

Colloids

Depending upon diffusion of various substances in a liquid medium, Graham classified substances as follows →

- i. **Crystalloids:** These substances diffuse rapidly in solution and can pass through animal or vegetable membranes. Some examples are urea, sugar, salt etc.
- ii. **Colloids:** They diffuse very slowly in solution and cannot pass through animal or vegetable membranes. Some examples are starch and gelatin etc.

It has been shown that every substance irrespective of its nature can be crystalloid or colloid under suitable condition. For example though sodium chloride is crystalloid in water, it behaves like a colloid in benzene. Soap is colloid in water, but it behaves like a crystalloid in benzene.

In modern Science colloidal state is defined as follows “A substance is said to be in the colloidal state when it is dispersed to another medium in the form of very small particles having diameter between 10^{-4} – 10^{-7} cm”.

Various phases of colloidal solution

A colloidal solution may be considered as a heterogeneous system consisting of following three essential components:

- i. **Dispersed phase:** The phase that is dispersed or present in colloidal particle shape is called the dispersed phase. It is just like the solute in solution. This phase is also known as discontinuous phase or inner phase.

- ii. **Dispersed medium:** It is the medium in which the dispersed phase is present. It is just like the solvent of a true solution. This phase is also known as continuous phase or outer phase or external phase.

- iii. **Stabilizing agent:** It is a substance which tends to keep the colloidal particles apart, otherwise colloidal particles precipitated out by collision.

- On the basis of appearance, colloids are classified into two categories:

- i. **Sol:** When a colloidal solution appears like a fluid, it is termed as sol. Sols are named after dispersion medium. For example, when dispersion medium is water, they are called hydrosols and when dispersion medium is alcohol, they are called alcosols.

- ii. **Gel:** When colloids have a solid like appearance they are termed as gels.

- Depending upon interaction of two phases (dispersed phase and dispersion medium) colloids is classified into:

- Lyophobic colloids:** When the dispersion medium has less affinity towards dispersed phase, the colloids are termed as Lyophobic colloids.

- Lyophilic colloids:** When the dispersion medium exerts attraction on the dispersed phase, then the colloids are known as Lyophilic colloids.

In general lyophilic sols are more stable than lyophobic sols. The additional stability is due to presence of an envelope of solvents around the colloidal particles.

Difference between Lyophilic and Lyophobic Colloids

Property	Lyophilic Colloids	Lyophobic Colloids
Preparation	Easy to prepare just by mixing, shaking or heating substance with the dispersion medium.	Require special methods to prepare and an electrolyte for stabilization.
Stability	Thermodynamically stable.	Thermodynamically unstable.
Solvation	Highly solvated, dispersed particles are covered by a layer of dispersion medium.	Dispersed particles are not solvated.
Force of attraction	There is a strong force of attraction between liquids and the colloids.	There is no or very less force of attraction between liquids and the colloids.
Coagulation	Require a large amount of electrolyte for coagulation.	Get coagulated even on adding a small amount of electrolyte.
Viscosity	Lyophilic sol is highly viscous.	Lyophobic sol carries the same viscosity as the solvent.
Surface Tension	Generally less than that of the dispersion medium.	Generally the same as that of the dispersion medium.
Tyndall effects	Lyophilic sols show less Tyndall effects.	Lyophobic sols show strong Tyndall effects.
Examples	Sols of organics substances such as proteins, starch, gum and gelatins.	Sols of inorganic substances such as Ferric Hydroxide, Aluminium hydroxide, Platinum and Arsenic.

- Depending on electrical charge on dispersed phase, colloids are classified into:
 - i. **Positive colloids:** In positive colloids, the dispersed phase carries positive charge. For example, the particles of ferric hydroxide $[\text{Fe}(\text{OH})_3]$ in water are positively charged.
 - ii. **Negative colloids:** In case of negative colloids, the dispersed phase carries negative charge. For example, the particles of arsenic trisulfide $[\text{As}_2\text{S}_3]$ in water are negatively charged.

The main characteristic properties of colloidal solution

(i) **Heterogeneous nature:** Colloidal sols are heterogeneous in nature. They consist of two phases; the dispersed phase and the dispersion medium.

(ii) **Stable nature:** Colloids are relatively stable in nature. The particles of the dispersed phase are in a state of continuous motion and remain suspended in the solution.

(iii) **Filterability:** Colloidal particles are readily passed through the ordinary filter papers. However they can be retained by special filters known as ultrafilters (parchment paper).

(iv) **Colligative properties:** Colloidal solutions exhibit the colligative properties osmotic pressure, elevation in boiling point, depression in freezing point and relative lowering of vapour pressure, in the same way as true solutions do.

Colloids exhibit measurable osmotic pressure, which can be determined with a reasonable degree of accuracy. This property of colloidal solutions is, therefore, used to determine the average molecular masses of certain colloidal particles, like proteins and other polymers.

Dialysis

After the preparation of the colloid, say, by a precipitation technique, it becomes necessary to remove the excess electrolyte from the sol to impart stability to the sol. One could think of filtering the colloidal system, wash the colloid, and re-disperse. But even the finest filter paper will retain little or none of the colloid. Electrolytes or other soluble materials in sols are removed by putting the sol in a membrane of cellophane or parchment surrounded by water as shown in Figure 1. The salts can pass through the membrane of parchment and are gradually washed away by the running water whereas the colloid is left inside the Vessel. This process of separation of colloid and crystalloid is called dialysis. Graham himself insisted on the importance

of dialysis. The assembly in which the dialysis is carried out is called a dialyzer. The process of separating the colloidal particles from those of crystalloids by diffusion of the mixture through a parchment or animal membrane is known as dialysis.

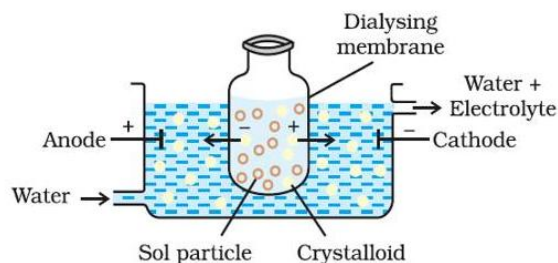


Figure 1. Purification of Colloids: Dialysis and Electrodialysis.

The membrane through which dialysis is carried out serves as a sieve of extremely fine pore size so that only the small molecules or ions can pass but not the relatively larger colloidal particles or large molecules of high polymers. The membrane also controls such selective retention and passage due to the difference in diffusion and absorption. The dialysis can be frequently improved and made faster if the assembly is subjected to a suitable electric field. The migration of the ions of the electrolytes through the membrane becomes quite fast in the electric field and makes the process rapid. This is known as electrodialysis.

(1) Dialysis: The process in which the ions are removed from the solution by the phenomenon of diffusion through a permeable membrane is known as dialysis.

(i) In this process, a sol consisting of ions or molecules is filled in a permeable membrane bag, dipped in the water. The ions from the solution diffuse through the permeable membrane.

(ii) Its principle is based upon the fact that colloidal particles cannot pass through a parchment or cellophane membrane while the ions of the electrolyte can pass through it.

(iii) The impurities slowly diffuse out of the bag leaving behind pure colloidal solution.

(iv) Distilled water is changed frequently to avoid an accumulation of the crystalloids otherwise they may start diffusing back into the bag.

(v) Dialysis can be used for removing from the ferric hydroxide sol.

(2) Electrodialysis: In this process dialysis of the colloidal solution is carried under the effect of an electric field. Some potential is applied between the metal screens that support the membranes.

(i) Due to this potential, the speed of the ions moving in the direction of the opposite electrodes is increased. Thus, the rate of dialysis is increased.

(ii) The ordinary process of dialysis is slow. However, it can be expedited by applying an electric field.

(iii) To increase the process of purification, dialysis is carried out by applying an electric field. This process is called electrodialysis.

(iv) Under the influence of the electric field, the impurity ions move faster to the oppositely charged electrodes and the process gets quickened.

(v) This method is not useful for non-electrolyte impurities like urea etc.