Chemistry Study Materials for Class 12
(NCERT Based Notes of Chapter – 05)
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Surface Chemistry

Classification colloids

1. *Based on the physical state of dispersed phase and the dispersion medium*

Depending upon physical state of the dispersed phase and the dispersion medium, there are eight types of colloidal systems. A gas mixed with another gas forms a homogeneous mixture and hence is not a colloidal system. The different types colloidal dispersion are:

Dispersed Phase	Dispersion medium	Type of colloid	Examples
Solid	Solid	Solid Sol	Some coloured glasses and gem stones
Solid	Liquid	Sol	Paints, Cell fluids
Solid	Gas	Aerosol of solid	Smoke, dust
Liquid	Solid	Gel	Cheese, butter, jellies
Liquid	Liquid	Emulsion	Milk, hair cream, cod liver oil
Liquid	Gas	Aerosol of liquid	Fog, mist, cloud, insecticide sprays
Gas	Solid	Solid foam	Pumice stone, foam rubber
Gas	Liquid	Foam	Froth, whipped cream, soap lather

2. *Based on the dispersion medium*, colloids are classified as follows:

Dispersion medium	Name of colloid
Air	Aerosol
Water	Hydrosol
Alcohol	Alco sol
Benzene	benzosol

3. *Based on the attraction between the dispersed phase and the dispersion medium*,

colloids are of two types: ***lyophilic*** (solvent loving) and ***lyophobic*** (solvent hating). *If the force of attraction between dispersed phase and dispersion medium is strong, it is called lyophilic sol*

e.g. gum, gelatin, starch, rubber etc in suitable dispersion medium.

If the force of attraction between dispersed phase and dispersion medium is weak, it is called lyophobic sol.

e.g. Arsenic sulphide (As_2S_3) sol, sulphur sol and metal sols like gold sol, silver sol etc.

Differences between lyophilic and lyophobic sols

Properties	Lyophilic sol	Lyophobic sol
Force of attraction	Strong	Weak
Preparation	Can be easily prepared by mixing the dispersed phase with the dispersion medium	Some special methods are used for the preparation
Reversibility	Reversible (i.e. they can be easily separated and remixed)	irreversible
Stability	Self stabilized	Less stable and requires some stabilizing agent
Coagulation	large amount of electrolyte is required for coagulation	Only small amount of electrolyte is required.

4. Based on the nature of particles:

Based on this, colloids are of three types – Multimolecular colloids, Macro molecular colloids and Associated colloids.

1. ***Multimolecular colloids***: They contain an aggregate of atoms or molecules having dimension < 1nm. These particles are bind together by weak van der Waal's force of attraction and form particles of colloidal dimension.

e.g. Arsenic sulphide (As_2S_3) sol, sulpher sol and metal sols like gold sol, silver sol etc.

2. ***Macromolecular colloids***: Macromolecules (Polymers) in suitable solvents form solutions in which the size of the particle is in the colloidal range. Such systems are called macromolecular colloids. These colloids are quite stable and resemble true solutions in many properties.

Example: solutions of starch, cellulose, proteins, enzymes, polythene, nylon, polystyrene, synthetic rubber, etc. in suitable dispersion medium.

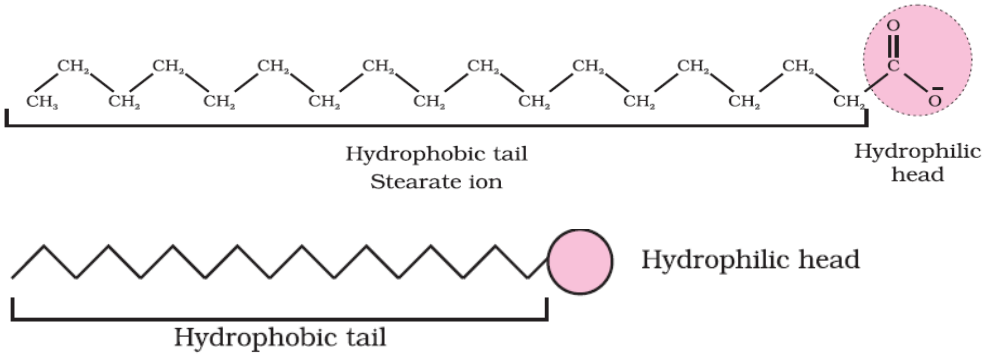
3. ***Associated colloids***: These are substances which behave as normal strong electrolytes at low concentrations, but as colloids at higher concentrations. The colloidal behavior is because of the formation of aggregates. They are also called ***micelles***.

The formation of micelles takes place only above a particular temperature called ***Kraft temperature*** (**T_k**) and above a particular concentration called ***critical micelle concentration*** (**CMC**).

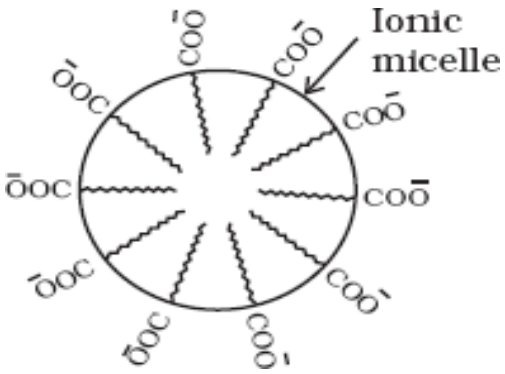
Surface active agents such as soaps and synthetic detergents are examples for micelles. These colloids have both lyophobic and lyophilic parts.

Mechanism of micelle formation

An example for micelle is soap solution. Soap is sodium or potassium salt of a higher fatty acid and may be represented as $RCOO^-Na^+$. When dissolved in water, it dissociates into $RCOO^-$ and Na^+ ions. The $RCOO^-$ ions consist of two parts — a long hydrocarbon chain R (also called non-polar 'tail') which is hydrophobic (water repelling), and a polar group COO^- (also called polar-ionic 'head'), which is hydrophilic (water loving).



The $RCOO^-$ ions are present on the surface with their COO^- groups in water and the hydrocarbon chains (R) at the surface. But at critical micelle concentration, the anions are pulled into the bulk of the solution and aggregate to form a spherical shape. Thus a micelle is formed.



Cleansing action of soaps

The cleansing action of soap is due to micelle formation. The soap molecules form micelle around the oil droplet in such a way that hydrophobic part is in the oil droplet and hydrophilic part projects out. Since the polar groups (hydrophilic end) can interact with water, the oil droplets are pulled in water and removed from the dirty surface. Thus soap helps in emulsification and washing away of oils and fats.

Preparation of colloids

Some of the methods used for the preparation of colloids are:

a) **Chemical methods**:

Colloidal solutions can be prepared by chemical reactions like oxidation, reduction, double decomposition, hydrolysis etc.

1. ***Oxidation***: Sulphur sol can be prepared by passing H_2S gas through an *aqueous solution of sulphur dioxide.*

$$SO_2 + 2H_2S \xrightarrow{\text{Oxidation}} 3S\ (sol) + 2H_2O$$

2. ***Reduction***: Sols of metals like silver, gold and platinum are obtained by the reduction of their salts with reducing agents like formaldehyde, stannous chloride etc.

$$2AuCl_3 + 3HCHO + 3H_2O \xrightarrow{\text{Reduction}} 2Au(sol) + 3HCOOH + 6HCl$$

3. ***Hydrolysis***: Ferric hydroxide sol is obtained when concentrated solution of ferric chloride is added drop-wise to hot water.

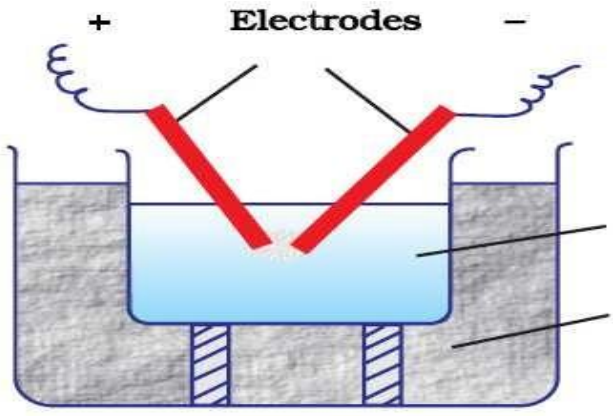
$$FeCl_3 + 3H_2O \xrightarrow{\text{Hydrolysis}} Fe(OH)_3\ (sol) + 3HCl$$

4. ***Double decomposition***: A colloidal solution of arsenic sulphide is formed by passing H_2S through a dilute solution of arsenious oxide in water.

$$As_2O_3 + 3H_2S \xrightarrow{\text{Double decomposition}} As_2S_3(sol) + 3H_2O$$

b) **Electrical disintegration (Bredig's arc method):**

This method is used for the preparation of metal sols like Ag, Au, Pt etc. The metal whose sol is to be prepared is taken in the form of two rods and it is kept in suitable dispersion medium containing small amount of electrolyte. The whole arrangement is kept in an ice bath. When high voltage is passed through the metal, the intense heat produced vaporizes the metal, which then condensed to form particles of colloidal dimension.



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