







Colloid Formation and Flocculation

key concepts:

- **Colloids** are **mixtures** with visible but small particles.
- The **Tyndall effect** is the scattering of a light beam through a colloid.
- Two common types of colloids in water are fat globules and **micelles**.
- **Flocculation** causes the particles of a colloid to clump and settle out of the mixture.

type	dispersed substance	dispersing medium	example
aerosol	liquid	gas	fog 
aerosol	solid	gas	smoke 
foam	gas	liquid	whipped cream 
emulsion	liquid	liquid	milk 
sol	solid	liquid	paint 
solid sol	solid	solid	gems 

Colloids are mixtures with visible but small particles.

Colloids can be classified based on the phase of the dispersed substance and the phase of the dispersing medium.

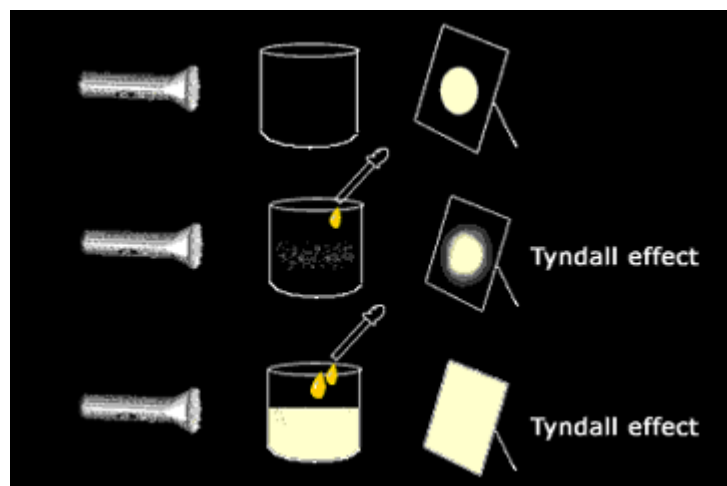
An **aerosol** (such as fog or smoke) is a liquid or solid dispersed in a gas.

A foam (such as whipped cream) is a gas dispersed in a liquid.

An **emulsion** (such as milk) is a liquid dispersed in a liquid.

A **sol** (such as paint) is a solid dispersed in a liquid.

A **solid sol** (such as a gem) is a solid dispersed in a solid.



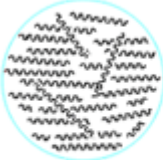
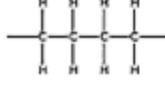
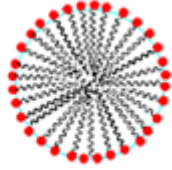
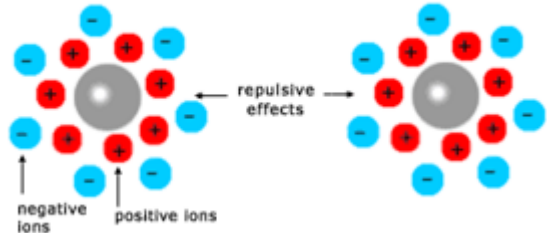


When a flashlight is shined through a beaker of water, the beam of light is not scattered.

After a drop of milk is added, the beam is slightly scattered. The path of the beam is visible as it passes through the mixture.

Addition of more milk causes the beam of light to be scattered to the point that the mixture seems to glow.

The scattering of a light beam passing through a colloid is the Tyndall effect.

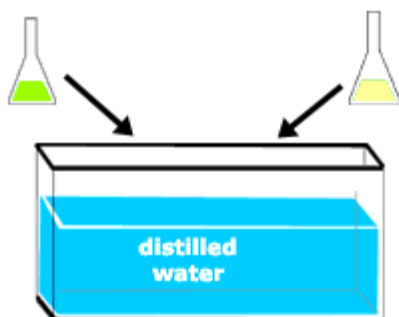
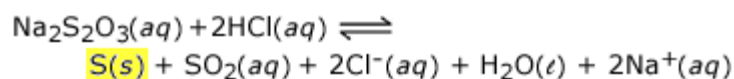
Colloid Formation and Flocculation

fat globule	micelle	
  hydrocarbon (nonpolar)	 nonpolar hydrocarbon tail hydrophobic polar head hydrophilic	<p>When nonpolar molecules such as fats are added to water, they group together to minimize interactions with the polar water, and form fat globules.</p> <p>When molecules with polar heads are added to water, micelles are formed. The hydrophobic (nonpolar) tails group together, with the hydrophilic (polar) heads pointed towards the water.</p>
 repulsive effects		<p>Colloid particles such as fat globules and micelles tend to collect charge on their surfaces. This collection of charge prevents the particles from grouping together and settling out of the mixture.</p>
flocculation	example:	<p>Flocculation causes a colloid to clump and settle out of the mixture.</p>
	 river deltas	<p>The repulsive effects of the charges surrounding colloid particles can sometimes be overcome by adding heat. When the repulsive forces are overcome, flocculation occurs, and the colloid particles clump and settle out of the mixture.</p> <p>Adding an electrolyte (such as salt) can also neutralize the charge shells, causing the colloid particles to clump and settle out of the mixture. Electrolytes are flocculating agents.</p> <p>Flocculation occurs at river deltas. Rivers pick up mud which becomes suspended in water. When the rivers empty into the ocean, the saltwater acts as a flocculating agent, and the mud settles out of the mixture.</p>

CIA Demonstration: Tyndall Effect

key concepts:

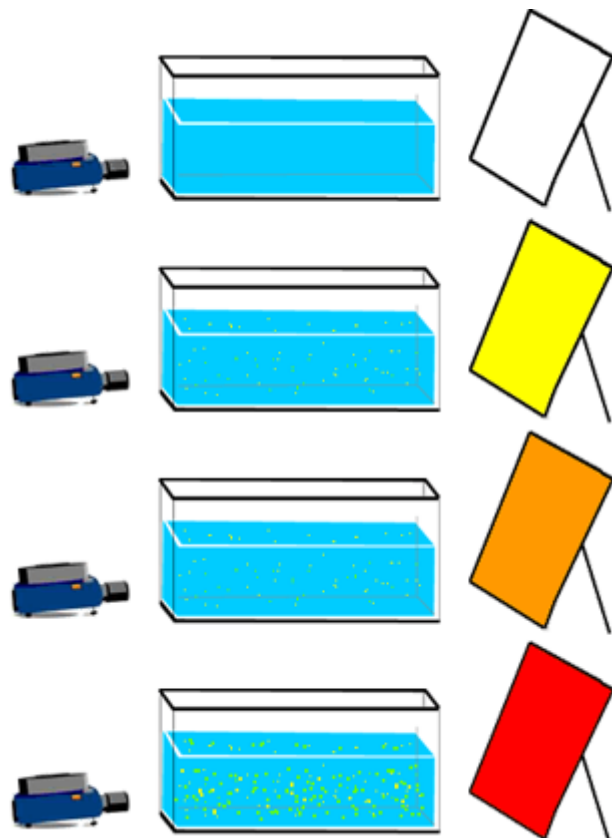
- Sodium thiosulfate and hydrochloric acid react to form a **sol** of elemental sulfur in water.
- As the particles grow larger, only longer wavelengths can pass through the mixture.



A saturated sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) solution is combined with 6 M hydrochloric acid (HCl) in an aquarium filled with distilled water. Sodium thiosulfate and hydrochloric acid react to form solid elemental sulfur.

The solid elemental sulfur forms a sol with the water. A sol is a **colloid** composed of a solid (the sulfur) dispersed in a liquid (the water).

As the reaction progresses, more and more sulfur is produced.



The **Tyndall effect** is the scattering of light by the particles of a dispersed substance observed when a beam of light is projected through a colloid.

Before the reaction, the beam of the projector passes through the aquarium without being scattered.

When a small amount of solid sulfur forms, the beam of the projector is scattered. Several wavelengths are present, so the light scattering onto the poster board appears yellow.

As more sulfur is produced, the suspended particles become larger. The shorter wavelengths of light are not able to pass through the mixture, so the light scattering onto the poster board appears orange.

As still more sulfur is produced, only longer wavelengths (red light) can pass through the mixture, and the poster board appears red.