

SURFACE CHEMISTRY

TOPIC-2

Colloidal state and classification of colloids, gold number and related phenomena, emulsions and classification of emulsions, cleaning action of soap

VERY SHORT ANSWER QUESTIONS

1. What is Lyophilic colloid? Give example.

Ans: Lyophilic colloids (or) Hydrophilic colloids:

Strong attractions will exist between colloids particles and medium.

Eg: organic substances like Starch, RBC, Albumin, Blue gelatin etc., and certain polymers in organic medium also formed.

2. What is Lyophobic colloid? Give example.

Ans: No attractions will exist between colloidal particles and medium

Eg: Metalsols, Metaloxidesols, Metalsulphide sols

3. What is emulsion? Give example.

Ans: Emulsion: Emulsion is liquid in liquid type colloid. These two liquids are immiscible with one another.

One of the liquid is water and other one is oil in nature.

Based on the relative amounts of these two liquids emulsions are two types

1) **Oil in water type:**

Eg : Milk [liquid disguised liquid water)

Kerosene oil in H₂O ; Vanishing cream.

2) **Water in oil type:**

Cold cream, stiff greases, cold liver oil

These emulsions are unstable. As they contain immiscible liquid

4. What is Micelle? Give examples.

Ans: Micelles:

It is the colloidal size particles formed by the spontaneous aggregation of soap anions or molecules at higher concentration (CMC). If the dispersed phase consists of micelles, such a colloid is called associated colloid. Soaps and detergents will form micelles at higher concentrations. The minimum concentration above which micelles are formed is called critical micellisation concentration.

Ex: At very low concentration soaps and detergents exist as true solution.

Soap : Sodium stearate: C₁₇H₃₅COO Na[⊖]

stearate : C₁₇H₃₅ COO

5. What is Gold sol?

Ans: GOLD SOL: It is an aquasol or hydrosol. It is a lyophobic colloid. It is a solid in liquid type colloid. It is coagulated by adding small amount of electrolytes. Dispersion phase is gold particles and dispersion medium is water. It is prepared by **Bredig arc** method.

6. What is Cloud?

Ans: CLOUD: Cloud is an aerosol. It is a colloidal suspension of water droplets in air. It is a lyophobic colloid. Droplets in cloud precipitate as rain. It is a liquid in gas sol. Dispersion phase is droplets of water (liquid) and dispersion medium is air (gas).

7. What is milk?

Ans: MILK: It is an emulsion. It is oil in water (O/W) type emulsion. It is a liquid in liquid type colloid. Dispersion phase is droplets of liquid fat and dispersion medium is water. Milk on coagulation gives emulsified fat (casein). Milk cream from milk can be separated by centrifugation. Curding of milk is coagulation of milk. On souring lactose in milk converts to lactic acid which coagulates the milk.

8. What is emulsifying agent or emulsifier?

Ans: Emulsifier: Emulsifier or emulsifying agent is the substance which stabilizes the emulsion when added to it. Emulsifier stabilizes the emulsion by reducing the surface tension. Any hydrophilic colloid can act as emulsifier.

Eg : Gelatin, Egg albumin, Soap, Mercuric iodide etc

9. What is smoke?

Ans: SMOKE: It is an aerosol, A colloidal solution of carbon in air. A lyophobic colloid, dispersion phase is carbon and dispersion medium is air. A solid in gas sol. Carbon particles are precipitated electrically to avoid pollution in electrified chimney, where carbon particles can get discharged.

10. What is Gold number?

Ans: It is defined as the weight of protective colloid (in mg) which prevents the coagulation of a given gold solution on adding 1 ml of 10% solution of sodium chloride.

11. What is protective colloid?

Ans: Some lyophilic colloids possess the property by which they protect lyophobic colloids from precipitation (or coagulation) when an electrolyte is added to it. Lyophilic colloids used for this purpose are called protective colloids.

Ex: Gelatin is lyophilic colloid which acts as protective colloid when added to gold sol. which is lyophobic.

SHORT ANSWER QUESTIONS

1. What is colloidal solution? Give two examples.

Ans: Colloidal solution: It is the heterogeneous binary system in which the dispersed particle is the aggregate of few hundreds of molecules or ions. Colloid consists of two phases.

Dispersed phase → particles which are dispersed in medium. It is also called distentiuous phase or internal phase.

Dispersion medium → It is the medium in which particles are dispersed. It is also called as external phase.

Dispersed phase can be a solid or liquid or gas. Dispersion medium can be a solid or liquid or gas.

Ex: Shaving cream, soda water froth, soap surf lemonade froths

2. Give the differences between true solutions and colloidal solutions.

Properties	Colloidal solution	True solution
Size	1 mμ → 1 μ	Less than 1 m μ
Diffusion through animal membrane	Diffuses slowly	Diffuses rapidly
Settling of particles	Will not settle by gravity but settles by centrifugation	Will not settle at all
Filterability	Can not be filtered	Can not be filtered
Filtration with ultrafilter	Can be filtered	Can not be filtered
Appearance	Turbid (clear)	Very clear
Nature	Heterogeneous	Homogenous
Tyndall effect	Will show tyndall effect	Does not show
Number of molecules are in one particle	Particle is the aggregate of few hundreds of molecules	Particle is single molecule or ion

3. What are lyophilic colloid and lyophobic collids? Give two examples.

Ans: Based on the affinity between particles and medium, colloids are classified into two types

1) Lyophilic colloids (or) Hydrophilic colloids: Strong attractions will exist between colloids particles and medium.

Eg: organic substances like Starch, RBC, Albumin, Blue gelatin etc., and certain polymers in organic medium also formed.

2) **Lyophobic colloids or hydrophobic colloids:** No attractions will exist between colloidal particles and medium

Eg: Metalsols, Metaloxidesols, Metalsulphide sols.

4. What is emulsion? Give two examples.

Emulsion:

Emulsion is liquid in liquid type colloid. These two liquids are immiscible with one another. One of the liquid is water and other one is oil in nature based on the relative amounts of these two liquids.

Emulsions are two types

1) Oil in water type:

Eg : Milk [liquid disguised liquid water)
Kerosene oil in H₂O ; Vanishing cream.

2) Water in oil type:

Cold cream, stiff greases, cold liver oil

5. How emulsions are classified?

Ans: Emulsions are two types. They are;

1) Oil in water type:

Eg : Milk [liquid disguised liquid water)
Kerosene oil in H₂O; Vanishing cream

2) Water in oil type:

Cold cream, stiff greases, cold liver oil

- These emulsions are unstable. As they contain immiscible liquid

6. What is micelle? Give an example..

Ans: Micelle: It is the colloidal size particles formed by the spontaneous aggregation of soap anions or molecules at higher concentration (CMC).

If the dispersed phase consists of micelles, such a colloid is called associated colloid. Soaps and detergents will form micelles at higher concentrations. The minimum concentration above which micelles are formed is called critical micellisation concentration.

Ex; At very low concentration soaps and detergents exist a true solution.

Soap : Sodium stearate: $C_{17}H_{35}COO \cdot Na^{\oplus}$
stearate: $C_{17}H_{35} COO$

Detergent: Sod. Lauryl sulphate – $C_{12}H_{25}OSO_3Na$

Lauryl sulphate $\rightarrow C_{12}H_{25}OSO_3$

7. Explain the cleaning action of soap?

Cleaning action of soap: In aqueous solution of soap head is towards the surface of water and tail is pointing away from the water, tail part being non – polar it has affinity towards grease, dust on the clothes. Micelles are formed by the soap with grease or dust. The micelles are then emulsified by soap. The charged layer

present around the micelle will present from aggregation.

LONG ANSWER QUESTIONS

1. What are colloids? Give the differences between “colloidal solutions and true solution”.

Colloids : which diffuse slowly through parchment membrane are Eg: starch, gum, gelatin etc., In practice it is found that a crystalloid can be made into colloid and some of the colloids were found to be crystalline in nature. There fore the term colloidal substance is replaced by colloidal state

Properties	Colloidal solution	True solution	Suspension
Size	1 m μ \rightarrow 1 μ	Less than 1 m μ	More than 1 μ
Diffusion through animal membrane	Diffuses slowly	Diffuses rapidly	Will not diffuse
Settling of particles	Will not settle by gravity but settles by centrifugation	Will not settle at all	Settles by just gravity
Filterability	Can not be filtered	Can not be filtered	Can be filtered
Filtration with ultrafilter	Can be filtered	Can not be filtered	Can be filtered
Appearance	Turbid (clear)	Very clear	Opaque
Nature	Heterogeneous	Homogenous	Heterogeneous
Tyndall effect	Will show tyndall effect	Does not show	Will show tyndall effect
Number of molecules are in one particle	Particle is the aggregate of few hundreds of molecules	Particle is single molecule or ion	Particle is the aggregate of millions of molecule

2. Explain the terms “disperse phase” and “dispersion medium” with reference to smoke, cloud, blood, Gold Sol and milk.

Ans: Colloid consists of two phases.

1. Dispersed phase \rightarrow particles which are dispersed in medium. It is also called distentiuous phase or internal phase.
 2. Dispersion medium \rightarrow It is the medium in which particles are dispersed. It is also called as external phase.
- Dispersed phase can be a solid or liquid or gas.
 - Dispersion medium can be a solid or liquid or gas.
 - Based on the physical state phase and medium colloids are classified into 8 types.

- Gas in gas will not form colloid because it is homogenous mixture. \

SMOKE:

- An aerosol,
- A colloidal solution of carbon in air.
- A lyophobic colloid, dispersion phase is carbon and dispersion medium is air.
- A solid in gas sol. Carbon particles are precipitated electrically to avoid pollution in electrified chimney, where carbon particles can get discharged.

CLOUD:

- Is an aerosol.
- It is a colloidal suspension of water droplets in air.
- It is a lyophobic colloid.
- Droplets in cloud precipitate as rain.
- It is a liquid in gas sol.
- Dispersion phase is droplets of water (liquid) and dispersion medium is air (gas).

BLOOD:

- It is an aquasol or hydrosol.
- It is a colloidal suspension of albuminoid substance in water.
- Addition of ferric chloride (large amounts) coagulates the blood and clot during bleeding of wound.
- Dispersion phase is albuminoid substance containing RBC (erythrocytes) WBC (leucocytes).
- Dispersion medium is water containing some inorganic ions and organic molecules.
- It is a solid in liquid colloid.
- Impure blood is purified by kidneys through dialysis.
- It is a negative colloid, It coagulates with positive ions like Al^{+3} or Fe^{+3} etc.,

MILK:

- It is an emulsion.
- It is an oil in water (O/W) type emulsion.
- It is a liquid in liquid type colloid.
- Dispersion phase is droplets of liquid fat and dispersion medium is water.
- Milk on coagulation gives emulsified fat (casein).
- Milk cream from milk can be separated by centrifugation.
- Curding of milk is coagulation of milk.
- On souring lactose in milk converts to lactic acid which coagulates the milk.

GOLD SOL:

- It is an aquasol or hydrosol.
- It is a lyophobic colloid.
- It is a solid in liquid type colloid.
- It is coagulated by adding small amount of electrolytes.

- Dispersion phase is gold particles and dispersion medium is water.
- It is prepared by **Bredig arc** method.

3. **How colloids are classified/ Give two examples.**

Ans: Based on the affinity between particles and medium, colloids are classified into two types

1) **Lyophilic colloids (or) Hydrophilic colloids:**

Strong attractions will exist between colloids particles and medium.

Eg: organic substances like Starch, RBC, Albumin, Blue gelatin etc., and certain polymers in organic medium also formed.

2) **Lyophobic colloids or hydrophobic colloids:**

No attractions will exist between colloidal particles and medium

Eg: Metalsols, Metaloxidesols, Metalsulphide sols.

Some example of colloids:

Property	Lyophilic	Lyophobic
Attractive forces	Strong attractions will exist [H –H bonds]	No attractions will exist
Salvation	Particles are more solvated	Particles are not solvated
Viscosity	Is more than that of medium	Same as that of medium
Ease of preparation	Can be easily prepared by direct mixing of particles with medium	Cannot be prepared by direct mixing and requires special methods.
Reversible nature	Reversible	Irreversible
Tyndall effect	Weak	Strong Tyndall effect
Stability	More stable due to salvation	Less stable because of no salvation.
Presence of electric charge	Particles may carry little charge or no charge	Particles defiantly carry charge
Ease of coagulation	Not easily coagulated. It requires large amounts of electrolyte for coagulation.	Easily coagulated by adding little amount of electrolyte.

4. **What are protective colloids? Define and explain gold number.**

Ans: Protective Colloids and Gold Number

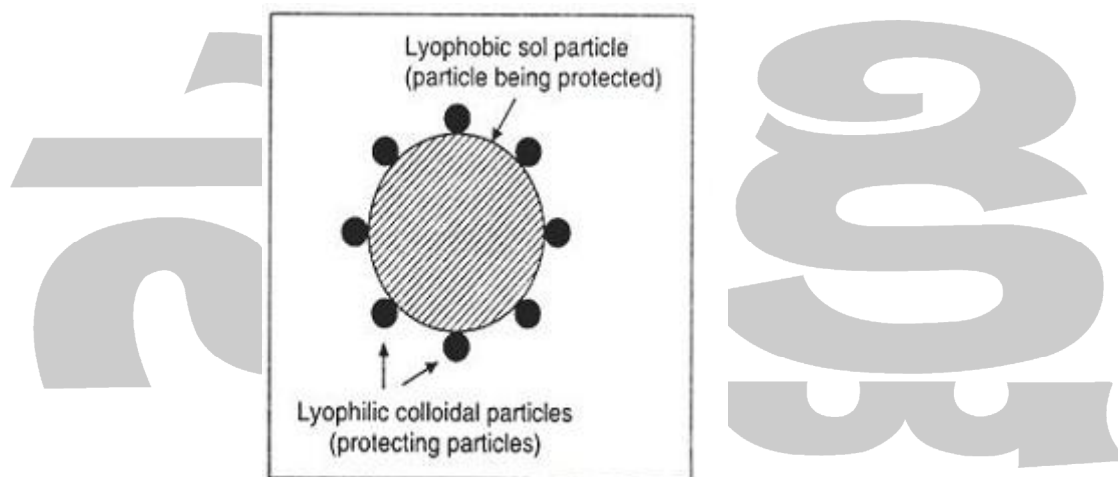
Lyophobic sols such as those of metals (e.g. Au, Ag, Pt etc.) are not very stable in the sense that they get easily coagulated (precipitated) in the presence of an electrolyte. This poses a big problem in their storage and usage. Contrary to this, lyophilic sols are much more stable and do not get coagulated easily under similar conditions.

It has been observed that in the presence of certain lyophilic colloids such as gum Arabic, gelatin, starch etc. the hydrophobic sols acquire greater stability towards coagulation, i.e. they get protected and do not get coagulated easily when an electrolyte is added.

The process of protecting a lyophobic sol from being coagulated (precipitated) on addition of an electrolyte by the use of a lyophilic colloids is called protection and the lyophilic colloid used for purpose is called a protective colloid.

For example, the addition of gelatin (a lyophilic colloid) to a gold sol (lyophobic sol) protects the latter from being coagulated on addition of sodium chloride solution.

The exact mechanism of protection is not very clearly understood. However, it is believed that the lyophilic colloid particles get adsorbed on the surface of the colloid particles present in the lyophobic sol. The adsorbed lyophilic particles thus form an envelope around the lyophobic sol particles and protect them from the action of electrolytes.



Protective action of lyophilic colloid particles

Gold Number: The protective power a lyophilic colloid is usually expressed in terms of a number called gold number introduced by Zsigmondy (1901). It may be defined as follows.

The gold number of a protective colloid is its minimum amount in milligrams which is just sufficient to prevent the coagulation of 10 ml of a gold sol on the addition of 1 mL of 10% sodium chloride solution.

It is to be noted that the smaller the value of gold number, the greater is the protective power of the protective colloid. The gold numbers of a few protective colloids are given in the Table below.

Table: Gold Number of Some Protective Colloids

Protective (Lyophilic) Colloid	Gold Number
Gelatin	0.005-0.01
Casein	0.01-0.02
Haemoglobin	0.03-0.07
Egg albumin	0.08-0.10
Gum Arabic	0.10-0.15
Dextrin	6-20
Starch	20.25

5. What are emulsions how they are prepare? Give examples. Explain how emulsions are prepared and what is the role of emulsifier?

Emulsions

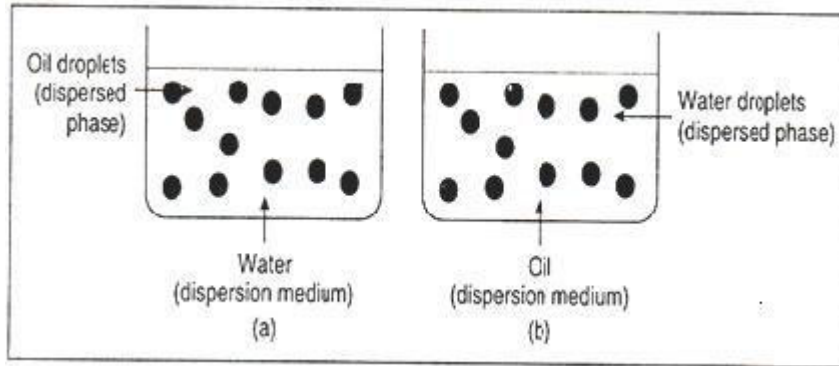
The liquid-liquid colloidal dispersions are called emulsions. An emulsion may be defined as follows:

The colloidal dispersion of two immiscible liquids in which one liquid acts as the dispersion medium and the other as dispersed phase is called an emulsion.

Types of emulsion: Depending upon the nature of dispersed phase, emulsions can be classified into following two types.

(i) Oil-in-water (O/W) type emulsions: In oil-in-water emulsions, oil acts as the dispersed phase while water acts as the dispersion medium. The most common example of oil in water type emulsion is milk which consists of liquid fat globules dispersed in water.

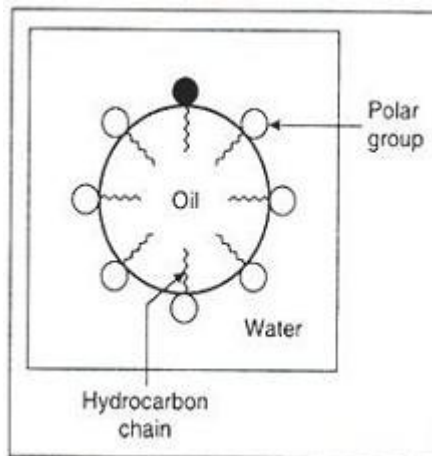
(ii) Water-in-oil (W/O) type emulsions: In water-in-oil type emulsions, water acts as the dispersed phase, whereas oil acts as the dispersion medium. This type of emulsions is also referred to as oil emulsions. Cod liver oil emulsion is a typical example of this type of emulsions in which water is dispersed in cod liver oil. The two types of emulsions are diagrammatically shown in figure below.



(a) Oil-in-water type emulsion (b) Water-in-oil type emulsion

Preparation of emulsions: Emulsions are usually prepared by vigorously mixing the two liquids by using either a high speed mixing machine or by using ultrasonic vibrators. The process is known as emulsification. Since the two liquids used for the preparation of an emulsion are completely immiscible, a stabilizing substance, known as emulsifying agent or emulsifier is required to stabilize the resulting emulsion. The emulsifier is added along with the component liquids. In the absence of emulsifying agent, the dispersed phase particles of colloidal size combine together resulting in the breaking up of emulsion into two separate layers. Some of the important emulsifying agents are soaps, detergents, proteins, gums and agar. Among these, soaps and detergents are most commonly used emulsifiers.

Role of emulsifier: The emulsifiers form a protective film around the oil droplets dispersed in water. This prevents them to come closer and to coalesce, i.e. to combine together. Thus, the emulsion gets stabilized. For example, let us consider the role of soap which acts as an emulsifier for an oil-in-water emulsion. When soap is added to an o/w emulsion, the soap molecule (RCOO^-Na^+) arrange themselves in such a way that the polar end groups dip in water whereas the hydrocarbon chains dip in oil droplet as shown in the figure below. Thus soap molecules get concentrated over the surface of the oil droplet and form a protective film. This decreases the interfacial tension between oil and water and the emulsion gets stabilized.



Emulsification of an oil droplet by soap