Colloidal State

Many amorphous substances like gelatin, starch and gum, exhibit little or no tendency to diffuse through the membranes and were, because of their glassy nature called colloids. The word colloid is derived from greek words kolla (glue) and eidos (form) and suggest glue like. Colloid is not a class but a state. Colloid is state of matter and not kind of matter. A substance can behave as crystalloid in some solvent and colloid in other. Sodium chloride is a crystalloid in water but it has been obtained in the colloidal state in benzene. Soap behaves as colloid in water and as crystalloid in alcohol. Gold, silver etc are insoluble in water but can be obtained in colloidal state.

According to Thomas Graham (1961) all the soluble substances can be divided into two classes:

a) Crystalloids: The substances which can readily pass through vegetable and animal membranes eg inorganic salts acids, bases, urea sugar

b) Colloidal: The substances which can not pass through vegetable and animal membranes eg Starch, gelatin silicic acid.

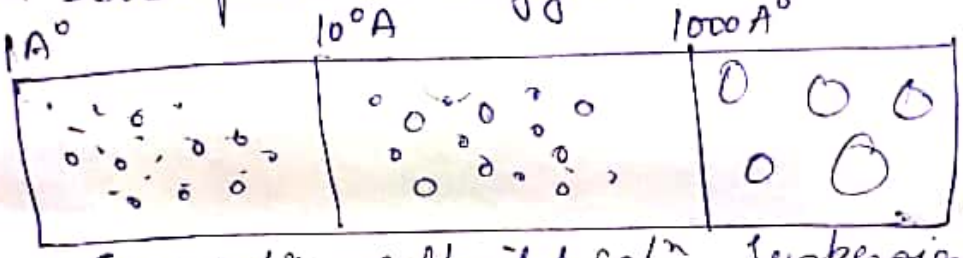
Dispersion system: Any system made up of a substance distributed as scattered as minute particle of a solid droplet of liquid or extremely tiny bubbles of a gas through another substance is called dispersion system.

Depending on the degree of dispersion, the dispersion system are classified as i) true solution
ii) colloidal solution iii) suspension

i) True solution: A system of homogeneous mixture in which the molecules or ions of ~~homogeneous~~ mixture of each solute are dispersed in the mass of dispersed molecule of the solvent. There is no dispersed phase in true solution, system is one single phase. The size of the particles are with in the range of 1A° to 10A° in diameter. ($\mu = 10^{-4}$cm $= 10^{4}$A°)

ii) Colloidal solution: The size of the particles of a substance dispersed in a solvent is bigger than that of the solute molecule in a true solution and smaller than that of coarse suspension the system is colloidal system. size range 10 A° to 1000A°

iii) Suspension or coarse suspension: It consist of a solid particles bigger than 1000A° in diameter



True Sol^{n} Colloidal sol^{n} Suspension

A colloidal state regarded as intermediate stage between molecules and particles of coarse suspension

Colloidal solution: It is a heterogeneous system consisting of two phases:

a) Dispersed phase b) Dispersion medium.

Dispersed phase + Dispersion medium = colloidal system

Dispersion phase: It is the phase which is present in the form of extremely small particles dispersed in a solvent and it is also known as inner phase / discontinuous phase

Dispersion medium: It is the medium (solvent) in which the colloidal particles are dispersed. This phase forms the larger fraction of the colloid it is outer phase or continuous phase

colloidal solutions using water as the dispersion medium are called Hydrosol or sols. If alcohol is the dispersion medium it is called Alcosol.

Sols which are thick as jelly are called Gels

A colloidal system is two phase system and each of the two phase can be three physical state of matter gas, liquid and solid. There can be nine system by gas-gas system is not possible as all gases form single phase ad homogenous system eg air.

	Dispersed phase	Dispersion medium	Name of Colloid	Examples.
1.	liquid	gas	liquid aerosol	fog, mist cloud, hair set spray.
2.	Solid	gas	solid aerosol	smoke, dust fumes
3.	Gas	liquid	foam	Soap, lather whipped cream.
4.	liquid	liquid	Emulsion	milk hair cream.
5)	Solid	liquid	sol	paint, starch sol^{n} sol
6.	Gas	solid	Solid foam	pumice stone, foam rubber, icecream.
7.	liquid	Solid	Gel	butter, Cheese, jelly boot polish.
8.	Solid	solid	Solid sol	coloured glasses, pearls, some alloys wings of butterfly.

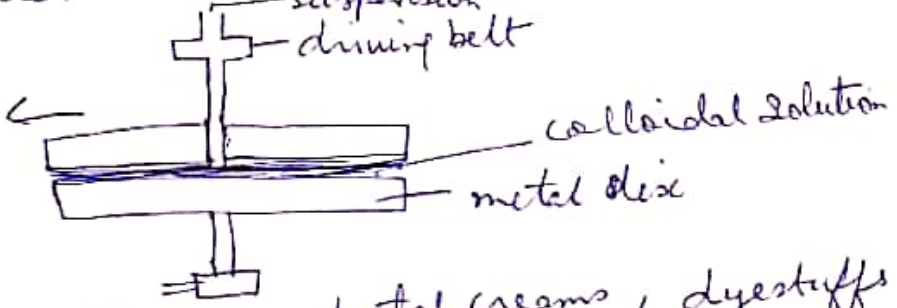
Lyophilic colloids: liquid loving colloids
Lyophobic: liquid hating colloids.
When dispersion medium is water colloids are hydrophilic water loving or hydrophobic water hating.
Hydrophilic colloids are starch, glue, proteins, gelatin
Hydrophobic - insoluble substances which do not readily yield colloidal solution eg metal, metal sulphides, metal hydroxides, sulphur, phosphorous.

Preparation of hydrophilic sols: These are prepared directly by addition of dispersion medium to dispersed phase.

Preparation of hydrophobic sols: These colloids are difficult to prepare so various methods are employed.
1) Dispersion method 2) Condensation method.

1) Dispersion method: Bulk quantity of hydrophobic material are disintegrated into colloidal size.

i) Mechanical dispersion: finely powdered substance to be dispersed is suspended in dispersion medium and introduced into a colloidal mill which consists of two metal disc rotating in opposite direction at a very high speed (7000 revolution per minute). There is minimum distance between the two disc.

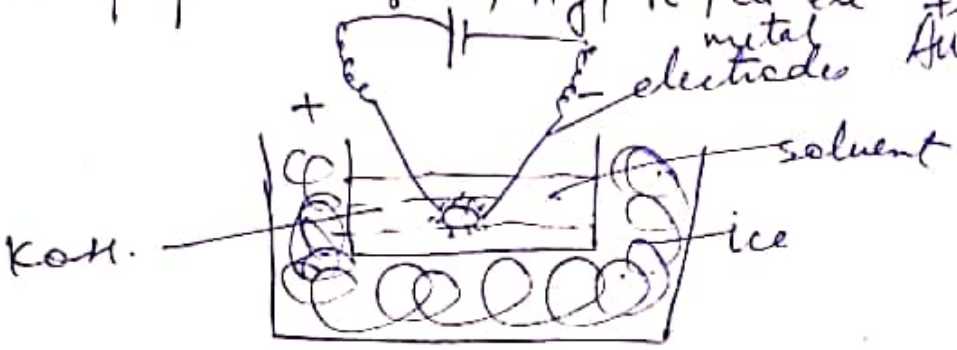


eg paints, ointments, dental creams, dyestuffs, varnishes are made by this method.

Electrodispersion: (Bredig's arc method): This method consist of sticking an arc between the electrodes of a metal which is to be obtained in the colloidal form

the electrodes being immersed in the dispersion medium like water. The intense heat of the arc turns the metal into vapours which are immediately condensed by the surrounding ice cold water to give particles of colloidal size. KOH is added as to stabilize the sol. Used for the preparation of Au, Ag, Pt, Cu etc.

$Au^{+3}Cl_3 \rightarrow Au^{0}$



ii) **Peptization**: It is the process by which a freshly precipitated substance is converted into the colloidal state by the addition of electrolyte. eg freshly ppt $Fe(OH)_3$ gets easily converted into a colloidal sol when treated with the dilute solution of ferric chloride. Fe^{+3} are absorbed by $Fe(OH)_3$ due to repulsion between similar charged particles a stable sol of positively charged $Fe(OH)_3$ particle is obtained.

b) **Condensation method**: In these methods molecules or ions of the substance present in true solution are so treated that the size of the particles grows to colloidal size.

i) **Oxidation**:- The colloidal sol^n of non metals like sulphur and iodine is obtained by oxidation. Sulphur sol is formed by passing hydrogen sulphide through the sol^n of an oxidising agent like nitric acid, sulphurous acid

$$2H_2S + H_2SO_3 \rightarrow 3H_2O + 3S\downarrow$$

$$HIO_3 + 5HI \rightarrow 3H_2O + 3I_2\downarrow$$

ii) **Reduction**: Colloidal sol^n of metal like silver, gold and platinum etc. are obtained by red^n of their dilute salt sol^n with suitable reagents. Colloidal gold is formed by red^n of auric chloride with stannous chloride

$$2AuCl_3 + 3SnCl_2 \rightarrow 2Au\downarrow + 3SnCl_4$$

iii) Hydrolysis: Metallic hydroxide are obtained by this method. Ferric hydroxide is obtained by boiling ferric acetate in a beaker containing distilled water.

$$(CH_3COO)_3Fe + 3H_2O \rightleftharpoons Fe(OH)_3 \downarrow + 3CH_3COOH.$$

iv) Double decomposition: This method is used for preparing colloidal solution of sulphide of metals. The colloidal solution of As_2S_3 is obtained by passing hydrogen sulphide gas through a sol^n containing arsenious oxides

$$As_2O_3 + 3H_2S \longrightarrow As_2S_3 + 3H_2O$$

The excess of hydrogen sulphide is removed by boiling.

v) Excessive Cooling: The colloidal sol^n of ice in an organic solvent like ether is obtained by freezing a sol^n of water in the solvent. The molecules of water which can no longer be held in the sol^n get together to form particles of colloidal size

vi) Vapour condensation: If the vapours of a boiling element are conducted into a liquid condensation takes place. eg mercury sols are prepared by passing vapours of boiling liquid into cold water and stabilizing electrolyte such as ammonium salts are added.

vii) Cathodic reduction: when lead salts are electrolysed a sol of lead is obtained at the cathode.

viii) Exchange of Solvent: Sol^n of the substance in one solvent is poured into another solvent in which the substance is insoluble. Sulphur sol is prepared by dissolving sulphur in alcohol and diluting this sol^n with water in which sulphur is less soluble.

ix) Peptization of Colloidal solution: Colloidal solutions when