

GENERAL CHARACTERISTICS OF DISPERSED SYSTEMS

A dispersion is a system in which particles are dispersed in a continuous phase of a different composition (or state). A dispersion is classified in a number of different ways, including how large the particles are in relation to the particles of the continuous phase, whether or not precipitation occurs, and the presence of Brownian motion.

There are three main types of dispersions: Coarse dispersion (Suspension), Colloid and solution

Types of dispersions

		Solution:	Colloid:	Coarse dispersion (Suspension):
Dissolved or dispersed phase	Continuous medium	Homogeneous mixture: Dissolved < 1 <u>nanometer</u>	Dispersed phase between 1 nanometer and 1 <u>micrometer</u>	Heterogeneous mixture: Dispersed phase > 1 micrometer

Structure and Properties of Dispersions

It is still common belief, that dispersions basically do not display any structure, i.e., the particles (or in case of emulsions: droplets) dispersed in the liquid or solid matrix (the "dispersion medium") are assumed to be statistically distributed. Therefore, for dispersions usually percolation theory is assumed to appropriately describe their properties.

In chemistry, a suspension is a heterogeneous mixture containing solid particles that are sufficiently large for sedimentation. Usually they must be larger than 1 micrometer. The internal phase (solid) is dispersed throughout the external phase (fluid) through mechanical agitation, with the use of certain excipients or suspending agents. Unlike colloids, suspensions will eventually settle. An example of a suspension would be sand in water. The suspended particles are visible under a microscope and will settle over time if left undisturbed. This distinguishes a suspension from a colloid, in which the suspended particles are smaller and do not settle. Colloids and suspensions are different from solutions, in which the dissolved substance (solute) does not exist as a solid, and solvent and solute are homogeneously mixed.

A suspension of liquid droplets or fine solid particles in a gas is called an aerosol or particulate. In the atmosphere these consist of fine dust

and soot particles, sea salt, biogenic and volcanogenic sulfates, nitrates, and cloud droplets.

Suspensions are classified on the basis of the dispersed phase and the dispersion medium, where the former is essentially solid while the latter may either be a solid, a liquid, or a gas. In modern chemical process industries, high shear mixing technology has been used to create many novel suspensions.

COLLOID

A colloid is a substance microscopically dispersed throughout another substance.

A colloidal system consists of two separate phases: a *dispersed phase* (or *internal phase*) and a *continuous phase* (or *dispersion medium*) in which the colloid is dispersed. A colloidal system may be solid, liquid, or gas.

The dispersed-phase particles have a diameter of between approximately 1 and 1000 nanometers. Such particles are normally invisible in an optical microscope, though their presence can be confirmed with the use of an ultramicroscope or an electron microscope. Homogeneous mixtures with a dispersed phase in this size range may be called *colloidal aerosols*, *colloidal emulsions*, *colloidal foams*, *colloidal dispersions*, or *hydrosols*. The dispersed-phase particles or droplets are affected largely by the surface chemistry present in the colloid.

Some colloids are translucent because of the Tyndall effect, which is the scattering of light by particles in the colloid. Other colloids may be opaque or have a slight color.

Colloidal solutions (also called colloidal suspensions) are the subject of interface and colloid science. This field of study was introduced in 1861 by Scottish scientist Thomas Graham.

Hydrocolloids

A hydrocolloid is defined as a colloid system wherein the colloid particles are hydrophilic polymers dispersed in water. A hydrocolloid has colloid particles spread throughout water, and depending on the quantity of water available that can take place in different states, e.g., gel or sol (liquid). Hydrocolloids can be either irreversible (single-state) or reversible. For example, agar, a reversible hydrocolloid of seaweed extract, can exist in a gel and solid state, and alternate between states with the addition or elimination of heat.

Many hydrocolloids are derived from natural sources. For example, agar-agar and carrageenan are extracted from seaweed, gelatin is produced by

hydrolysis of proteins of bovine and fish origins, and pectin is extracted from citrus peel and apple pomace.

Gelatin desserts like jelly or Jell-O are made from gelatin powder, another effective hydrocolloid. Hydrocolloids are employed in food mainly to influence texture or viscosity (e.g., a sauce). Hydrocolloid-based medical dressings are used for skin and wound treatment.

Other main hydrocolloids are xanthan gum, gum arabic, guar gum, locust bean gum, cellulose derivatives as carboxymethyl cellulose, alginate and starch.

Interaction between particles

The following forces play an important role in the interaction of colloid particles:

- Excluded volume repulsion: This refers to the impossibility of any overlap between hard particles.
- Electrostatic interaction: Colloidal particles often carry an electrical charge and therefore attract or repel each other. The charge of both the continuous and the dispersed phase, as well as the mobility of the phases are factors affecting this interaction.
- van der Waals forces: This is due to interaction between two dipoles that are either permanent or induced. Even if the particles do not have a permanent dipole, fluctuations of the electron density gives rise to a temporary dipole in a particle. This temporary dipole induces a dipole in particles nearby. The temporary dipole and the induced dipoles are then attracted to each other. This is known as van der Waals force, and is always present (unless the refractive indexes of the dispersed and continuous phases are matched), is short-range, and is attractive.
- Entropic forces: According to the second law of thermodynamics, a system progresses to a state in which entropy is maximized. This can result in effective forces even between hard spheres.
- Steric forces between polymer-covered surfaces or in solutions containing non-adsorbing polymer can modulate interparticle forces, producing an additional steric repulsive force (which is predominantly entropic in origin) or an attractive depletion force between them. Such an effect is specifically searched for with tailor-made superplasticizers developed to increase the workability of concrete and to reduce its water content.

