B.Sc. (Honours) Part-I

Paper-IA

Topic: Introduction of Colloids

UG

Subject-Chemistry

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Introduction of Colloids

Solution is an intimate mixture of two or more chemical substances. In solution, the dissolving agent is the solvent (dispersion medium) and the substance which dissolves is the solute (dispersed phase). The state of matter of a solution may be solid, liquid or gas which are in the form of atoms, ions, or molecules. According to Scottish chemist Thomas Graham (1861), depending on the size of solute particles, the solutions are classified as given in Fig. 1.

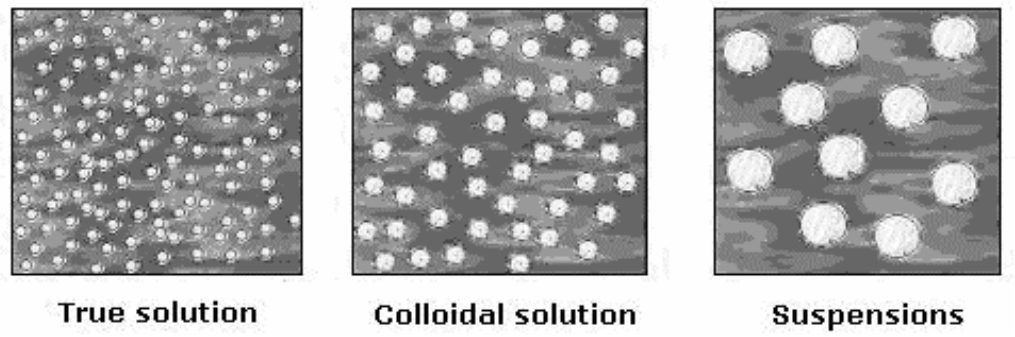

Fig. 1 Types of solutions

1 (a)True solutions

A true solution is a homogeneous solution in which the solute particles have diameters lesser than 1 nm i.e., the solute particles are of molecular dimensions. Such dispersed particles dissolve in solution to form a homogenous system. These do not settle down when the solution is left standing. The particles are invisible even under powerful microscopes and cannot be separated through filter paper, parchment paper or animal membranes, e.g. sodium chloride in water, sugar in water.

1 (b) Suspensions

Suspensions consist of particles of a solid suspended in a liquid medium. Suspensions are systems with two distinct phases. The particles in suspensions are bigger than 1000 nm. The particles of a suspension are visible to the naked eye or under a microscope. Suspensions are heterogeneous systems. They stay only for a limited period i.e. these are not stable as the particles have a tendency to settle down

under the influence of gravity. The particles of a suspension can neither pass through ordinary filter paper nor through animal membranes, e.g. sand in water, oil in water.

1 (c)Colloids

Colloids or Colloidal solutions, represent an intermediate kind of a mixture between true solution and suspension. A colloid is one of the three primary types of mixtures, with the other two being a solution and suspension. A colloid is a solution that has particles ranging between 1 and 1000 nanometers in diameter, yet are still able to remain evenly distributed throughout the solution. These are also known as colloidal dispersions because the substances remain dispersed and do not settle to the bottom of the container. In colloids, one substance is evenly dispersed in another. The substance being dispersed is referred to as being in the dispersed phase, while the substance in which it is dispersed is in the continuous phase. When a dispersed phase is dispersed in a dispersion medium then depending on the degree of dispersion, the systems are classed as i) true solution, ii) colloidal solution, and iii) suspension

Properties	**True solution**	**Colloidal solution**	**Suspension**
Particle size	1 Å – 10 Å	10 Å – 1000 Å	More than 1000 Å
Appearance	Clear	Generally clear	Opaque
Nature	Homogeneous	Heterogeneous	Heterogeneous
Separation by filtration	Not possible	Not possible	Possible
Separation by cellophane paper	Not possible	Possible	Possible
Visibility	Not visible under microscope	Visible under ultra-microscope	Visible to naked eye
Brownian motion	Not observable	Occurs	May occur

Example of colloids

Colloidal AgCl, AgI, Ag proteinate (effective germicide), colloidal sulphur. Many natural and synthetic polymers are important in pharmaceutical practice.

Polymers: These are macromolecules formed by polymerization or condensation of small non- colloidal molecules e.g. proteins, natural colloids, plasma proteins which are responsible for binding certain drug molecules so that the pharmacological action of the drug molecule is affected by them. Starch and hydroxymethylallulose, cyclodeztrin are also examples.

Dispersion Medium	Dispersed Phase	Type of Colloid	Example
Solid	Solid	Solid sol	Ruby glass
Solid	Liquid	Solid emulsion/gel	Pearl, cheese
Solid	Gas	Solid foam	Lava, pumice
Liquid	Solid	Sol	Paints, cell fluids
Liquid	Liquid	Emulsion	Milk, oil in water
Liquid	Gas	Foam	Soap suds, whipped cream
Gas	Solid	Aerosol	Smoke
Gas	Liquid	Aerosol	Fog, mist

Classification

Colloidal solutions can be classified in different ways :

(a) on the basis of interaction between the phases.

(b) on the basis of molecular size.

on the basis of interaction between the phases:

Lyophilic colloids (solvent loving): They are so called because of affinity of particles for the dispersion medium. Solutions of lyophiles are prepared by simply dissolving the material in the solvent. Because of attraction between the dispersed phase and dispersion medium, salvation (hydration in case of water) of the particles occur. Most of these colloids are organic n nature e.g. gelatin, acacia, insulin, albumin. The solution is viscous because of strong affinity for water (called gels).

Lyophobic colloid (solvent hating): The dispersed phase has little attraction to the solvent (solvent hating). Their properties differ from the lyophilic (hydrophilic). They are usually inorganic n nature

e.g. gold, silver, sulphur. In contrast to lyophilic colloid, it is necessary to use special method to prepare hydrophobic colloid.

Hydrophilic sol: For lyophilic sol when the dispersion medium is water then it is called then they are called hydrophilic sols. Such as starch, glue, proteins, gelatin and certain other organic compounds.

Hydrophobic sols: For lyophobic sol when the dispersion medium is water then it is called then they are called hydrophobic sols. Examples are sol of metals, metal sulphides, metal hydroxides, suipher, phosphorous and other inorganic substances.

Properties	Lyophobic sols or Hydrophobic sol	Lyophilic sols or hydrophilic sol
Detection of particles	The particles may be readily detected by means of an ultra-microscope	The particles are not detected by means of an utra-microscope
Viscosity	Hardly differs from that of the dispersion medium	Much higher than that of the dispersion medium
Electric charge	All particles in a sol have the same charge resulting from the adsorption of ions from solution	The charge on colloidal particles depends upon the pH of the medium, since the particles readily adsorb H+ or OH- ions. This charge is often due to the dissociation of the molecules of the disperse substance.
Migration of particles in the electric field	The particles migrates in one characteristic direction depending on the charge they bear	The particles may migrate in either direction or may not migrate at all, depending on the pH of the medium
Stability	Dispersed particles are precipitated by the addition of small amount of an electrolyte	Dispersed particles are not precipitated by small amounts of electrolytes although large quantities cause precipitation
Nature	When the liquid is removed, the resulting solid does not form sol again by the simple addition of the liquid	When the liquid is removed, resulting jelly-like solid is recoverted into sol by the addition of the liquid
Occurrence	Generally, do not occur naturally	Most of these occur naturally

Classification Based on Molecular Size:

Depending upon the molecular size the colloids have been classified as

(a) Macromolecular colloids –In this type of colloids the size of the particles of the dispersed phase are big enough to fall in the colloidal dimension as discussed earlier (i.e.–100 nm)

Examples of naturally occurring macromolecular colloids are starch, cellulose, proteins etc.

(b) 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 S_8 molecules which fall in colloidal dimension.

(c) Associated colloids – 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. Soap is sodium salt of long chain fatty acid R COONa. When put in water, soap forms $RCOO^{—}$ and Na^{+}. These $RCOO^{—}$ ions associate themselves around dirt particles as shown below forming a miscelle.