Today's Lecture

Course No.: CHE 223

Topics

- True solution, Colloids, and Suspension
- Classification of Colloids
- Preparation of Colloids

Speaker's Information

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Solution

❑ The solution consists of two parts-

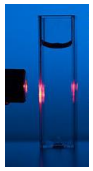
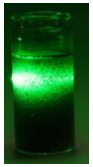
- Solute or Particle (Atoms/Ions/Molecules)
- Solvent

❑ Based on the particles size "Solutions" are 03 types-

True Solution	Colloidal Solution	Suspension
< 1 nm (Particle size)	1 to 100 nm (Particle size)	> 100 nm (Particle size)
		
Sugar water (A solution of Crystalloids)	*Milk*	*Mud water*

[Homework: Check definitions]

Differences between true solution, colloidal solution & suspension

Property	True solution	Colloidal solution	Suspension
Nature	Homogeneous mixture	Heterogeneous mixture	Heterogeneous mixture
Particle size	< 1 nm	1 to 100 nm	> 100 nm
Visibility	The particles are not visible even under ultra-microscope	The particles are only visible under ultra-microscope	The particles are visible under necked eyes
Filtration	Solute can not be filtered even by using Ultra-filter papers	Solute can be filtered only by using Ultra-filter papers	Solute can be filtered by using ordinary filter papers
Tyndall effect	No 	Yes (Path of light is visible) 	No 
Setting	Their particle do not settle down under any condition	Their particle settle down only in a centrifuge	Their particle settle down under gravity
Diffusibility	They diffuse rapidly	They diffuse slowly	Do not diffuse

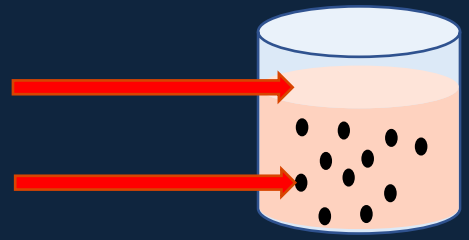
Colloidal State

❑ Colloidal State

A substance is said to be in the colloidal state (Colloids), when it is dispersed in another medium in the form of very small particles having diameter between 1 to 100 nm.

❑ Colloidal Solution consisting of two phases

- ✓ Dispersion medium
- ✓ Dispersion phase



- **Dispersion phase**

  Dispersion phase can be comparable to the solute in true solution. It consists of discrete particles significantly larger than ordinary molecules.

- **Dispersion Medium**

  It is the medium in which disperse phase is present. It consists of continuous interlinked molecules. It is comparable to the solvent in a true solution.

Classification of Colloids

❑ Based on the nature of disperse phase and disperse medium-

SL. No.	Disperse Phase	Disperse Medium	Name	Examples
1.	Solid	Solid	Solid Sol	Glass, Alloy
2.	Solid	Liquid	Sol	Paints, Ink,
3.	Solid	Gas	Aerosol	Smoke, Dust
4.	Liquid	Solid	Gel	Pudding, Curds
5.	Liquid	Liquid	Emulsion	Milk, Cream
6.	Liquid	Gas	Liquid Aerosol	Mist, Fog
7.	Gas	Solid	Solid Foam	Cake, Bread
8.	Gas	Liquid	Foam	Whipped cream, Coffee foam

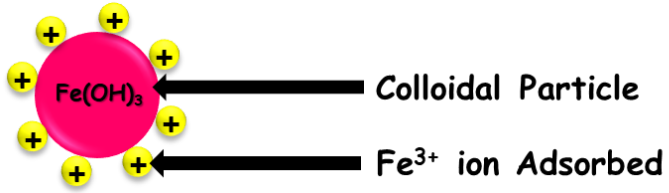
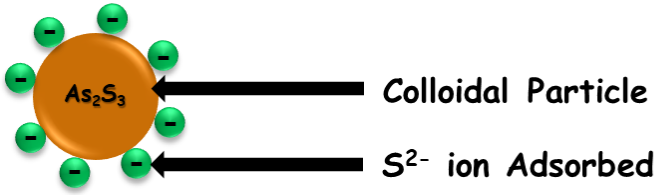
Classification of Colloids

❑ Based on appearance-

Sol	When a colloidal solution appears as a fluid, it is termed as sol. Disperse phase = Solid; Disperse Medium = Liquid Sols are named after the dispersion medium. *e.g.;* If the disperse medium is water then they are called hydrosols. If the disperse medium is alcohol then they are called alcosols.
Gel	When a colloid has a solid-like appearance, it is termed as gel. Disperse phase = Liquid; Disperse Medium = Solid The rigidity of gel varies from substance to substance. Some substances may occur both as sol as well as gels. This depends upon the relative concentration of the disperse phase and medium. *e.g.;* At high temperature and low concentrations of gelatin it occurs as hydrosol in water. But if the temperature is lowered and concentration of the gelatin is high, the colloids takes the form of a gel.

Classification of Colloids

❑ Based on the electrical charge on the dispersed phase

Positive colloids	The disperse phase carries the positive charge. *e.g.;* The particles of $Fe(OH)_3$ sol in water are positively charged. 
Negative Colloids	The disperse phase carries the negative charge. *e.g.;* The particles of As_2S_3 sol in water are negatively charged. 

❑ How to prepare positively or negatively charged AgI colloidal particles from the mixture of $AgNO_3$ and KI solution?

$AgNO_3 + NaI \longrightarrow NaNO_3 + AgI + Ag^+ + NO_3^-$ (Excess)

$AgNO_3 + NaI \longrightarrow NaNO_3 + AgI + Na^+ + I^-$ (Excess)

Classification of Colloids

❑ Based on the interaction of the two phases or solvent affinity

Lyophobic **or** **Solvent-hating** **or** **Non-reversible**	The dispersed phase has less affinity for the dispersion medium. Lyophobic colloids are also known as Suspensoids. If the dispersion medium is water then it's called Hydrophobic. *e.g.;* Metals, sulfur, sulfide, silver halides, egg albumin, $Fe(OH)_3$ in water.
Lyophilic **or** **Solvent-loving** **or** **Reversible**	The dispersed phase has a greater affinity for the dispersion medium. Lyophilic colloids are also known as Emulsoids. Lyophilic colloids are also known as Natural Colloids. If the dispersion medium is water then it's called Hydrophilic. *e.g.;* Protein, starch, glue gelatin in water; Rubber in benzene.

Differences between Lyophilic and Lyophobic colloids

Property	Lyophilic	Lyophobic
Preparation	They form a colloidal solution when brought in contact with a dispersed medium/solvent.	They do not form a colloidal solution easily when brought in contact with a dispersed medium/solvent.
Nature	They are known as reversible sol. As they can be recovered from the colloidal solutions and reconverted into colloidal form when needed.	They are known as irreversible sol. As they cann't be recovered from the colloidal solutions form.
Hydration	Colloidal particles are highly hydrated	Colloidal particles are poorly hydrated
Effect of electrolyte	A small quantity of electrolytes has no effect but a larger quantity of electrolyte causes coagulation.	A small quantity of electrolytes causes coagulation.
Effect of electric field	The particles may or may not migrate in an electric field. The migration may be in any direction.	The particles migrate only in one direction in the presence of the electric field.
Concentration of dispersed phase	Higher concentrations of disperse phase is possible.	Only lower concentrations of the dispersed phase are possible.
Stability	Very stable. (Coagulated with difficulties)	Less stable. (Coagulated easily)

Classification of Colloids

❑ Some other types of colloids-

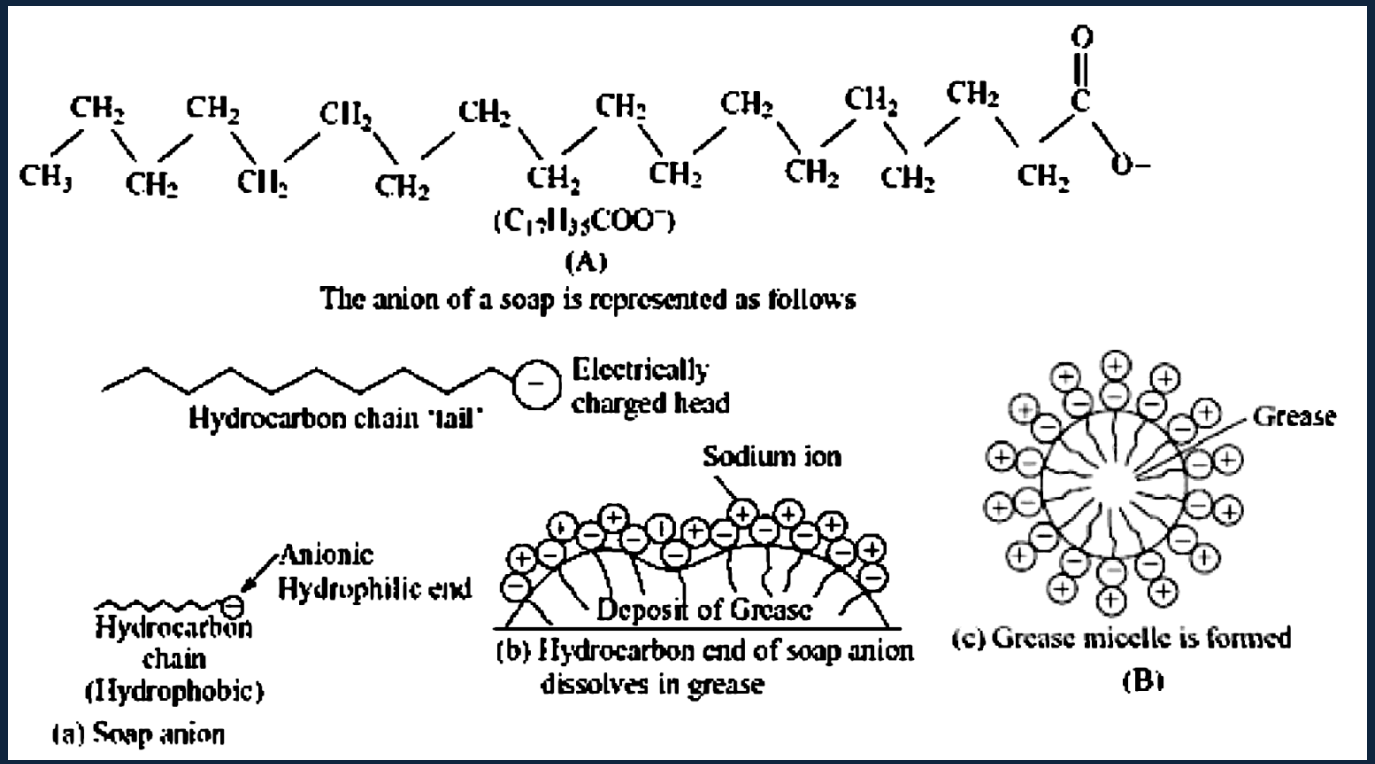
Dispersion Colloids	The dispersion phase has little affinity for the dispersion medium and the size of the solid particles lies in the colloidal range (1 to 100 nm). Generally, this type belongs to lyophobic sols. *e.g.;* Au sol, hydrated ferric oxide sol etc.
Multimolecular or Association Colloids	An individual colloidal particle consists of an aggregate of a large number of small atoms or molecules. The size of such species lies in the colloidal range. Generally, in this type, both lyophobic and lyophilic parts are present in the same molecules. Thus the aggregates of ions or molecules with lyophobic and lyophilic parts produce associated colloids or Micelles. *e.g.;* Soap solution, dye, surface active agents etc.
Macromolecular or Molecular Colloids	Each particle of the dispersed phase is of colloidal dimensions. Generally, this type belongs to lyophilic sols. This resembles a true solution in some respects. *e.g.;* Protein, cellulose, the solution of rubber and polymer in organic solvents etc.

Formation of Micelles

❑ Micelles

An individual colloidal particle consists of aggregates of many small ions or molecules (as many as 100 molecules) with lyophobic and lyophilic groups are called Micelles.

❑ Cleaning action of soaps on the basis of "Micelles" formation



Preparation of Colloidal Solution

❑ Physical Method

Dispersion method

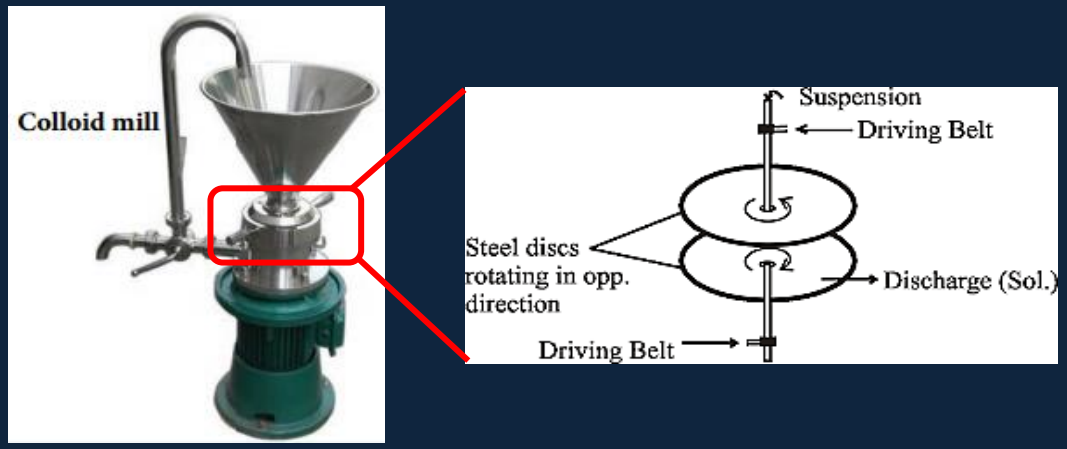
- ✓ Mechanical dispersion or Disintegration
- ✓ Electrical dispersion or Bredig's arc method
- ✓ Peptization (Dispersion of a precipitate)
- ✓ Dispersion by ultrasonic wave
- ✓ Exchange of solvent

❑ Chemical Method

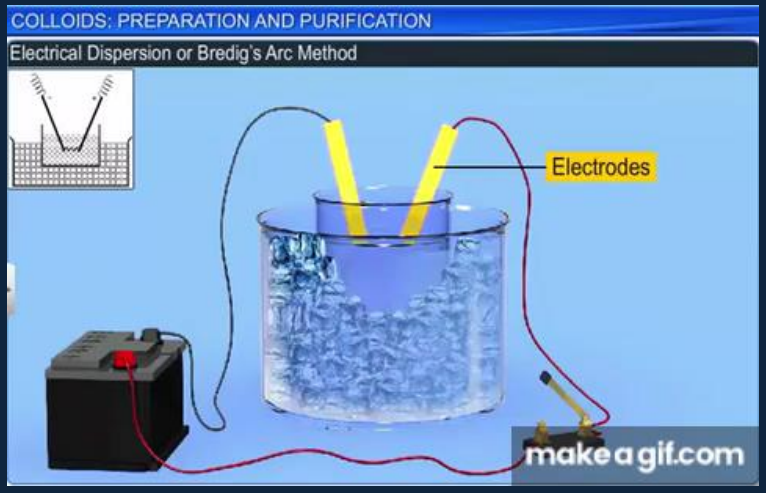
- ✓ Oxidation
- ✓ Reduction
- ✓ Hydrolysis
- ✓ Double decomposition

Preparation of Colloidal Solution

❖ Mechanical dispersion or Disintegration

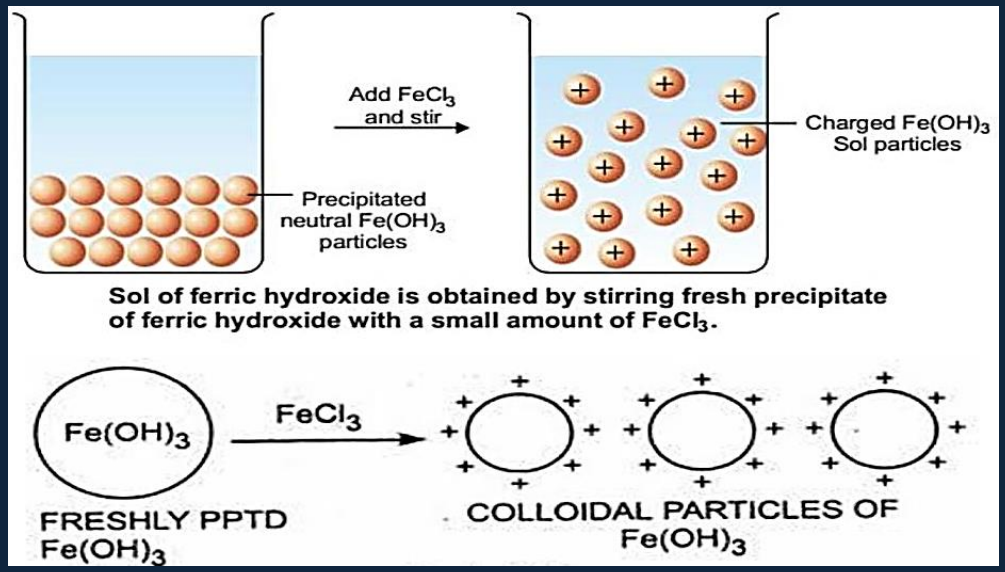


❖ Electrical dispersion or Bredig's arc method



Preparation of Colloidal Solution

❖ Peptization (Dispersion of a precipitate)



❖ Dispersion by ultrasonic wave

Preparation of Colloidal Solution

❖ Exchange of solvent

There are certain substances which are more soluble in one solvent as compared to another. A colloidal solution of such substances can be obtained by pouring the solution of the substances in which it is more soluble to the other solvent, in which it is soluble to a smaller degree.

For example-

Sulphur and phosphorus are more soluble in alcohol than water. If their alcoholic solution is added to a small quantity of water, hydrosol results.

❖ Oxidation reaction

Colloidal particles of some non-metals are obtained by oxidation.

For example-

The sulfur colloidal form is obtained by passing H_2S gas through bromine water or oil.

$$H_2S + Br_2 \longrightarrow 2HBr + S$$ (Colloidal Particles)

Preparation of Colloidal Solution

❖ Reduction reaction

Colloidal particles of some metals are obtained by the reduction of their salts.

For example-

A colloidal solution of gold is obtained by adding a stannous chloride solution to a solution of gold chloride.

$$2AuCl_3 + 2SnCl_2 \longrightarrow 3SnCl_4 + 2Au \quad \text{(Colloidal Particles)}$$

❖ Hydrolysis reaction

This method is generally used for the preparation of colloids of a number of hydroxides and hydrous oxides.

For example-

A colloidal solution of ferric hydroxide is obtained by adding ferric chloride to hot boiling water.

$$FeCl_3 + 3H_2O \longrightarrow Fe(OH)_3 \text{ (Colloidal Particles)} + 3HCl$$

Preparation of Colloidal Solution

❖ Double decomposition

This is the usual way of forming colloids of insoluble salts. If the solutions containing the component ions of an insoluble substance are mixed, a precipitate will result.

For example-

A colloidal solution of arsenious sulphide is obtained by adding water saturated with H_2S gas to a solution of arsenious oxide.

$$As_2O_3 + 3H_2S \longrightarrow As_2S_3 \text{ (Colloidal Particles)} + 2H_2O$$

❑Purification of Colloidal Solution

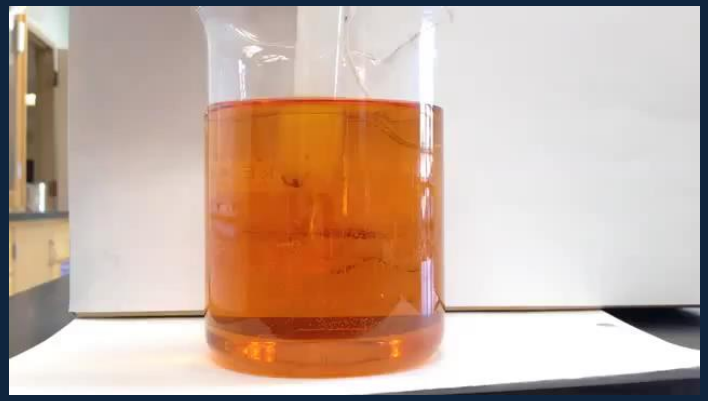
- ✓ Dialysis
- ✓ Electro-dialysis
- ✓ Ultra filtration

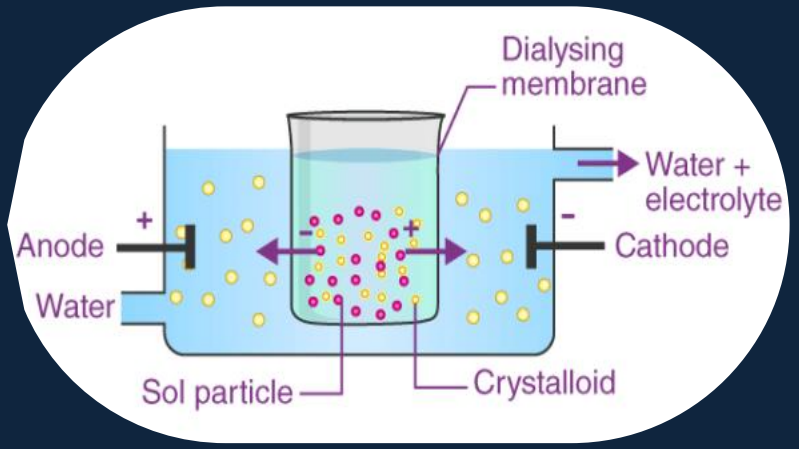
Purification of Colloidal Solution

❖ Dialysis

The process of removing the dissolved electrolytes or crystalloids from the sol by means of a membrane is called dialysis. The colloidal particles are retained by an animal membrane or parchment paper while electrolytes/crystalloids pass through them.

- The sol is taken in a parchment or cellophane bag, which itself is placed in running water in a trough.
- Gradually the soluble impurities diffuse out leaving a pure sol behind.
- It's a slow process and takes several hours or a day for complete purification.



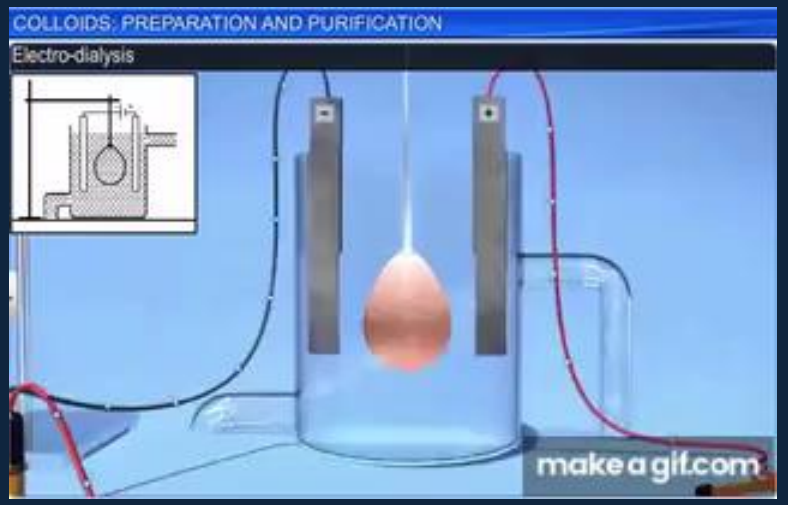


Purification of Colloidal Solution

❖ Electro-dialysis

Dialysis can be fastened by applying an electrical field if the substance in the true solution is an electrolyte. This process is called electro-dialysis.

In this process, it is possible to get a colloid in pure state in a short time.



❖ Ultra-filtration

This is a method not only for the purification of sol but also for concentrating the sol. The pore of the ordinary filter papers are large enough (1030 mμ) for the colloidal particles (1 to 100 nm) to pass through. But if the pores are made smaller the colloidal particles may be retained on the filter paper. This process is known as ultra-filtration.