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COLLOIDS

DISTINCTION BETWEEN A TRUE SOLUTION, COLLOIDAL SOLUTION AND SUSPENSION

- **True Solution:** It is a homogeneous mixture of two or more materials with a particle size of less than 10-9 m or 1 nm dissolved in the solvent. Example: Simple sugar solution in water.
- **Suspension:** A suspension is defined as a homogenous mixture of particles with a diameter greater than 1000 nm such that the particles are visible to naked eyes. Ex. Muddy water and Milk of magnesia.
- **Colloidal solution:** Colloidal solutions are intermediate between true solutions and suspensions. Their size ranges in the order 1 nm to 1000 nm

PHASES OF COLLOIDS SOLUTION

- Colloids solutions are heterogeneous in nature and always consist of at least two phases: the dispersed phase and the 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. For example, in a colloidal solution of sulphur in water, sulphur particles constitute the 'dispersed phase' and water is the 'dispersion medium'.

CLASSIFICATION OF COLLOIDS

Colloidal solutions can be classified in different ways: **(a) On the basis of interaction between the phases:** Two types: **(i) Lyophilic colloids:** There is strong attraction between dispersed phase and dispersion medium. These are formed by organic substances like gum, starch, protein etc. These are reversible and more stable.

(ii) Lyophobic Colloids: There is very little interaction between dispersed phase and dispersion medium and are formed by inorganic substances like metals, their sulphides etc. These are irreversible and less stable.

(b) On the basis of molecular size: Three types:

(i) Macromolecular colloids: In this type of colloids the size of the particles of the dispersed phase is big enough to fall in the colloidal dimension as discussed earlier (i.e. 1–100 nm) Examples of naturally occurring macromolecular colloids are starch, cellulose, proteins etc.

(ii) Multi molecular colloids: Here individually the atoms are not of colloidal size but they aggregate to join together forming a molecule of colloidal dimension. For example sulphur sol contains aggregates of S8 molecules which fall in colloidal dimension.

(iii) These are substances which behave as normal electrolyte at low concentration but get associated at higher concentration to form miscelle and behave as colloidal solution. Soap is an example

PREPARATION OF COLLOIDA SOLUTIONS

- Lyophilic sols are prepared simply by the stirring dispersed phase with dispersion medium. Examples include sol of starch, gelatin, and egg albumin.

Methods of preparation of lyophobic sols can be prepared by two types of methods: **(i)** Condensation and **(ii)** Dispersion

- **Condensation methods:** Condensation methods are in turn of four different types:

(i) Hydrolysis, **(ii)** Reduction, **(iii)** Oxidation and **(iv)** Double decomposition method

- **Dispersion method:** It involves breaking down of large particles of a substance into particles of colloidal size. There are three such methods:
- **Mechanical dispersion**
- **Bredig's arc method** (to prepare metal sol)
- **Peptisation method** (to convert precipitate into particles of colloidal size using suitable *peptizing agent*). The peptizing agent used is usually an electrolyte.

PURIFICATION OF COLLOIDAL SOLUTION

- Colloidal contains a number of electrolytic impurities. The following method are used to purify colloids:
- **Dialysis** (by using semi permeable membrane)
- **Ultra-filtration** (by using ultra fine quality filter papers)
- **Ultra-centrifugation**

PROPERTIES OF COLLOIDS

The colloidal solution shows the following properties:

- **Colligative properties:** The properties of a solution which depends on the number of moles of solute particles present in the solution are called colligative properties like osmotic pressure, elevation in boiling point etc.
- **Tyndall effect:** The scattering of light by colloidal particles is known as Tyndall effect. True solutions do not show Tyndall effect.
- **Brownian movement**: The zigzag motion of the colloidal particles is termed as Brownian movement. This is due to the impact of the molecules of the dispersion medium on the molecules of the dispersed phase.
- **Electrophoresis**: The movement of colloidal particles towards their respective electrodes in the presence of electric field is known as electrophoresis. This is also known as cataphoresis. This helps in determining the charge present on the colloid.

COAGULATION OR PRECIPITATION

- **Coagulation and Flocculation:** The process of forming aggregates from colloidal particles by the addition of suitable electrolyte is called ***coagulation*.**
- The addition of an electrolyte to a lyophobic colloid results in its coagulation. At lower concentration of electrolyte, the aggregation of particles is called ***flocculation*.** Flocculation is reversible while coagulation is irreversible.
- **Hardy-Schulze's rules:** The precipitation or coagulating power of an electrolyte is determined by using Hardy-Schulze's rules.
- The effective ions of the electrolyte in bringing about coagulation are those which carry charge opposite to that of the colloidal particles. These ions are called coagulating ions.
- **Emulsion:** Emulsions are colloids in which both the dispersed phase and the dispersion medium are in the liquid states.
- **Types of Emulsion: (i)** Oil in water For example: Milk, vanishing cream and **(ii)**

Water in oil For example: Cold cream and butter

- **Emulsification:** The process of making emulsion is called *emulsification*.
- **Emulsifier or Emulsifying agent:** The emulsions are generally prepared by shaking strongly the mixture of two colloids these emulsions are generally unstable, e.g., oil and water are immiscible and form unstable emulsions.
- **Demulsification:** The process of converting the emulsion back into two distinct components, oil and water is called demulsification. This can be carried out by Boiling, Freezing, Changing pH, and by Electrostatic precipitation.

Classification of the state of aggregation of the dispersed phase and the dispersion medium

Dispersed phase	Dispersion medium	Type of dispersed system	Example
Gas	Liquid	Foam	soap lather, whipped cream, soda water
Gas	Solid	Solid foam	bread, pumice, slag, foam concrete, lava
Liquid	Gas	Aerosol	fog, cloud, spray
Liquid	Liquid	Emulsion	milk, mayonnaise, oil in water
Liquid	Solid	Solid emulsion	pearls, cheese, curd, jelly, butter
Solid	Gas	Aerosol, powder	smoke, haze, dust-laden air, flour
Solid	Liquid	Suspension (coarsely dispersed) or sol (highly dispersed)	paints, clay, starch dispersed in water
Solid	Solid	Solid sol	alloys, colored glass, gems (ruby, emerald, black diamond)

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- The colloidal systems show Brownian movement, Tyndall effect and

- The stability of lyophilic sols is due to their greater hydration in the solution.
- The colloidal systems show Brownian movement, Tyndall effect and electrophoresis.

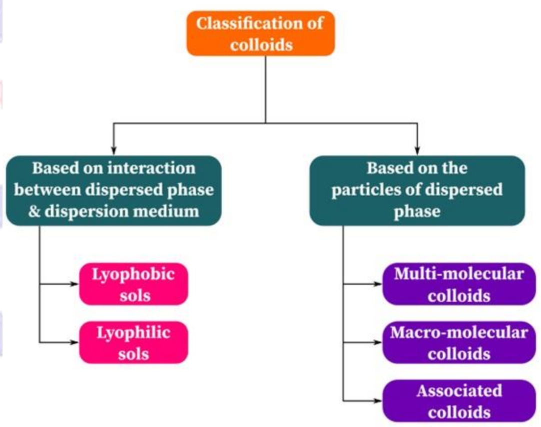
APPLICATIONS OF COLLOIDAL SOLUTIONS

- **Sewage disposal:** Colloidal particles of the dirt, mud etc.
- **Cleansing action of soap:** Soap solution is colloidal in nature.
- **In rubber plating**
- **Medicines:** Number of medicines are emulsions.
- **Artificial rain**: Artificial rain can be caused by spraying oppositely charged colloidal dust or sand particles over a cloud.
- **Disinfectant:** Certain disinfectants like Dettol and Lysol are formed of oil-in-water type emulsion.

TYPES OF COLLOIDAL SOLUTIONS

electrophoresis.

CLASSIFICATION OF COLLOIDS



Examples of Colloids

(1) Blood: A respiration pigment which has albumin protein in water. Pigment part contains albumin that acts as the dispersed phase and the dispersion medium is water. It is a hydrosol.

(2) Cloud: It contains air which is the dispersion medium and droplets of water as a dispersed phase. These are aerosol.

(3) Gold sol: It is a metallic sol in which gold particles are dispersed in the water.

- Aggregate of ions in an associated colloidal sol is called *ionic micelle*. The concentration above which these are formed is called *critical micelle concentration* (CMC) and the temperature above which these are formed is called Kraft temperature (T_k).

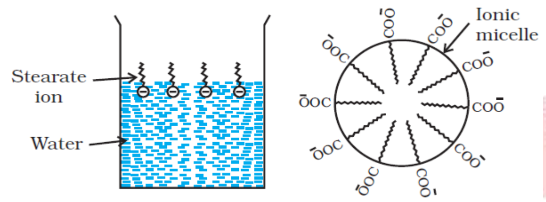


Fig. 8.1: Aggregation of $RCOO^-$ ion to form a micelle

- The minimum number of milligrams of a lyophilic sol needed to protect 10 mL of gold sol by the addition of 1 mL of 10% NaCl is called *gol number*. Protective power is the reciprocal of gold number.

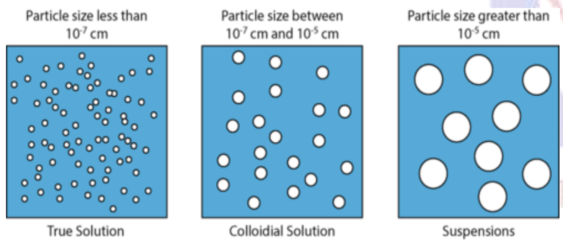


Fig. 8.1 Distinction between a True solution, Colloidal solution and Suspension

- The potential difference between the fixed layer and the diffused layer of opposite charges in colloids is called *electrokinetic potential* or *zeta potential*.

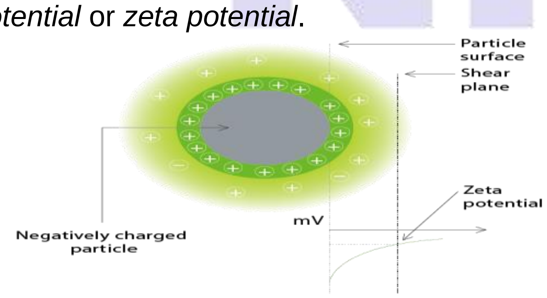


Fig. 8.2 Electro kinetic potential or zeta potential.

Check Yourself

1. Which shape selective catalyst is used to convert alcohol to gasoline?

(a) Trpsin (b) Calgon

(c) ZSM-5 (d) Zeigler-Natta catalyst

2. Lyophillic colloids are stable due to

(a) Charge on the particles.

(b) Large size of the particles.

(c) Small size of the particles.

(d) Layer of dispersion of medium on the particles.

3. Cottrell precipitator is used to

(a) Precipitate mud from muddy water.

(b) Precipitate carbon particles from smoke.

(c) Purify the ordinary drinking water.

(d) Precipitate salts in qualitative analysis.

4. In Freundlich adsorption isotherm $x/m = Kp^{1/n}$, the value of 'n' at low pressure is

(a) More than one. (b) Less than one.

(c) Equal to one. (d) From zero to one.

5. Peptization is a process of

(a) Precipitation of colloidal particles.

(b) Purification of colloids.

(c) Dispersing precipitate into colloidal solution.

(d) Movement of colloidal particles in the electric field.

Stretch Yourself

1. Out of NH_3 and CO_2 which gas will be adsorbed more readily on the surface of activated charcoal and why?

2. What are emulsions? Name an emulsion in which water is a dispersed phase.

3. A delta is formed at the melting point of sea water and river water. Why?

4. In reference to surface chemistry, define dialysis.

5. Which of the following is most effective in coagulating negatively charged hydrated ferric oxide sol?

(i) $NaN0_3$ (ii) $MgSO_4$ (iii) $AlCl_3$

Test Yourself

Question: Out of NH_3 and CO_2 which gas will be adsorbed more readily on the surface of activated charcoal and why?

Answer: NH_3 gas will be adsorbed more readily on activated charcoal. It has higher critical temperature than CO_2 and is an easily liquefiable gas. Its Van der Waals forces are stronger.

Answers

Check Yourself

Answer: 1(C); 2(C); 3(B); 4(C); 5(C)

Stretch Yourself

1. NH_3 has higher critical temperature than CO_2, *i.e.,* NH_3 is more liquefiable than CO_2. Hence, NH_3 has greater intermolecular forces of attraction and hence will be adsorbed more readily.
2. Do it by yourself.
3. River water is a colloidal solution of clay and sea water contains a number of electrolytes. When river water meets the sea water, the electrolytes present in the sea water coagulate the colloidal solution of clay resulting in its deposition with the formation of delta.
4. Dialysis is a process of removing a dissolved substance from a colloidal solution by means of diffusion through a suitable membrane
5. Hydrated ferric oxide sol $AlCl_3/Al^{3+}$