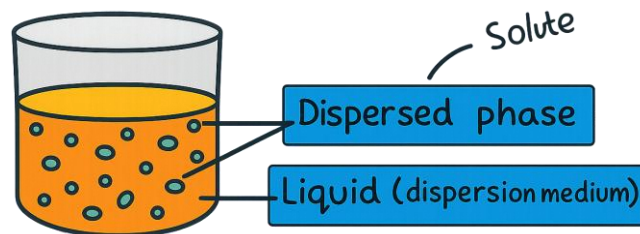


Coarse Dispersions

Coarse Dispersion

Definition:

- A **coarse dispersion** is a type of dispersed system where the dispersed phase (particles) is relatively large in size (usually greater than $1\text{ }\mu\text{m}$) and is distributed throughout a continuous phase (usually a liquid).



- Examples:** Suspensions and emulsions.
- Contrast with:**
 - Colloidal dispersions** ($1\text{ nm} - 1\text{ }\mu\text{m}$)
 - True solutions** (molecular size)
- In coarse dispersions:
 - The particles are visible under a microscope
 - They tend to settle over time due to gravity
 - Suspensions** are a prime example and are widely used in pharmaceuticals

Comparison with Other Dispersions:

Type	Particle Size	Example
Solution	$<1\text{ nm}$	Salt in water
Colloid	$1-1000\text{ nm}$	Milk, fog
Coarse Dispersion	$>1000\text{ nm} (>1\text{ }\mu\text{m})$	Sand in water, muddy water

Suspensions

Definition:

- A **suspension** is a heterogeneous system in which insoluble solid particles (dispersed phase) are suspended in a liquid medium (dispersion medium).

Applications in Pharmaceuticals:

- Used to administer insoluble drugs orally, topically, or parenterally

- Examples: Antacids (e.g., aluminum hydroxide), antibiotics (e.g., amoxicillin suspension)

Desirable Properties of Suspensions:

- Uniform particle size
- Stability (no rapid settling or caking)
- Redispersibility (easy to resuspend after shaking)
- Pleasant taste and appearance
- Controlled viscosity

Interfacial Properties of Suspended Particles

At the interface between suspended particles and the surrounding liquid, several key properties affect the behavior and stability of the suspension:

A. Interfacial Tension

- Exists between the solid particle surface and the liquid.
- Higher tension = more energy, promoting aggregation unless stabilized.

B. Wettability

- Measured by the **contact angle** between the solid and liquid.
 - **Hydrophilic particles:** well-wetted → stable dispersion.
 - **Hydrophobic particles:** poorly wetted → aggregation.

C. Zeta Potential

- Reflects the **electrostatic potential** at the particle's slipping plane.
- A high absolute zeta potential ($> \pm 30$ mV) indicates strong repulsion → stability.
- Low zeta potential → particles come closer → flocculation/aggregation.

D. Stabilization

- **Electrostatic stabilization:** Charged particles repel each other.
- **Steric stabilization:** Surfactants or polymers form barriers around particles.

Why Interfacial Properties Matter:

- **Pharmaceuticals:** affect drug suspension stability
- **Paints/Coatings:** influence sedimentation and uniformity
- **Food emulsions:** stability of suspended particles (e.g. cocoa in chocolate milk)
- **Environmental science:** transport of particulates in water

Settling In Suspensions

- Settling is a natural consequence in suspensions due to **gravity** acting on particles denser than the liquid.

Stokes' Law

- The **rate of settling** V of spherical particles in a fluid is described by:

$$V = \frac{2r^2(\rho_p - \rho_f)g}{9\eta}$$

- Where:
 - r = radius of the particle
 - ρ_p = density of the particle
 - ρ_f = density of the fluid
 - g = gravitational acceleration
 - η = viscosity of the fluid

Key Factors Influencing Settling

- Particle Size:** Larger particles settle faster.
- Density Difference:** Greater density difference increases settling rate.
- Viscosity:** Higher viscosity slows down settling.
- Temperature:** Higher temperature lowers viscosity, increasing settling.

Sedimentation vs. Flocculation

- Sedimentation:** Settling of individual particles
- Flocculation:** Loose clusters form and settle faster (but are easily redispersed)

Problems with Settling

- Caking:** Formation of a hard sediment that is difficult to redisperse.
- Non-uniform dose:** Especially problematic in oral suspensions.

Flocculated Suspensions

- Particles form **loosely bound clusters** called **flocs**.
- Flocs are light and settle rapidly but form a **loose sediment** that is easily redispersed.
- Zeta potential is **reduced** (but not too low) to promote controlled aggregation.
- Flocculation agents (like **electrolytes**, **polymers**) are used.



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