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Adapted from OpenStax: By the end of this section, you will be able to: Describe the composition and properties of colloidal dispersions List and explain several technological applications of colloids As a child, you may have made suspensions such as mixtures of mud and water, flour and water, or a suspension of solid pigments in water, known as tempera paint. These suspensions are heterogeneous mixtures composed of relatively large particles that are visible (or that can be seen with a magnifying glass). They are cloudy, and the suspended particles settle out after mixing. On the other hand, when we make a solution, we prepare a homogeneous mixture in which no settling occurs and in which the dissolved species are molecules or ions. Solutions exhibit completely different behavior from suspensions. A solution may be colored, but it is transparent, the molecules or ions are invisible, and they do not settle out on standing. A group of mixtures called colloids (or colloidal dispersions) exhibit properties intermediate between those of suspensions and solutions (Figure 11.30). The particles in a colloid are larger than most simple molecules; however, colloidal particles are small enough that they do not settle out upon standing. Figure 11.30 (a) A solution is a homogeneous mixture that appears clear, such as the saltwater in this aquarium. (b) In a colloid, such as milk, the particles are much larger but remain dispersed and do not settle. (c) A suspension, such as mud, is a heterogeneous mixture of suspended particles that appears cloudy and in which the particles can settle. (credit a photo: modification of work by Adam Wimsatt; credit b photo: modification of work by Melissa Wiese; credit c photo: modification of work by Peter Burgess) The particles in a colloid are large enough to scatter light, a phenomenon called the Tyndall effect. This can make colloidal mixtures appear cloudy or opaque, such as the searchlight beams shown in Figure 11.31. Clouds are colloidal mixtures. They are composed of water droplets that are much larger than molecules, but that are small enough that they do not settle out. Figure 11.31 The paths of searchlight beams are made visible when light is scattered by colloidal-size particles in the air (fog, smoke, etc.). (credit: “Bahman”/Wikimedia Commons) The term “colloid”—from the Greek words kolla, meaning “glue,” and eidos, meaning “like”—was first used in 1861 by Thomas Graham to classify mixtures such as starch in water and gelatin. Many colloidal particles are aggregates of hundreds or thousands of molecules, but others (such as proteins and polymer molecules) consist of a single extremely large molecule. The protein and synthetic polymer molecules that form colloids may have molecular masses ranging from a few thousand to many million atomic mass units. Analogous to the identification of solution components as “solute” and “solvent,” the components of a colloid are likewise classified according to their relative amounts. The particulate component typically present in a relatively minor amount is called the dispersed phase and the substance or solution throughout which the particulate is dispersed is called the dispersion medium. Colloids may involve virtually any combination of physical states (gas in liquid, liquid in solid, solid in gas, etc.), as illustrated by the examples of colloidal systems given in Table 11.4. Examples of Colloidal Systems Dispersed Phase Dispersion Medium Common Examples Name solid gas smoke, dust — solid liquid starch in water, some inks, paints, milk of magnesia sol solid solid some colored gems, some alloys — liquid gas clouds, fogs, mists, sprays aerosol liquid liquid milk, mayonnaise, butter emulsion liquid solid jellies, gels, pearl, opal (H2O in SiO2) gel gas liquid foams, whipped cream, beaten egg whites foam gas solid pumice, floating soaps — Solutions Suspensions Colloids Appearance Clear, transparent and homogeneous Cloudy, heterogeneous, at least two substances visible Cloudy but uniform and homogeneous Particle Size molecule in size larger than 10,000 Angstroms 10-1000 Angstroms Effect of Light (Tyndall Effect) none -- light passes through, particles do not reflect light variable light is dispersed by colloidal particles Effect of Sedimentation none particles will eventually settle out none ==>> For more on Mixtures (Solutions, Suspensions, Emulsions, Colloids) In summary: A solution is always transparent, light passes through with no scattering from solute particles which are molecule in size. The solution is homogeneous and does not settle out. A solution cannot be filtered but can be separated using the process of distillation. A suspension is cloudy and heterogeneous. The particles are larger than 10,000 Angstroms which allows them to be filtered. If a suspension is allowed to stand the particles will separate out. A colloid is intermediate between a solution and a suspension. While a suspension will separate out a colloid will not. Colloids can be distinguished from solutions using the Tyndall effect. Light passing through a colloidal dispersion, such as smoky or foggy air, will be reflected by the larger particles and the light beam will be visible. A hydrocolloid can simply be defined as a substance that forms a gel when it comes in contact with water. Such substances include both polysaccharides and proteins . TRY THE ONLINE ASSESSMENT QUIZ ON SOLUTIONS SUSPENSIONS AND COLLOIDS Written By Pavithra VG Last Modified 24-01-2023 Classification of Colloids: Milk looks like a homogenous mixture, but it is a heterogeneous mixture of fat particles dispersed in water. Similarly, in smoke, solid particles are dispersed in gas. These are some examples of the class of substance called colloids. In this article, you will explore different methods of classification of colloids based on the physical state of the dispersed phase and dispersion medium and the interaction between them. Colloids are heterogeneous systems having a particle size ranging from \(1\,{\rm{nm}}\) to \(100\,{\rm{nm}}{\rm{.}}\) It consists of two phases, i.e., dispersed phase and a dispersion medium. Dispersed phase: The substance present in the form of colloidal particles in the colloidal system is called the dispersed phase. Dispersion medium: The medium in which the colloidal particles are dispersed is called dispersion medium. Example: In a colloidal solution of ferric hydroxide in water, ferric hydroxide is the dispersed phase, and water is the dispersion medium. Colloids are classified in three different ways as follows: Based on the physical state of the dispersed phase and the dispersion mediumBased on the nature of the interaction between the dispersed phase and dispersion mediumBased on the types of particles of the dispersed phase. Depending upon the physical state, i.e., solid, liquid, and gas of the dispersed phase and dispersed medium, colloids are classified into the following eight types. S. No.Dispersed PhaseDispersion mediumNameExamples\(1\)SolidSolidSolid Solcoloured glasses, gemstones, ruby, pigmented plastics\(2\)SolidLiquidSolPaints, cell fluids, muddy water, gold sol, sulphur sol\(3\)SolidGasAerosolSmoke, dust\(4\)LiquidSolidGelCheese, butter, jellies, boot foolish\(5\)LiquidLiquidEmulsionMilk, Hair cream, emulsified oils\(6\)LiquidGasAerosolFog, mist, cloud, insecticide sprays\(7\)GasSolidSolid foamPumice stone, foam rubber, styrene foam\(8\)GasLiquidFoamFroth, whipped cream, soap lather The colloidal system of a gas dispersed in the gaseous dispersion medium is not possible because a gas with another is a homogeneous mixture. However, the colloid system is a heterogeneous mixture. A colloidal system in which solid dispersed in a liquid medium is called sol. Based on the dispersed medium, sols are named hydrosol, alcosols, benzosols. In hydrosol dispersion medium is water. In alcosols dispersion medium is alcohol and in benzosols dispersion medium is benzene. Depending upon the affinity of the dispersed phase for the dispersion medium, colloidal systems can be classified into two types, i.e., lyophilic and lyophobic colloids. On the other hand, if water is the dispersion medium, colloids are called hydrophilic and hydrophobic sols. Lyophilic colloid: The word lyophilic means liquid-loving. The colloidal solution in which the dispersed phase particles have a great affinity for the dispersion medium is called lyophilic colloids. These are also called intrinsic colloids. These are reversible, stable in nature. Therefore, it cannot be easily precipitated. Examples of classification of colloids lyophilic are gelatin, albumin, starch, and gum. Lyophobic colloids: The word lyophobic means liquid-hating. The colloidal solutions in which the dispersed phase particles have no affinity for the dispersion medium are called lyophobic colloids. They are irreversible in nature. These are also called extrinsic colloids. It easily gets precipitated or coagulated by adding a small amount of electrolyte by heating or agitation. Hence these are unstable. Example: Gold sol, and platinum sol. Lyophilic SolsLyophobic Sols1. Prepared by directly mixing with dispersed particles and the liquid dispersion medium.1. Prepared by special methods.2. They are stable and are not easily precipitated or coagulated.2. The sols are easily precipitated by the addition of a small amount of suitable electrolyte.3. They are highly hydrated.3. They are not very hydrated.4. They are reversible.4. They are irreversible.5. These sols are usually formed by organic substances like starch, gum, proteins, etc.5. These sols are usually formed by inorganic materials like metals, and their sulphides.6. Their viscosity is much higher than that of the medium.6. The viscosity is almost the same as that of the medium.7. Their surface tension is usually lower than that of the dispersion medium.7. The surface tension is nearly the same as that of the dispersion medium. Classification Based on the Types of Particles of the Dispersed Phase Colloidal particles have a size in the range of \(1\,{\rm{nm}} – 100\,{\rm{nm}}\) in the colloidal system. Depending on how different substances forming colloidal solutions acquired the particle range of \(1\,{\rm{nm}} – 100\,{\rm{nm,}}\) colloidal solutions are classified into three types, i.e., multimolecular colloids, macromolecular colloids, and associated colloids. When a large number of atoms or small molecules having a diameter of less than 1 nm of a substance combine in a dispersion medium to form aggregates having the size in the colloidal range, the colloidal solution thus formed is called multimolecular colloids or micromolecular colloids. The atoms or molecules constituting the dispersible particles in multimolecular colloids held together by Van der Waals’ forces. Example: Gold sol, sulphur sol, etc. A gold sol may contain particles of various sizes composed of several atoms of gold. For example, sulphur sol consists of particles containing thousands of \({{\rm{S}}_{\rm{8}}}\) molecules. In this type of colloids, the dispersed phase particles are sufficiently large to be a colloidal dimension. Such molecules have a very high molecular mass and are termed macromolecules. When such substances are dispersed in a suitable dispersion medium, colloidal solutions formed are known as macromolecular colloids. Most of the lyophilic sols are macromolecular colloids. Starch, proteins, gelatin, cellulose, nucleic acids, etc., are examples of natural macromolecules. On the other hand, synthetic polymers like polyethylene, synthetic rubber, etc., are examples of manufactured macromolecular colloids. Associate colloids are substances that behave as normal electrolytes at a low concentration but behave as colloidal particles at higher concentration. These associated particles are also called micelles. The formation of micelles occurs only above a particular temperature called Kraft temperature \(\left({{\rm{T}}_{\rm{k}}}} \right)\) and above a particular concentration called Critical Micelle Concentration (CMC). Example: Surface active agents like soaps and synthetic detergents. In an aqueous solution, soap (sodium stearate) ionises as: \({{\text{C}}_{{\text{17}}}}{{\text{H}}_{{\text{35}}}}}{\text{COONa}} \rightleftharpoons {{\text{C}}_{{\text{17}}}}{{\text{H}}_{{\text{35}}}}{\text{CO}}{{\text{O}}^{\text{-}}}{\text{ + N}}{{\text{a}}^{\text{ + }}}\) In concentrated solutions, these ions get associated, forming an aggregate of colloidal size. Multimolecular ColloidsMacromolecular ColloidsAssociated colloids1. They are formed by aggregating a large number of atoms or molecules that generally have diameters less than \(1\,{\rm{nm}}.\)1. They are molecules of large size.1. They are formed by an aggregation of a large number of ions in a concentrated solution.2. Their molecular masses are not very high.2. They have high molecular masses.2. They have high molecular masses.3. Their atoms and molecules are held together by weak van der Waals forces.3. Due to the long chain, the van der Waals forces holding them are comparatively stronger.3. Higher the concentration, the greater the van der Waals forces. Based on appearance, colloids are classified into two types, i.e., sols and gels Sols: Colloidal solution with fluid appearance is called sols. In the naming of sols, the dispersion medium is named before the sol. Example: In hydrosol dispersion medium is water. In alcosols dispersion medium is alcohol and in benzosols dispersion medium is benzene. Gels: Colloids with a solid-like appearance is called gel. Example: Butter, jelly, cheese, curd, etc. Based on dispersion medium, colloids are classified into hydrophilic colloids and hydrophobic colloids. Hydrophilic colloids: The water-loving colloids are called hydrophilic colloids. Example: Agar, gelatin, pectin, etc. Hydrophobic colloids: The colloids that repelled by water are called hydrophobic colloids. Example: Gold sol, clay particles, etc. With this article, we studied the classification of colloids system- \(8\) types of colloids based on the type of dispersed phase and the dispersion medium. We looked at the meaning and examples of lyophilic colloid, lyophobic colloid, macromolecular colloid, multimolecular colloid and associated colloids. Q.1. What are the \(3\) types of colloidal systems?Ans: Based on the types of dispersed phase particles, colloidal systems are of three types. They are multimolecular colloids, macromolecular colloids, and associated colloids. Q.2. What are the \(8\) types of colloids?Ans: Colloids are classified into the following eight types depending upon the physical state of the dispersed phase and the dispersion medium, i.e., solid sol, sol, aerosol, gel, emulsion, solid foam and foam Q.3. What are the applications of colloids?Ans: The applications of colloids are:a. Colloids are used for creating artificial rain by throwing oppositely charged sand or common salt to bring about coagulation of water particles.b. Blue colour of the sky is due to the scattering of light by colloidal dust particles.c. Purification of water by coagulation of mud particles on adding alum.d. The formation of the delta is due to the coagulation of sand or clay particles by \({\rm{NaCl}}\) present in seawater. Q.4. What is a colloidal solution? How are they classified? Give examples?Ans: A substance dispersed in a dispersion medium is called a colloidal solution.Based on the interaction between the dispersed phase and dispersed medium, colloids are classified into lyophilic and lyophobic colloids.Example: Starch in water, and gold sol. 5. What are Multimolecular colloids? Give examples.Ans: When a large number of atoms or small molecules, having a diameter of less than 1 nm, of a substance combine in a dispersion medium to form aggregates having a size in the colloidal range, the colloidal solutions thus formed are called multimolecular colloids or micromolecular colloids.Example: Gold sol, and sulphur sol. Q.6. How are the colloidal solutions classified?Ans: Colloids are classified in three different ways as follows:a) Based on the physical state of the dispersed phase and dispersion medium, colloids are classified into eight types, i.e., solid sol, sol, aerosol, gel, emulsion, solid foam and foam.b) Based on the interaction between the dispersed phase and dispersed medium, colloids are classified into lyophilic and lyophobic colloids.c) Based on the types of dispersed phase particles, colloids are classified into multimolecular colloids, macromolecular colloids, and associated colloids. Study Preparation of Colloids Solutions are mixtures where the solute fully dissolves in the solvent, like sugar in water.Suspensions have larger particles that don’t dissolve and will settle over time, like oil in water.Colloids have particles that don’t settle, and light passes through them due to larger size, like milk. Solutions, suspensions, colloids, and other dispersions are similar but have characteristics that set each one apart from the others. A solution is a homogeneous mixture of two or more components. The dissolving agent is the solvent. The substance that is dissolved is the solute. The components of a solution are atoms, ions, or molecules, making them 10-9 m or smaller in diameter. Example: Sugar and water The particles in suspensions are larger than those found in solutions. Components of a suspension can be evenly distributed by mechanical means, like by shaking the contents but the components will eventually settle out. Example: Oil and water Particles intermediate in size between those found in solutions and suspensions can be mixed in such a way that they remain evenly distributed without settling out. These particles range in size from 10-8 to 10-6 m in size and are termed colloidal particles or colloids. The mixture they form is called a colloidal dispersion. A colloidal dispersion consists of colloids in a dispersing medium. Example: Milk Liquids, solids, and gasses all may be mixed to form colloidal dispersions. Aerosols: Solid or liquid particles in a gasExamples: Smoke is solid in a gas. Fog is a liquid in a gas. Sols: Solid particles in a liquidExample: Milk of Magnesia is a sol with solid magnesium hydroxide in water. Emulsions: Liquid particles in a liquid Example: Mayonnaise is oil in water. Gels: Liquids in solidExamples: Gelatin is protein in water. Quicksand is sand in water. You can tell suspensions from colloids and solutions because the components of suspensions will eventually separate. Colloids can be distinguished from solutions using the Tyndall effect. A beam of light passing through a true solution, such as air, is not visible. Light passing through a colloidal dispersion, such as smoky or foggy air, will be reflected by the larger particles and the light beam will be visible. 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ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Home » Differences Between A colloid is a mixture in which one of the soluble or insoluble particles is microscopically dispersed throughout the other substance. The colloid can be differentiated from a solution in that the solute and solvent in a solution are of the same phase, but a colloid has a dispersed phase and a continuous phase as a result of the phase separation. Colloids usually do not settle completely and take a longer time to separate into different layers. Colloids contain particles that are substantially larger than atoms and molecules but still microscopic. The dimension of the particles usually ranges between 10-7 to 10-3 cm. Most colloids are opaque and have a slight color, but some might appear translucent as a result of the Tyndall effect. In general, colloids can be classified into two systems; reversible and irreversible colloids. In reversible systems, the products of the reactions can be induced to interact in a way to generate the original components. The colloidal matters in reversible systems usually have smaller molecules with small molecular weights that associate spontaneously to form larger particles. In an irreversible system, the products of the reactions are so stable or different that the original components of the system cannot be reproduced. Colloidal systems can be generated or separated by natural as well as industrial and technological processes. It is difficult to measure the size of the dispersed phase in colloids due to the small size, thus most colloids are identified and characterized by the physio-chemical and transport properties. The stability of a colloid system is defined by the measure of particles that remain suspended in solution at equilibrium. Aggregation is one of the most important reasons for the decreased stability of colloidal systems. Colloids have been recently identified as a model system for atoms as the forces that govern the structure and behavior of matter are known to govern the behavior of colloidal systems. Created with BioRender.com Suspension Definition A suspension is a heterogeneous mixture of two substances where the solute particles do not dissolve but remain dispersed through the bulk of the solvent. The particles in suspension are larger in size, usually ranging above one micrometer. These can be observed with our naked eyes. The particles in a suspension eventually settle down; however, they cannot be classified as a suspension when the particles are settled down. The solid particles in the suspension are termed the internal phase, whereas the solvent or fluid is termed the external phase. The dispersion of the internal phase to the external phase is often the result of mechanical agitation with the use of suspending agents. Suspensions are of different types and are named differently depending on the state of the internal and external phases. A suspension of liquid or solid particles in a gas is called an aerosol, whereas suspension of gases in solid-like hydrogen in palladium can also be found. Suspensions are also classified on the basis of the state of the dispersed phase and dispersion medium. The dispersed phase is usually solid, but the dispersion medium may be solid, liquid, or gas. From a thermodynamic point of view, suspensions are highly unstable; however, over a long period of time, these can be kinetically stable. The stability of a suspension also determines its shelf life. Separation of a suspension is comparatively easy as these can be separated by simple methods by filtration and sedimentation. Most suspensions are opaque as these do not transmit light but cause scattering of light. Some suspensions might even exhibit the Tyndall effect. Suspensions are essential in pharmaceutical industries for the production of medicines and other pharmaceutical products. 12 Major Differences (Colloid vs Suspension) Characteristics Colloid Suspension Definition A colloid is a mixture in which one of the soluble or insoluble particles is microscopically dispersed throughout the other substance. A suspension is a heterogeneous mixture of two substances where the solute particles do not dissolve but remain dispersed through the bulk of the solvent. Size of the particles Colloid particles are comparatively smaller, usually ranging in size between 10-7 to 10-3 cm. Suspension particles are comparatively larger with sizes greater than 10-3 cm. Filter paper Colloid particles can pass through filter paper. Suspension particles cannot pass through filter paper. Visibility The particles are microscopic and, thus, cannot be seen with our naked eyes. The particles can be clearly seen with naked eyes. Sedimentation The particles in the colloid do not sediment as a result of gravity. The particles in suspension undergo sedimentation as a result of gravitational force. Phase separation Phase separation is rather slow or might not even happen. Distinct phase separation can be observed. Homogeneity Colloids are homogenous. Suspensions are heterogeneous. Diffusion Colloids diffuse slowly. Suspensions do not diffuse at all. Optical Properties Colloids can be either opaque or transparent, and they scatter light through them. Suspensions are opaque as they do not transmit light. Tyndall effect Colloids demonstrate the Tyndall effect. Suspension may or may not exhibit the Tyndall effect. Uses Colloids have industrial applications in paint, food, and various other industries. Suspensions are essential in the production of medicines and other products. Examples Examples of colloids include milk, shampoo, foam rubber, etc. Examples of suspension include muddy water, soot in the air, oil and water, etc. Examples of colloids Milk Milk is a colloid consisting of microscopic dispersion of fat in the aqueous solution of plasma with dispersed lactose, other mineral salts, and colloidally dispersed proteins. The important colloidal proteins in milk include calcium phosphate, caseinate, and lactalbumin. The physio-chemical structure of milk is determined by various proteins, including colostrum which is rich in globulin. The content of milk proteins and fat differs in different types of milk. Cow’s milk has lesser fat content than the milk for a buffalo. The casein content of cow’s milk is between 2.25% to 2.75%, whereas the lactalbumin ranges between 0.5-0.7%. The colloidally dispersed minerals like calcium phosphate can be filtered out from milk by ultra-filters with larger porosity. The stability of milk is determined by the concentration of different particles in milk and various environmental factors as well. Examples of suspension Blood Blood is a suspension consisting of larger blood cells suspected in extracellular fluid material called plasma. It is a specialized fluid connective tissue essential for the transport of oxygen, nutrients, and water to different parts of the body. The plasma occupies about 55% of the total volume of blood, whereas the rest is occupied by blood cells, nutrients, respiratory gases, and waste products. Blood also contains plasma proteins like albumin and globulins essential to maintain the osmotic pressure and transport of various molecules. The blood cells can be separated with the help of centrifuges that enable the separation of plasma. References and Sources Leroy S. Palmer. The Chemistry of Milk and Dairy Products Viewed from a Colloidal Standpoint. Industrial & Engineering Chemistry 1924 16 (6), 631-635 DOI: 10.1021/ie50174a041 4% – 28chemistry%29 2% – 1% – 1% – 1% – 1% – 1% – 1% – 1% – 1% – 1% – 1% –