Subject: Organic Chemistry, paper III(A)
Topic: Colloids

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Colloids: A **colloid** is a mixture in which one substance is dispersed throughout another substance. Colloids solutions are heterogeneous in nature. In such a mixture, dispersed phase is a substance dissolved in another substance, known as a dispersion medium.

Dispersed Phase: It is the substance present in small proportion and consists of particles of colloids size (1 to 100 nm).

Dispersion Medium: It is the medium in which the colloids particles are dispersed. Each of the two phases namely, dispersed phase and dispersion medium can be solid, liquid or gas. Thus, different types of colloidal solutions are possible depending upon the physical state of the two phases. Different types of colloidal solutions and their examples are shown in Table 1. You should note that gases cannot form a colloidal solution between themselves, because they form homogenous mixtures.

Table 1: Types of Colloidal Solutions

Phase/Medium		Dispersed phase		
		Gas	Liquid	Solid
Dispersion medium	Gas	**None** (All gases are mutually miscible)	**Liquid aerosol** Examples: Fog, Mist, Cloud, Hair sprays	**Solid aerosol** Examples: Smoke, Dust in air
	Liquid	**Foam** Example: Shaving cream	**Emulsion** Examples: Milk, Cream	**Sol** Examples: Pigmented ink, Blood, Paints, Muddy water, Gold sol, Starch sol
	Solid	**Solid foam** Examples: Foam rubber, Pumice stone	**Gel** Examples: Silica gel, Jelly	**Solid sol** Example: Glass, Gemstones

Depending upon the nature of interactions between dispersed phase and the dispersion medium, Colloidal solutions, are classified into two types as (i) lyophilic (solvent loving) and (ii) lyophobic colloids (solvent hating).

(i) ***Lyophilic colloids*****:** "The colloidal solution in which the particles of the dispersed phase have a great affinity for the dispersion medium, are called lyophilic collodis." In such colloids, the dispersed phase does not precipitate easily and the colloids are quite stable. If the dispersion medium is separated from the dispersed phase, the colloids can be reconstituted by simply remixing with the dispersion medium. Hence, these colloids are reversible in nature, e.g. colloids of gum, polymers in organic solvents.

(ii) *Lyophobic colloids*: "The colloidal solution in which there is no affinity between particles of the dispersed phase and the dispersion medium are called lyophobic colloids." These colloids are easily precipitated on addition of small amount of electrolytes, by heating or by shaking and therefore are not stable. Once precipitated, it is not easy to reconstitute the colloid by simple mixing with the dispersion medium. Hence these colloids are irreversible in nature, e.g. colloids of metals.

Preparation of colloids: As discussed earlier, the lyophilic sols can be prepared directly by mixing the dispersed phase with the dispersion medium. For example, colloidal solutions of starch, gelatin, gum etc. are prepared by simply dissolving these substances in hot water.
However, lyophobic colloids cannot be prepared by **direct method**.
Hence two types of methods are used for preparing lyophobic colloids. These are : (A) Dispersion methods and **(B) Condensation methods**

(A) Dispersion methods: In this method, coarse particles are reduced in size by;

1) Ultrasonic generator: Dispersion achieved by high intensity UG at frequency *more than 20,000 cycles/second*

2) Electric arc. Involves production of an electric arc within the liquid and dispersion achieved by *intense heat generated by the arc* so some metal of the electrodes dispersed as vapour then condense to colloidal particles.

3) Colloid mill**:** Material *sheared* between two rapidly rotating close plates.

(B) Condensation methods: In this method, materials of sub colloidal dimensions are caused to aggregate into particles with colloidal size range by;

1) Change in solvent:

Change in solvent ⟶ Super saturation ⟶ Formation & growth of nuclei.
(colloidal system formation)
e.g. sulfur and alcohol in excess of water

2) Chemical reaction:

- Hydrogen sulfide $\xrightarrow{\text{Oxidation}}$ Sulfur atoms ⟶ Sulfur sol
  $Br_2 + H_2S \longrightarrow S + 2HBr$
  $HNO_3 + H_2S \longrightarrow H_2O + NO_2 + S$
- Ferric chloride + water $\xrightarrow{\text{Hydrolysis}}$ Ferric oxide sol. (red color).

Peptisation: Peptisation is the process of converting a freshly prepared precipitate into colloidal form by the addition of a suitable electrolyte. The electrolyte is called peptising agent. For example when ferric chloride is added to a precipitate of ferric hydroxide, ferric hydroxide gets converted into reddish brown coloured colloidal solution. This is due to preferential adsorption of cations of the electrolyte by the precipitate. When $FeCl_3$ is added to $Fe(OH)_3$, Fe^{3+} ions from $FeCl_3$ are adsorbed by $Fe(OH)_3$ particles. Thus the $Fe(OH)_3$ particles acquire + ve charge and they start repelling each other forming a colloidal solution.

Purification of colloids: *Why?*

Freshly prepared colloidal solutions usually contain the impurities of electrolytes. The presence of electrolytes in smaller concentrations stabilizes a sol but their presence in large concentration tends to destabilize the colloidal solution.

Therefore, it is necessary to purify colloidal solutions by removing the impurities of electrolytes present in them.

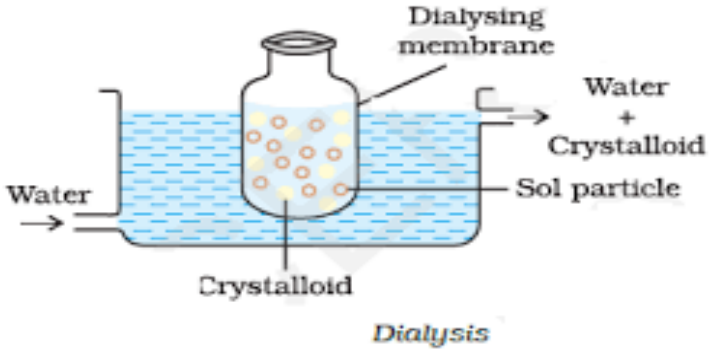
Therefore colloidal solutions are purified by the following methods:

(a) Dialysis.

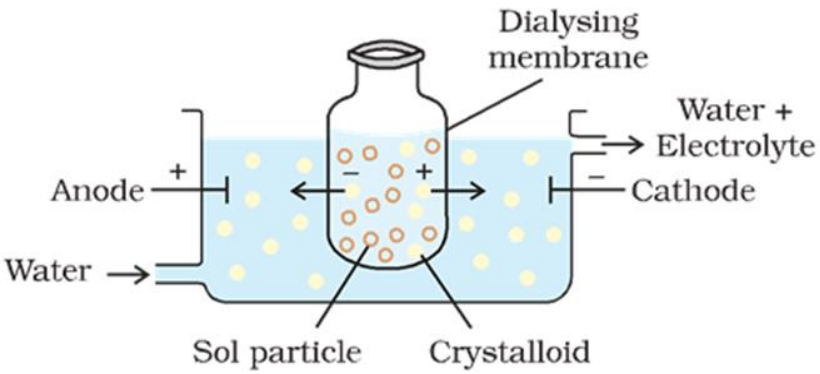
(b) Electro dialysis.

(c) Ultra filtration.

(a) Dialysis: This process depends on ***difference in size*** between colloidal particles & molecular particles (impurities). Semi permeable membrane (e.g. collodion (nitrocellulose), cellophane) is used in this procress. Pore size of used semi permeable membrane prevent passage of colloidal particles & permit passage of small molecules & ions (impurities) such as urea, glucose, and sodium chloride, to pass through. The colloidal solution is taken in a bag of cellophane which is suspended in a tub full of fresh water. The impurities diffuse out leaving pure coloidal solution in the bag. This process of separating the particles of colloids from impurities by means of diffusion through a suitable membrane is called ***dialysis***.



(b) Electro dialysis: The dialysis process is slow and to speed up its rate, it is carried out in the presence of an electrical field. Under the influence of electric field, the impurity ions move faster to the oppositely charged electrodes and the process gets quickened. The dialysis carried out in the presence of electric field is known as electrodialysis.



(c) Ultra filtration: The pores of an ordinary filter paper are large enough to allow the passage of both impurity particles as well as colloidal particles. Therefore an ordinary filter paper cannot be used for removing the impurities of electrolytes from an impure sol. However, if the pore size of ordinary filter paper is reduced, it can be used for separating the impurities from impure sols. This is achieved by treating an ordinary filter paper with gelatin or collodion (nitrocellulose), followed by its hardening by dipping it in formaldehyde solution. This treatment reduces the pore size and enables it to check the passage of colloidal particles through it. Filter papers thus obtained are called ultrafilters. Filtration through ultrafilters is called ultrafiltration. In ultrafiltration, the ultrafilter is supported over a wire mesh and the impure sol is poured over it. The impurity particles (electrolytes) pass through the ultrafilter while the larger colloidal particles are retained.

The process is very slow. However, it can be expedited by applying pressure on sol side or by using a suction pump on the filtrate side.

Intext Questions

Question 1. What is the size of colloidal particles?

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Question 2. Give one example each of
(a) Sol (b) Gel (c) Aerosol (d) Emulsion

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Question 3. The process of separating the impurity particles from an impure sol by means of diffusion through a suitable membrane is called

(a) Dialysis (b) Electrodialysis (c) Ultrafiltration (d) Centrifugation

Question 4. The apparatus used for dialysis is called dialyser. It consists of a bag made of

(a) Cellulose (b) Cellophane (c) Cellobiose (d) Agar agar