the medium or the solvent (Au, $Fe(OH)_3$ in water) (Solvent hating.

② **Lyophilic sols** Lyophilic sols are those in which the dispersed phase exhibits a definite affinity for the medium or the solvent. (dispersion of starch, gum, protein in water) (solvent loving)

Comparison between Lyophobic and Lyophilic sols

Suspensoid — Lyophobic	Emulsoid — Lyophilic
① They show little attraction between disperse phase and disperse medium.	① This is a definite force of attraction between the particles of disperse phase and disperse medium.
② They are prepared by indirect method.	② They are prepared by simple mixing method.
③ The viscosity of the sol particles is similar to that of the solvent.	③ Viscosity is higher than the solvent.
④ They are mostly inorganic	④ They are molly organic.
⑤ They carry electric charge on their surface	⑤ They carry little or no charge.
⑥ Exhibit tyndall effect	⑥ Donot exhibit tyndall effect
⑦ Particles migrate to either anode or cathode	⑦ Particle migrate to anode or cathod. or not at all
⑧ No solvation of particle.	⑧ partical generally solvated.

Q. **Preparation of colloids**

small particles → large particles → dispersion / condensation

Methods

- Dispersion method
  - Electrical Dispersion / Bredig's arc method
  - Mechanical Dispersion method
  - Chemical Dispersion method / By peptization
- condensation method / Aggregation
  - Change of solvent
  - Reduction
  - Hydrolysis
  - oxidation
  - Ion exchange method / Double decomposition method.

I. **Dispersion method**: colloidal size particles can be obtained by disintegrating down bulkier materials. Methods under this category are called dispersion method.

II. **~~condensation~~ Aggregation method** colloidal size particles can be obtained by building up particles from single molecules. Methods under this category are called condensation methods.

→ Dispersion method in which large macro sized particles are broken down to colloidal size

→ Aggregation methods in which colloidal size particles are built up by aggregating single ions or molecules.

Electrical Dispersion / Bredig's arc method:

Sols of noble metals can be prepared by this method. An arc is struck between the two metal electrodes held close together beneath de-ionized water. The water is kept cold by immersing the container in ice-bath and a track of alkali ($NaOH/K_2CO_3$) is added. The intense heat of the spark across the electrodes vaporises some of the metal and the vapour condenses under water. Since the metal has been ultimately converted into sol particles, this method has been treated as of dispersion.

Non-metal sols can be made by suspending coarse particles of the substances in the dispersion medium and striking an arc between iron electrodes.

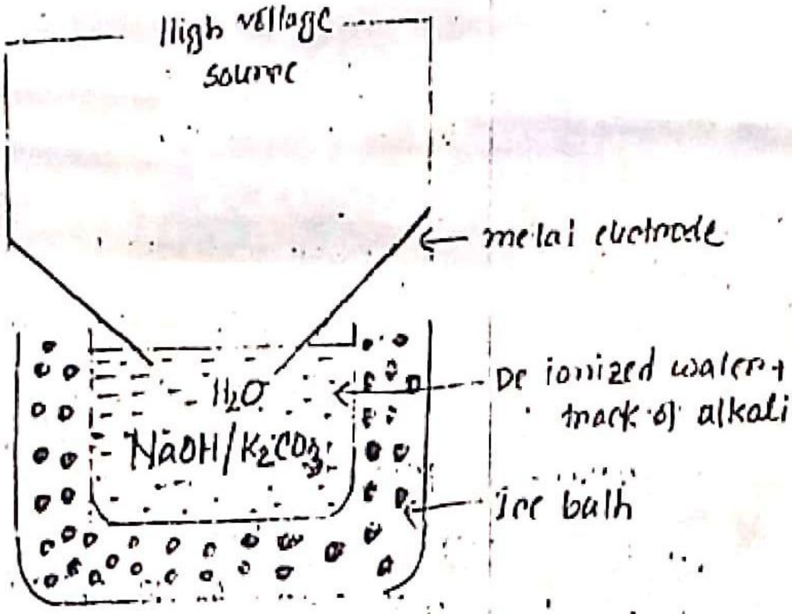
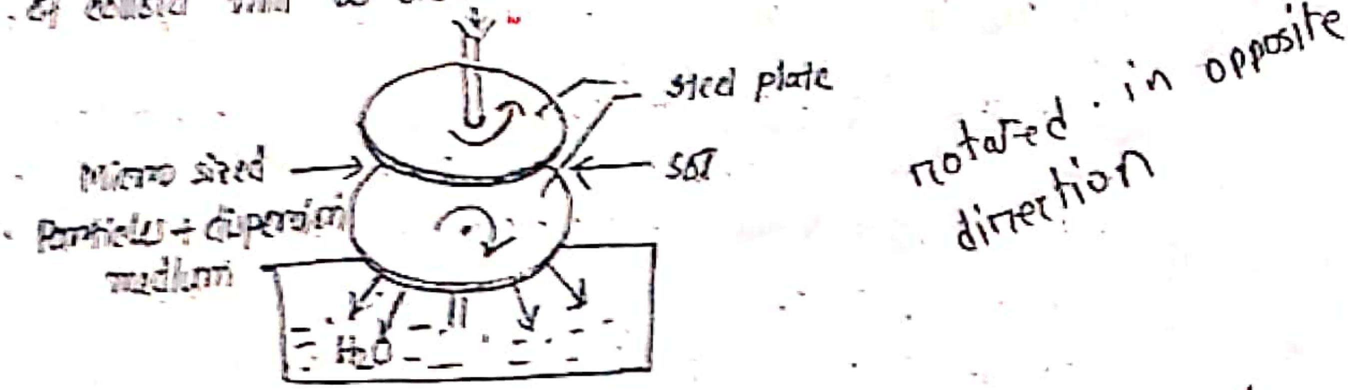


Fig: Bredig's Arc Method

Mechanical Dispersion Method:

A slurry of coarse suspension is sheared between the plates of colloid mill as shown in figure.



Under the influence of pressure the bulk materials disintegrated into smaller particles of various dimension and may reunite to form larger particles. Recently, mercury sol has prepared by disintegrating a layer of mercury into sol particles in water by means of ultrasonic vibration.

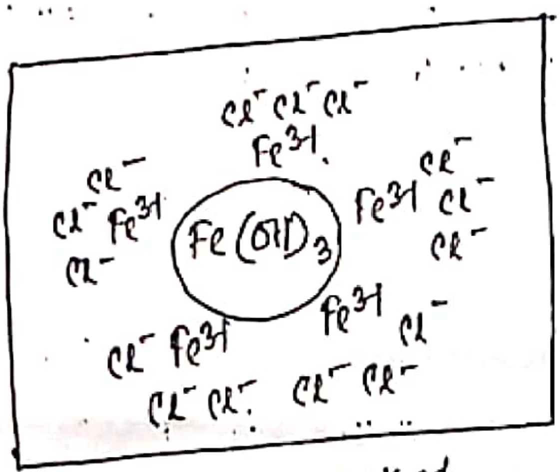
Chemical Method / Peptization method:

Some freshly precipitated ionic solids are dispersed into colloidal solution in water by the addition of small quantities of electrolytes, particularly those containing a common ion. The precipitate adsorbs the common ions and electrically charged particles then split from the precipitate as colloidal particles.

Fe^{3+} / Al^{3+} / Cr^{3+} $\xrightarrow{NH_4OH}$ $Fe(OH)_3$ / $Al(OH)_3$ / $Cr(OH)_3$ precipitate in group IIIA.

$Fe(OH)_3$ precipitates materials + $FeCl_3$ → sol particle dispersion water.

$Al(OH)_3$ precipitates materials + HCl → sol particle dispersion water.



Peptization method.

The dispersal of a precipitated material into colloidal solution by the action of an electrolyte in solution, is termed **Peptization**. The electrolyte used is called a **peptizing agent**.

Reduction method:

This method can also be used for the preparation of sols of noble metals by the addition of reducing agent to a solution of suitable compounds of the metals. The compounds which are used as a reducing agent (H_2, CO_2, NH_2-NH_2, NH_2OH) would not be electrolized.

Example: sols of Ag can be prepared by passing H_2 gas through an ageous suspension of Ag_2O.

$$Ag_2O + H_2 \rightarrow \underset{(sol)}{Ag} + H_2O$$

Oxidation method: Sols of sulpher or selenium can be prepared by oxidation of H_2S or selenium in SO_2 or air.

$$2H_2S + SO_2 \rightarrow \underset{(sol)}{3S\downarrow} + 2H_2O$$

Ion exchange method / Double decomposition method

A silver chloride sol is prepared by passing of KCl through a cold solution of $AgNO_3$. This is continued till the sol attains maximum intensity.

$$Ag^{+}NO_3^{-} + K^{+}Cl^{-} \rightarrow \underset{(sol)}{AgCl\downarrow} + K^{+}NO_3^{-}$$

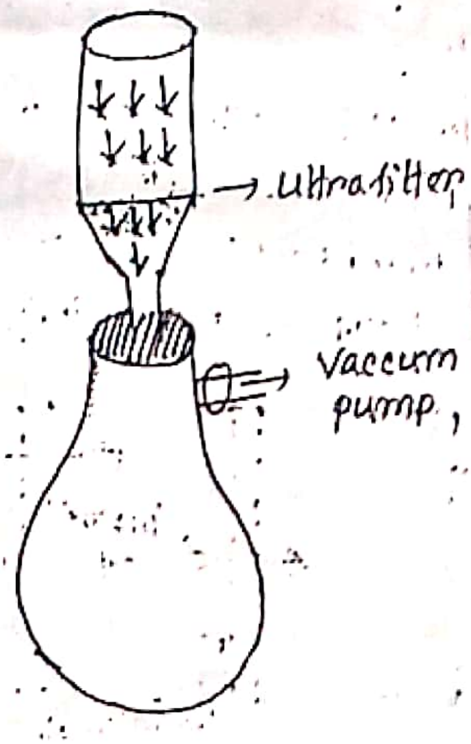
Q| Purification of colloids / sols:

In the method of preparation, the resulting sol frequently contains besides colloidal particles appreciable amount of electrolytes. To obtain the pure sol, The excess electrolytes have to be removed from the sol is called the purification of colloids.

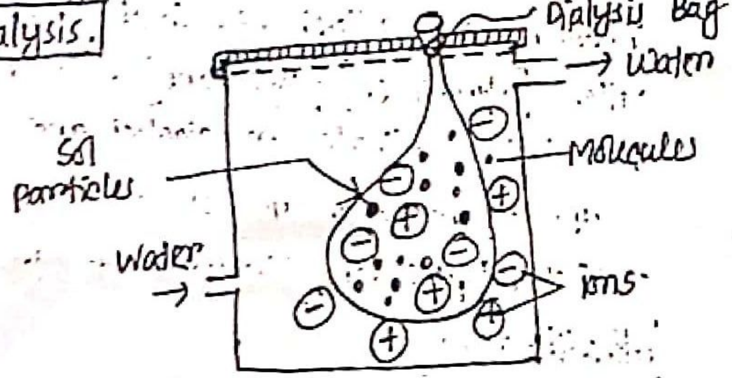
Q| Types of purification of colloid

① **Ultrafiltration:** Reduction of pore size of ordinary filtering media is achieved by impregnating the filtering media collodione or cellophane. such a modified filter paper is called **ultrafilter**. **Colladione** is a partially evaporated solution of cellulose nitrate in alcohol and ethor.

The separation of the sol particles from the liquid medium and electrolytes by filtration through an ultrafilter is called **ultrafiltration.**

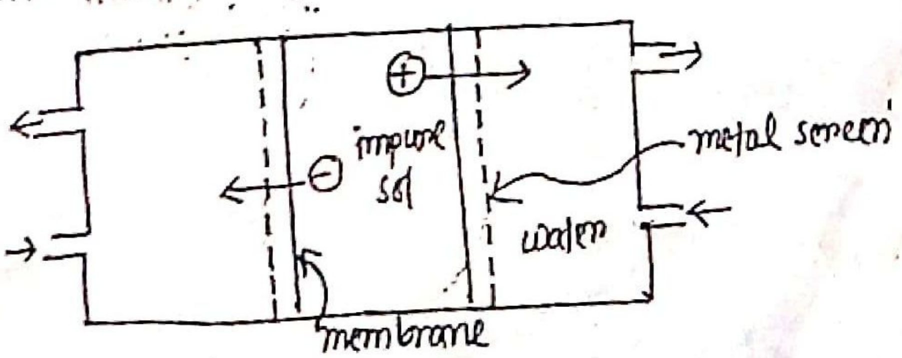


(ii) **Dialysis:** when a sol containing dissolved ions (electrolyte) or molecules is placed in a bag of permeable membrane dipping in pure water, the ions diffuse through the membrane. By using a continuous flow of fresh water, the concentration of the electrolyte outside the membrane tends to be zero. Thus diffusion of the ions into pure water remains brisk all the time. In this way, practically all the electrolyte present in the sol can be removed easily. The process of removing ions from a sol by diffusion through a permeable membrane is called **dialysis.**



(iii) **Electrodialysis:**

In this process, dialysis is carried under the influence of electric field. Potential is applied between the metal screens supporting the membranes. This speeds up the migration of ions to the opposite electrode. Hence, dialysis is greatly accelerated.



Properties of colloids: / sols:

- → nature of colour
- → optical propertise of sols
- → Kinetic properties of sols
- → Electrical properties of sols.

Nature of colour

The colour of a hydrophobic sol depends on the wavelength of the light scattered by the dispersed particles. The wavelength of the scattered light again depends on the size and the nature of the particles.

Colour of Ag-sol	Particle diameter
Orange - yellow	6×10^{-5} mm
orange - red	9×10^{-5} mm
Purple	13×10^{-5} mm
Violet	15×10^{-5} mm

[Colour variation of Ag sol depending on Particle size]
(above)

Optical properties of sol:

(I) Sols exhibit Tyndall effect

The phenomenon of scattering of light by the sol particles is called Tyndall effect.

True solution does not show Tyndall effect. Since ions or solute molecules are too small to scatter light, the beam of light passing through a true solution is not visible when viewed from the side. Thus Tyndall effect can be used to distinguish a colloidal solution from a true solution.

(II) Ultramicroscope shows up the presence of individual particles.

(III) Sol particles can be seen with an electron microscope.

Kinetic properties of sol

The continuous rapid zigzag movement executed by a colloidal particle in the dispersion medium is called Brownian movement. Suspensions and true solution do not exhibit Brownian movement.

It is caused having solvent molecule in the colloidal system.

Electrical Property of sols

① The sol particles carry an electric charge

② **Electrophoresis:** The movement of sol particle under an applied electric potential is called electrophoresis.

③ **Electro-osmosis** The movement of the dispersion medium under the influence of applied potential is known as electroosmosis.

④. **Coagulation or precipitation:** The flocculation and settling down of the discharged sol particles is called coagulation or precipation of the sol.

[I] Coagulation or precipitation can be **brought out**

(i) By adding of electrolytes

(ii) By electrophoresis

(iii) By mixing two oppositely charged sol

(iv) By boiling:

Q. II **Hardy - Schulze Rule** It states that the precipitating effect of an ion on dispersed phase of opposite charge increases with the valence of the ion.

The higher the valency of the effective ion, the greater is its precipitating power. Thus for precipitating an As_2S_3 sol (negative), the precipitating power of Al^{3+}, Ba^{2+}, Na^{+} ions is in the order $Al^{3+} > Ba^{2+} > Na^{+}$

Similarly for precipitating $Fe(OH)_3$ sol (positive) the precipitating power of cation $[Fe(CN)_6]^{3-}$, SO_4^{2-}, Cl^- is in the order

$$[Fe(CN)_6]^{3-} > SO_4^{2-} > Cl^-$$

Q. II **Flocculation value:**

The minimum concentration value in millimoles per litre required to cause the precipitation of a sol in 2 hours. This is called the flocculation value. The smaller the flocculation value, the higher the precipitating power of an ion.

Q. II **Stabilization of colloids / protection of colloids**

The protection of colloids consist in neutralizing these forces that will cause precipitation. This is done by the addition of suitable organic sol ~~such~~ as to a lyophobic sol.

Example of stabilizers: Albumin, Starch, gum aerabic, dextrin etc.

Q. II **Gold number**

The protective action of different colloids is measured in terms of the 'gold number'. It is defined as the number of milligrams of a hydrophillic colloid that will just prevent the precipitation of 10 ml of a gold sol on the addition of 1ml of 10 per cent sodium chloride solution.

The **smaller** the gold number of a hydrophillic colloid, the **greater** is its protective power.

lyophillic colloid	Gold number
Gelatin	0.005 – 0.01
Egg albumin	0.08 – 0.10
Gum arabic	0.10 – 0.15
Potato starch	25

Q. **Emulsions**

An emulsion may be defined as a dispersion of finely divided liquid droplets in another liquid.

Q. **Gel** A gel is a jelly like colloidal system in which liquid is dispersed in a solid medium.

Q. **Application of colloids:**

(i) In purification of air from industrial smoke.
(ii) In removal of suspended solid particles from water.
(iii) In textile industry to fasten the dye.

(iv) In leather technology to clean raw hides.

(v) In cleansing action of soap and detergent.

(vi) In the formation of delta in the junction point of river.

(vii) In war fare, for the purpose of concealment.