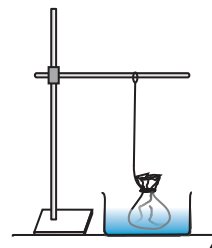


## UNIT-1

# COLLOIDS



**I**N a true solution, solute particles mix homogeneously with the molecules of the solvent and thus form a single phase. However, a colloidal solution is a heterogeneous system in which very fine particles of one substance disperse (**dispersed phase**) in another substance called **dispersion medium**. Particles of the dispersed phase do not form a single phase with the particles of the dispersion medium because of the fact that they are either very large molecules or essentially aggregates of small molecules. Colloidal particles are larger in size than simple molecules but small enough to remain suspended in the dispersion medium ( $10^{-9}$ – $10^{-6}$  m). Some examples of very large molecules which form colloidal dispersion are starch, gum and proteins, whereas colloidal sulphur is an example of aggregates of small molecules. Further, a heterogeneous system of a solid as dispersed phase and a liquid as dispersion medium is called a sol. Depending upon the nature of interaction between the dispersed phase and the dispersion medium, colloidal sols are divided into two categories, namely, **lyophilic** (solvent attracting) and **lyophobic** (solvent repelling). If water is the dispersion medium, the terms used are hydrophilic and hydrophobic. Egg albumin, starch and gum are lyophilic sols. Freshly prepared ferric hydroxide, aluminium hydroxide and arsenic sulphide sols are examples of lyophobic sols. A few methods of preparation of colloids are – chemical methods, electrical disintegration and peptization. In this unit you will learn to prepare both the types of sols. Also, you will learn a method of purification of sols.

### EXPERIMENT 1.1

#### Aim



To prepare (a) lyophilic sol; and (b) lyophobic sol.

#### Theory

Since particles of dispersed phase in lyophilic sols have an affinity for the particles of dispersion medium, these sols are more stable as compared to lyophobic sols. Two factors responsible for the stability of sols are – charge and the solvation of the colloidal particles by the solvent. Stability of lyophilic sols is primarily due to the solvation of colloidal particles by the solvent whereas lyophobic sols are stabilised by the charge on the colloidal particles. Due to their charges, colloidal

particles remain suspended in solution and coagulation does not take place. These charges may be positive or negative. Some examples of negatively charged sols are starch and arsenious sulphide. Positively charged sol of hydrated ferric oxide is formed when  $\text{FeCl}_3$  is added to excess of hot water and a negatively charged sol of hydrated ferric oxide is formed when ferric chloride is added to NaOH solution. The lyophilic sols are directly formed by mixing and shaking the substance with a suitable liquid. Lyophobic sols cannot be prepared by direct mixing and shaking. Special methods are employed to prepare these.

### Material Required

	• Beaker (250 mL) : One		• Egg : One
	• Watch glass : One		• Sodium chloride : 5g
	• Porcelain dish : One		• Ferric chloride : 2g
	• Measuring cylinder (100 mL) : One		• Aluminium chloride : 2g
	• Pipette (10 mL) : One		• Starch/gum : 500 mg
	• Graduated pipette (20 mL) : One		• Arsenious oxide : 0.2 g

### Procedure

#### A. Preparation of Lyophilic Sol

##### I. Egg Albumin Sol

- (i) Prepare 100 mL of 5% (w/v) solution of NaCl in water in a 250 mL beaker.
- (ii) Break one egg in a porcelain dish and pipette out the albumin and pour it in sodium chloride solution. Stir well to ensure that the sol is well prepared.

##### II. Starch/gum Sol

- (i) Measure 100 mL of distilled water with the help of a measuring cylinder and transfer it to a 250 mL beaker and boil it.
- (ii) Make a paste of 500 mg starch or gum in hot water and transfer this paste to 100 mL of boiling water with constant stirring. Keep water boiling and stirring for 10 minutes after addition of paste. To judge the efficacy of the prepared sol, you may compare it with the original paste prepared.

#### B. Preparation of Lyophobic Sol

##### I. Ferric hydroxide/Aluminium hydroxide

- (i) Take 100 mL of distilled water in a 250 mL beaker and boil it.

Aluminium chloride



Arsenic compounds



#### Hazard Warning

- While doing experiment do not eat, drink or smoke.

- (ii) Add 2g of ferric chloride/aluminium chloride powder to boiling water and stir it well.
- (iii) Take 100 mL of distilled water in another 250 mL beaker and boil it.
- (iv) Pour 10 mL of ferric chloride/aluminium chloride solution prepared in step (ii) drop by drop into the boiling water with constant stirring. Keep the water boiling till brown/white sol is obtained.

## II. Arsenious Sulphide Sol

- (i) Transfer 100 mL of distilled water to a beaker of 250 mL capacity.
- (ii) Add 0.2 g of arsenious oxide to it and boil the content of the beaker.
- (iii) Cool and filter the solution.
- (iv) Pass hydrogen sulphide ( $\text{H}_2\text{S}$ ) gas through the filtered solution till it smells of  $\text{H}_2\text{S}$ . (Use Kipp's apparatus to pass hydrogen sulphide gas).
- (v) Expel  $\text{H}_2\text{S}$  gas from the sol by slow heating and filter it.
- (vi) Label the filtrate as arsenious sulphide sol.

### Precautions

- (a) While preparing colloidal solutions of starch, gum, ferric chloride, aluminium chloride etc., pour the paste or solution gradually into the boiling water with constant stirring. Addition of these substances in excess may cause precipitation.
- (b) Arsenious oxide is poisonous in nature; so wash your hands immediately every time after handling this chemical.



### Discussion Questions

- (i) How will you differentiate between a true solution and a colloidal dispersion?
- (ii) Identify some sols (colloids) that you use in your daily life and mention their importance.
- (iii) How do colloids acquire a charge? Why is ferric hydroxide/aluminium hydroxide sol prepared in the experiment, positively charged while arsenious sulphide sol is negatively charged?
- (iv) What is coagulation? How is coagulation different from peptization?
- (v) How can you convert a colloidal dispersion of sulphur into a true solution?
- (vi) Out of lyophilic and lyophobic sols, which one can be easily converted into a gel and why?
- (vii) Differentiate between a gel and a sol.
- (viii) What are the applications of colloids in the field of Medicine, Defense and in Rocket Technology?

## EXPERIMENT 1.2

**Aim**

To purify prepared sol by dialysis.

**Material Required**

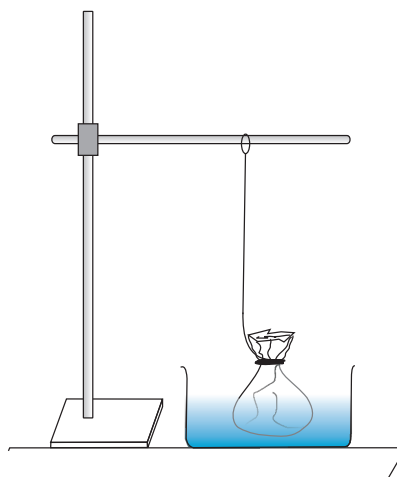
- Parchment/  
cellophane paper : One sheet  
(30 cm × 30 cm)
- Trough : One
- Thread : As per need
- Test tubes : Two



- Colloidal dispersion of : Prepared in  
egg albumin : experiment 1.1
- Distilled water : As per requirement
- Uranyl zinc acetate : As per requirement
- Silver nitrate : As per requirement

**Procedure**

- (i) Take a square sheet (30 cm × 30 cm) of parchment/cellophane paper.
- (ii) Soak the sheet in water and give it a conical shape.
- (iii) Pour the colloidal dispersion of egg albumin in the cone of parchment/cellophane paper.
- (iv) Tie the cone with a thread and suspend it in a trough containing distilled water as shown in Fig. 1.1.



**Fig. 1.1** : Purification of a colloid

- (v) After about half an hour, test for the presence of ions in the trough water.

- (vi) Change the water present in the trough after every half an hour till it is free of the impurities of  $\text{Na}^+$  and  $\text{Cl}^-$  ions. To check the presence of  $\text{Na}^+$  and  $\text{Cl}^-$  ions take water from the trough in two test tubes. To one test tube add uranyl zinc acetate and to the other add silver nitrate solution. A yellow precipitate with uranyl zinc acetate indicates the presence of  $\text{Na}^+$  ions, while a white precipitate of silver nitrate indicates the presence of chloride ions.
- (vii) Note the time required for the purification of colloidal dispersion.

**Note :** In some cases, dialysis may be a very slow process. Therefore, in such cases, it is advisable to change the water of the trough twice or thrice till the colloidal dispersion is free of ions.

### Precautions

- (a) For dialysis make the parchment bag air tight to prevent the entry of water into the bag. Keep the neck of the parchment bag above the surface of water.
- (b) Change the water in the trough from time to time during dialysis.



### Discussion Question

- (i) How can you make the process of dialysis quick? What are the limitations of this technique?

### EXPERIMENT 1.3

#### Aim

To study the role of emulsifying agents in stabilising the emulsions of different oils.

#### Theory

Emulsion is a type of colloid in which, both the dispersed phase and the dispersion medium are liquids. Here the dispersed phase and the dispersion medium are distinguished by their relative amounts. The one, which is present in smaller proportion, is called **dispersed phase**, while the other, which is present in relatively large quantity, is known as the **dispersion medium**.

When oil is shaken with water, a faint milky solution is often observed, which is unstable and is called an **emulsion of oil in water**. On standing, it gets separated into two layers, i.e. oil and

water. The mixing capacity of different oils with water is different. This mixing capacity of the oil in addition to its nature depends upon the method of shaking also (i.e. vigorous shaking or swirling).

The stability of an oil and water emulsion is increased by the addition of a suitable emulsifying agent such as soap solution. Soap contains sodium salt of long chain aliphatic carboxylic acids with the carboxyl group as the polar group, which decreases the interfacial surface tension between oil and water. Hence oil mixes with water and emulsification takes place. The concentration of soap required for complete emulsification is called **optimum concentration**. Any amount less or more than this optimum amount does not cause an effective stabilisation. In the presence of optimum amount of soap solution, oil in water emulsion is more stable and the separation of oil and water layers takes more time.

### Material Required



- Test tubes : Six
- Droppers : Five
- Test tube stand : One
- Glass rod : One
- Stop watch : One



- Soap/detergent : 5g
- Mustard oil, linseed oil, castor oil and machine oil : 10 mL each brand

### Procedure

- (i) Dissolve 1 g of soap/detergent in 10 mL of distilled water in a test tube with vigorous shaking and heat the content of the test tube if needed. Label it as 'A'.
- (ii) Take four test tubes. Mark these as B, C, D and E and to each of the test tubes, add 5 mL distilled water followed by 10 drops of mustard oil in test tube B, linseed oil in test tube C, castor oil in test tube D and machine oil in test tube E, respectively.
- (iii) Shake test tube B vigorously for five minutes, keep it in a test tube stand and simultaneously start the stopwatch. Record the time taken for the separation of the two layers.
- (iv) Repeat the same procedure with test tubes C, D and E and record the time for the separation of the layers in each case.
- (v) Now add two drops of soap/detergent solution from test tube 'A' into each test tube (B, C, D and E). Shake each test tube for five minutes and record the time of separation of the layers in each case again.
- (vi) Record your observations in a manner detailed in Table 1.1.

**Table 1.1 : Emulsification of different oils by soap/detergent**

Test tube specification	Name of oil used for emulsification	Time taken for the separation of layers	
		Without Soap/detergent	With Soap/detergent
B			
C			
D			
E			

**Precautions**

- Add equal number of drops of a soap/detergent solution to all the test tubes.
- To minimise the error in recording the time required for the separation of layers in different systems, shake all the test tubes for identical time span.
- Start the stopwatch immediately after shaking is stopped and stop it immediately when the two layers separate.

**Discussion Questions**

- Name a reagent other than soap, which can be used as an emulsifying agent in the *oil in water type emulsion*.
- Milk is said to be a stable emulsion. What provides stability to milk?
- Can two miscible liquids form an emulsion?
- Why do separation of layers of different oils forming an emulsion with water take different time?
- What are the points of similarity and dissimilarity among sol, gel and emulsion?
- Suggest a test to distinguish between *Oil in Water* and *Water in Oil* type of emulsions.
- Give some examples of emulsions that you come across in daily life.
- Dettol forms an emulsion in water. How does this emulsion get stabilised?