COARSE DISPERSIONS NOTES

1) EMULSIFYING AGENTS

An emulsifying agent (emulsifier) is a surface-active ingredient which adsorbs at the newly formed oil–water interface during emulsion preparation, and it protects the newly formed droplets against immediate re-coalescence.

Emulsifying agents can be classified as:-

i) Natural:

Vegetable source: Gum acacia, tragacanth, agar, starch, pectin.

Animal source: wool fat, egg yolk, gelatin.

ii) Semi synthetic: Methyl cellulose, Na CMC

iii) Synthetic:

Anionic: Sodium Lauryl Sulphate

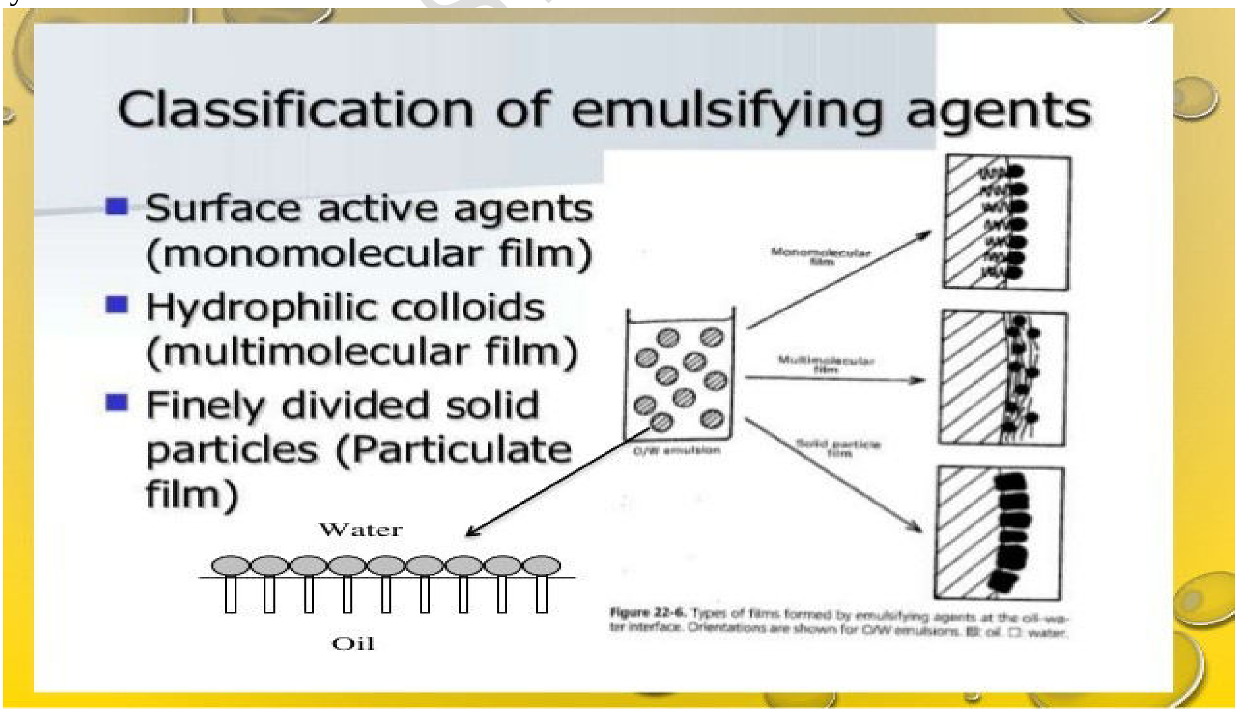
Cationic: Cetrimide, benzalkonium chloride.

Non-ionic: Glyceryl ester- glyceryl monoesters etc.

iv) Inorganic: Milk of magnesia, Mg oxide, Mg trioxide etc.

v) Alcohols (polyoles): Carbowax, cholesterol and lecithin.

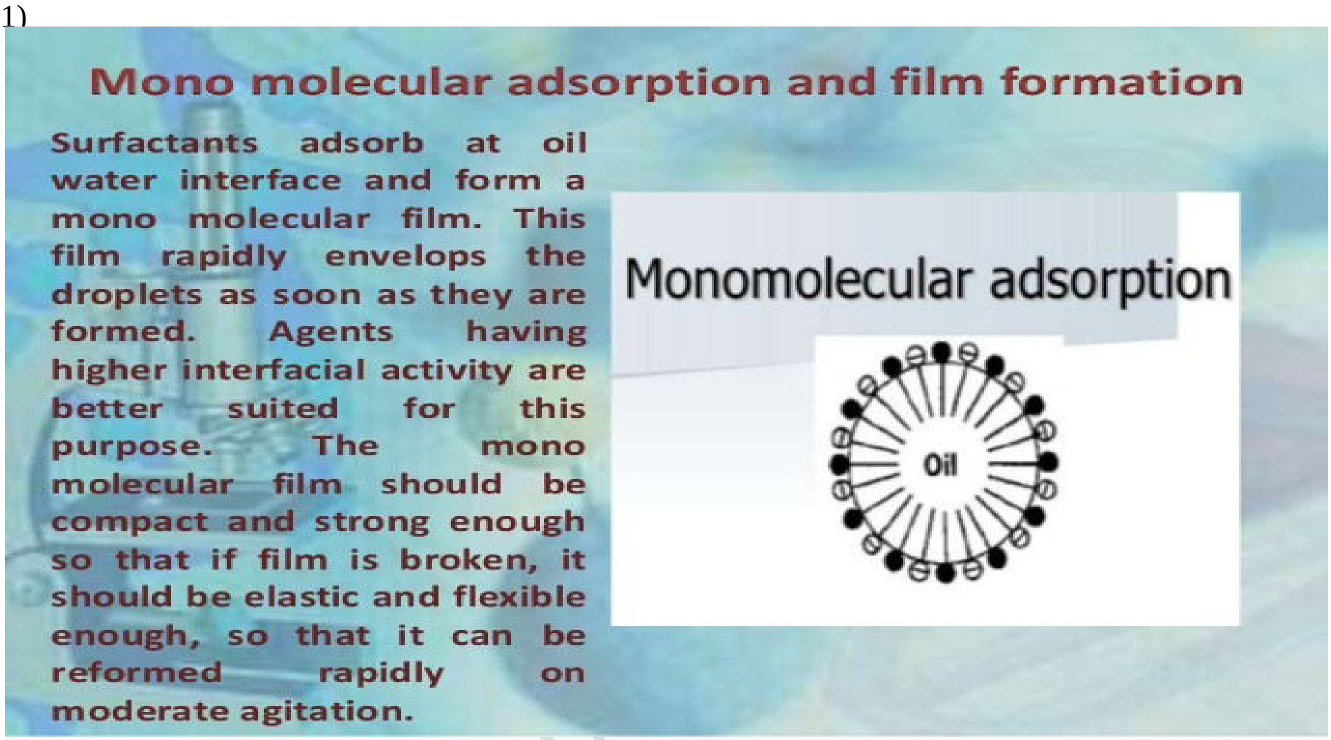
They can also be classified as:



2) THEORIES OFEMULSIFICATION

There are 3 theories of emulsification:-
1) Monomolecular adsorption and film formation theory
2) Multimolecular adsorption theory
3) Solid particle adsorption theory

1)



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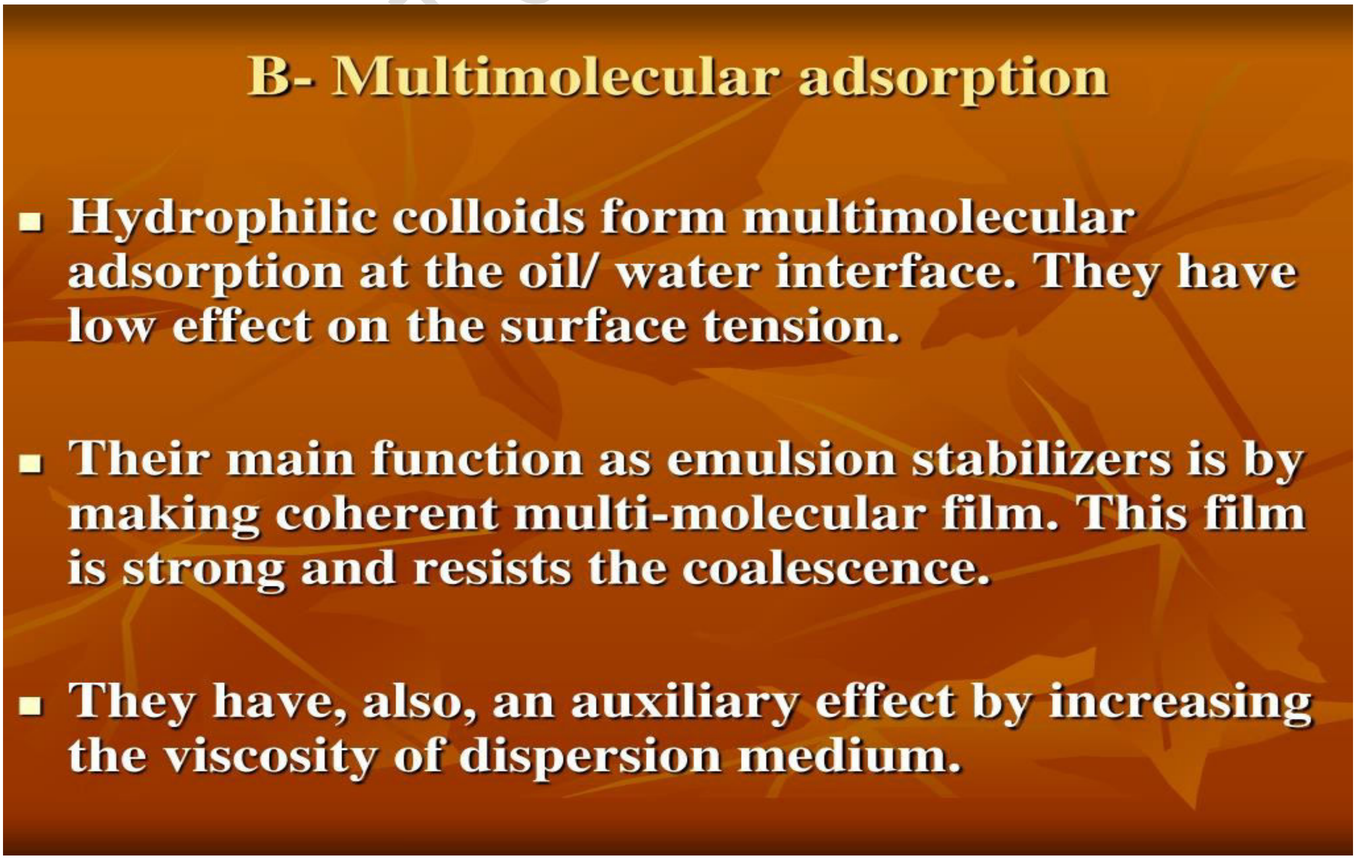

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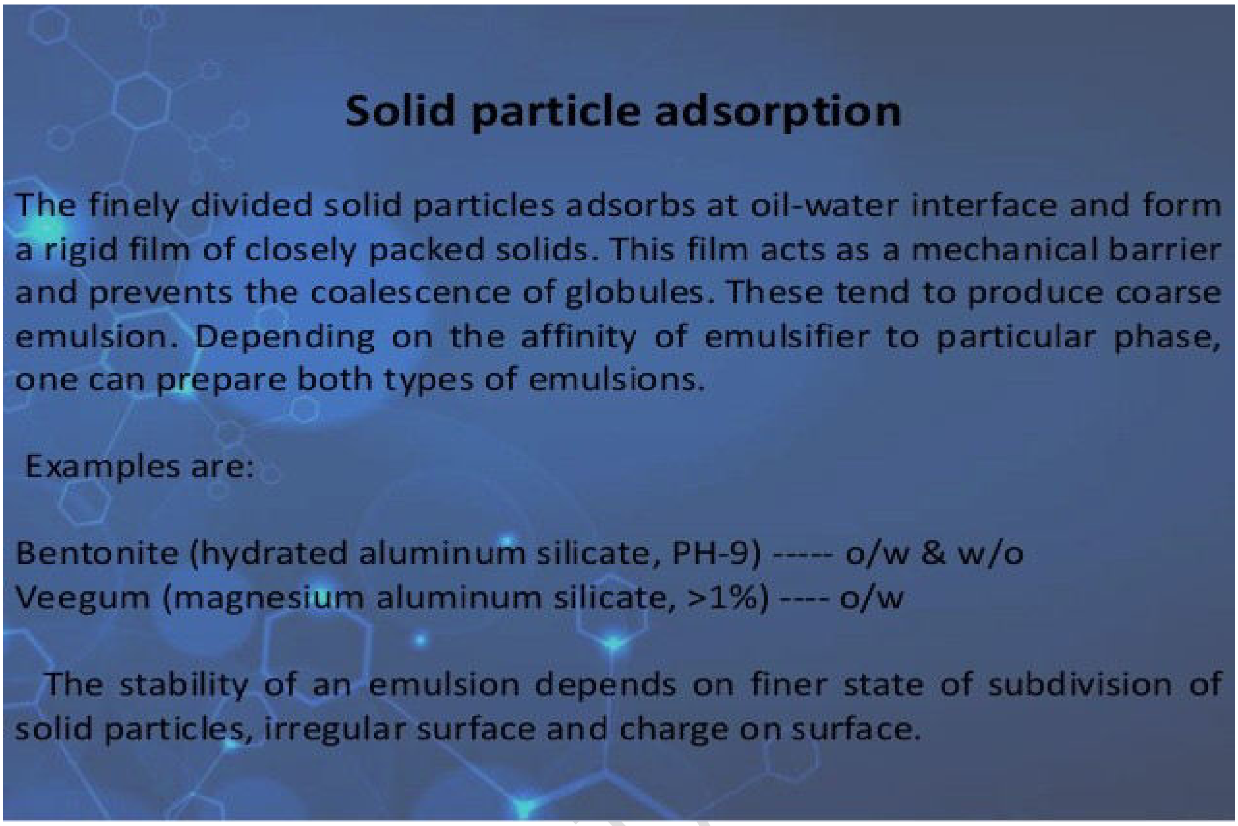


3) EVALUATION TEST FOR STABILITY OF EMULSION

i) Globule size analysis

Microscopic evaluation of Globule size gives idea of stability of an emulsion.

If the globule size are larger, it indicates the aggregation of globules and due to which the emulsion is not stable.

ii) Centrifugation

The Emulsion is kept in centrifuge and then plot of Depth of Oil in centrifuge Vs Time (in seconds) is plotted.

As the depth increases the stability is less.

iii) Viscosity:

Measured using Viscometers

iv) Stress condition:

Aging and temperature (Accelerated stability studies):

Helps in predicting the shelf life of emulsion.

4) THEORY OF SEDIMENTATION IN SUSPENSION

Settling is a phenomenon which occurs in dispersed system where the dispersed particles settle to the bottom of the container because of gravitational force.

This occurs because the particles are too large to remain permanently suspended in the vehicle.

Therefore suitable suspending agents are added to retard this process.

Theory of sedimentation: Stokes law

$$V = \frac{d^2 g(\rho_p - \rho_s)}{18\eta}$$

V= Velocity of sedimentation

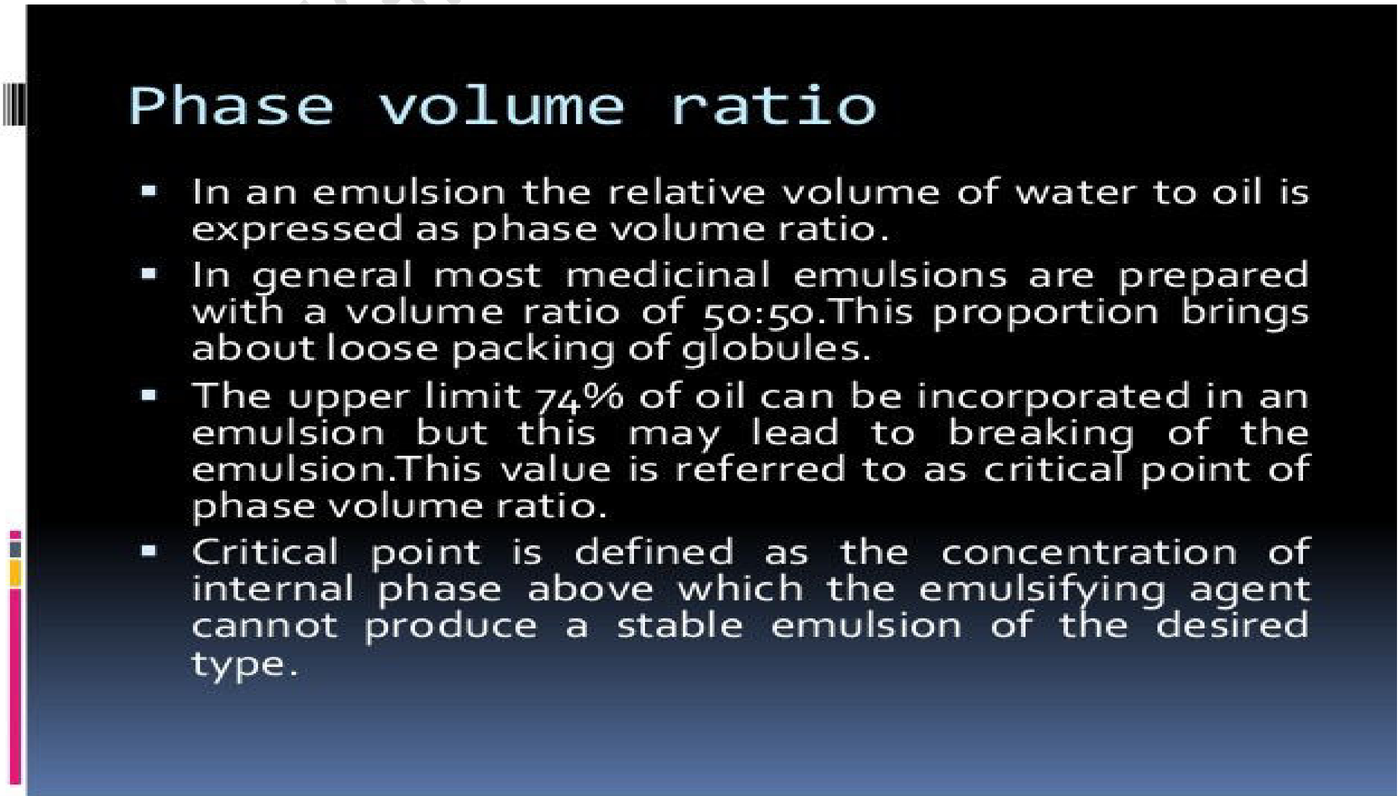
d= Diameter of particle

ρ1 and ρ2 =Density of particle and liquid

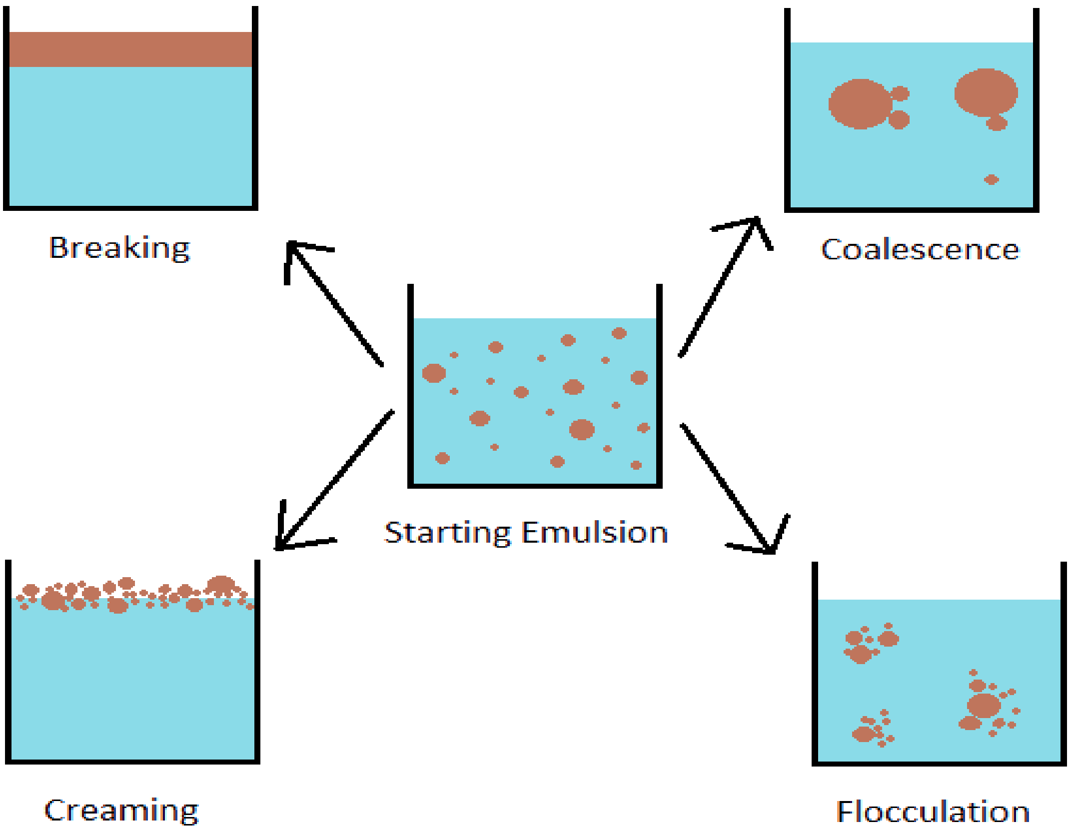
η = viscosity of liquid

g=gravitational const

Pharmaceutical suspension containing less than 2% (w/v) of solid follow Stoke's Law.



6) STABILITY PROBLEMS IN EMULSION



i) Flocculation

In this case, neighboring globules come closer to each other and form colonies in external phase. This aggregation of globules is not clearly visible.

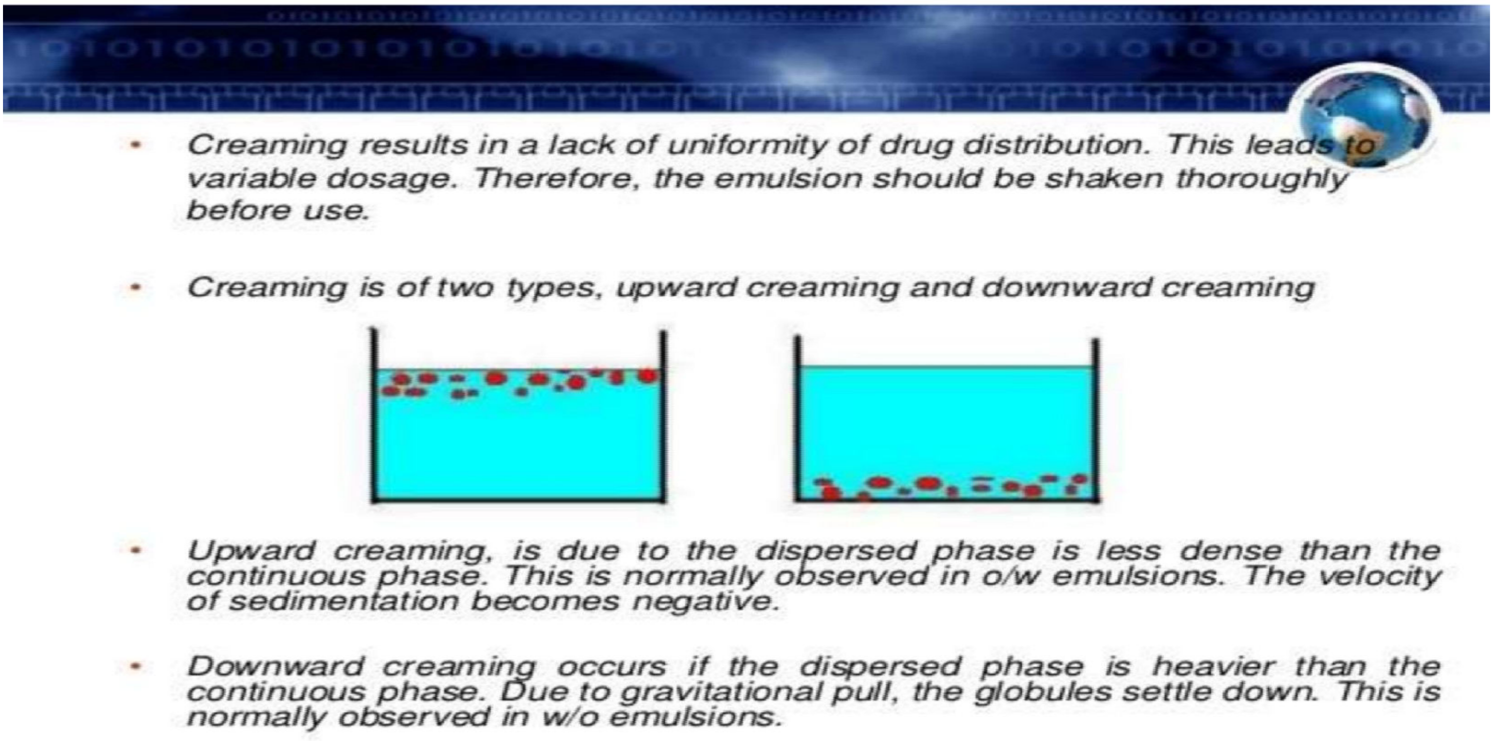
Uniform sized globules prevent flocculation. This can be achieved by proper size reduction process.

If the viscosity of external medium is increased, the globules become relatively immobile and flocculation can be prevented.

Flocs slowly move either upward or downward leading to creaming.

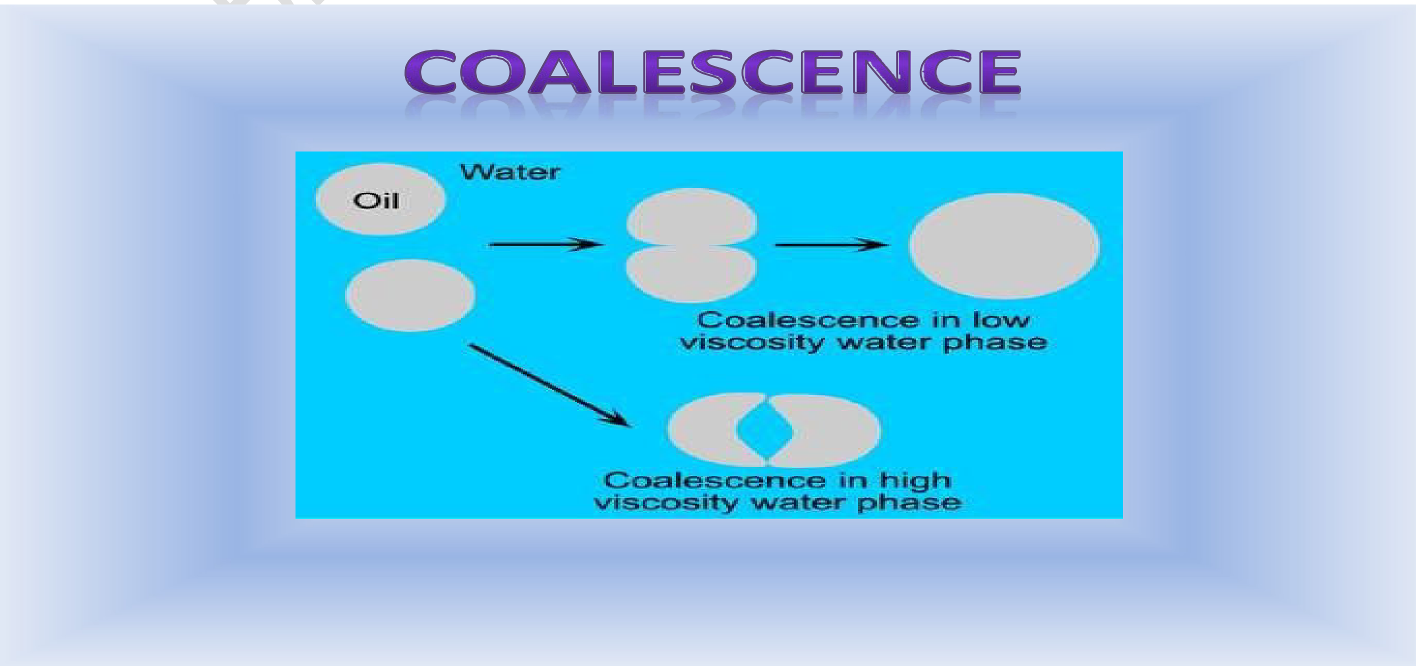
ii) Creaming

Flocculation is due to interaction of attractive and repulsive force, where as creaming is due to density differences in two phases.



Creaming can be prevented by:

*Reducing the particle size by homogenization.



Coalescence is observed due to:-

-Insufficient amount of emulsifying agent

-Altered partitioning of emulsifying agent

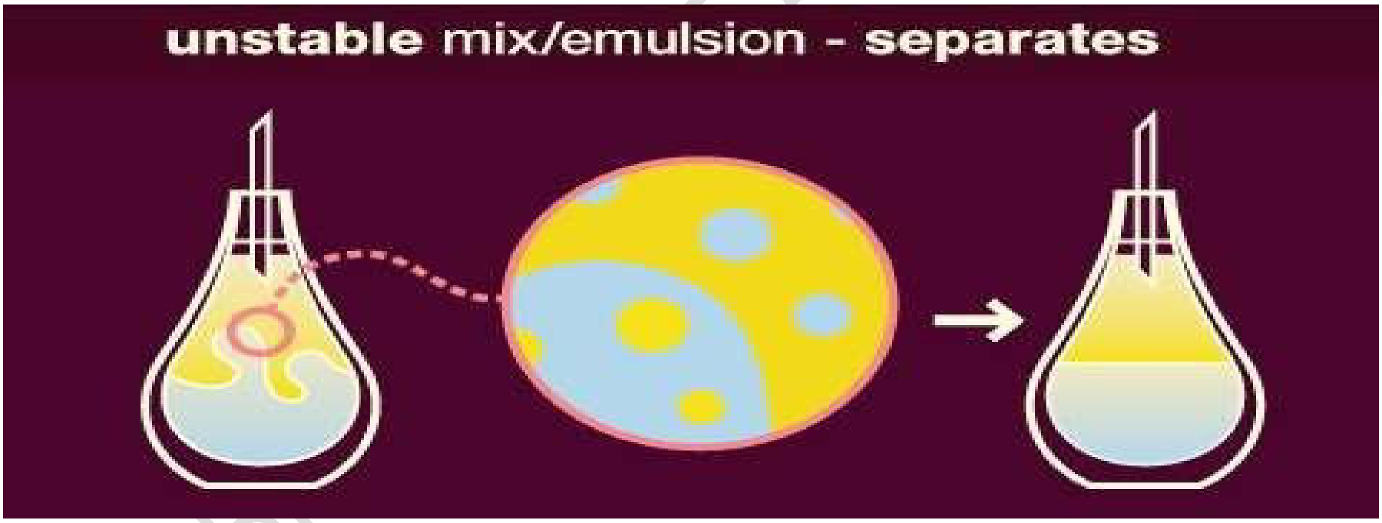
-Incompatibilities between emulsifying agents

iv) Breaking

This is indicated by complete separation of oil and aqueous phase.

It is an irreversible process i.e. simple mixing fails to re-suspend the globules into a uniform emulsion.

In breaking, protective sheath around the globules is completely destroyed.



v) Phase inversion

Phase inversion means change in the type of emulsion i.e. o/w to w/o or vice versa

Reasons for phase inversion.

*Addition of electrolyte.

*Changing phase volume ratio.

*Temperature change.

*Changing the emulsifying agent.

7) SEDIMENTATION VOLUME IN SUSPENSION

Sedimentation Volume (F)

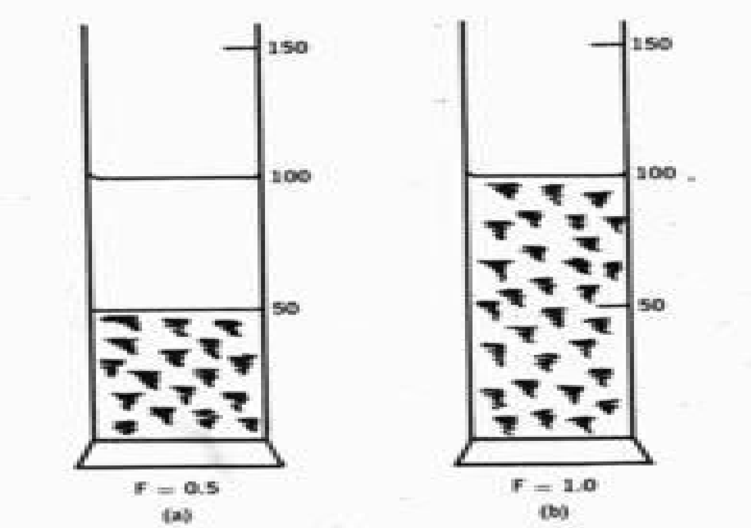
Sedimentation volume is the ratio of the ultimate volume of sediment (Vu) to the original volume of suspension (Vo) before settling.

F = Vu / Vo

Where,

Vu = final or ultimate volume of sediment

Vo = original volume of suspension before settling



F has values ranging from less than one to greater than one.

When F < 1 Vu < Vo

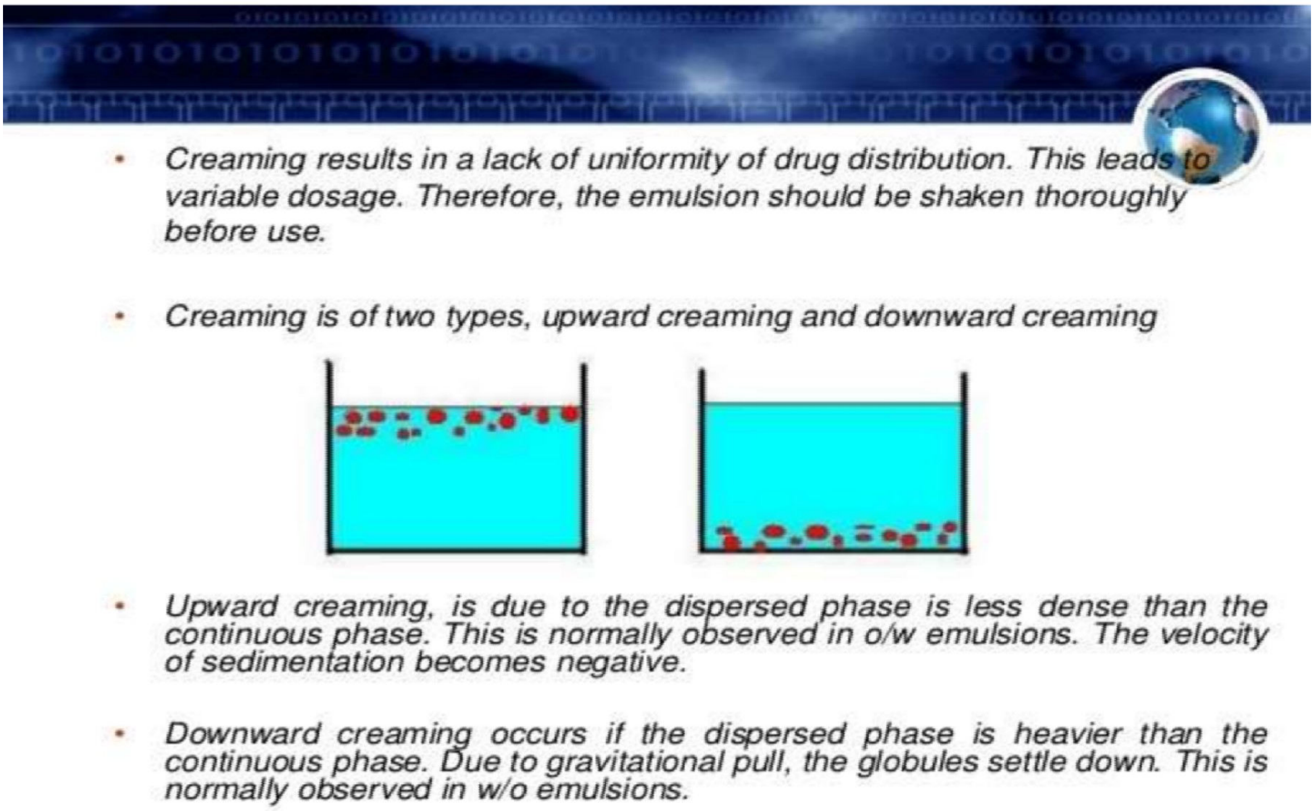
When F =1 Vu = VoThe system (F =1) is said to be in flocculation equilibrium and show no clear supernatant on standing.

When F > 1 Vu > Vo Sediment volume is greater than the original volume due to the network of flocs formed in the suspension and so loose and fluffy sediment and extra vehicle is needed (added) to contain the sediment

8) CREAMING IN EMULSION AND HOW IT IS PREVENTED

Creaming

Flocculation is due to interaction of attractive and repulsive force, where as creaming is due to density differences in two phases.



Creaming can be prevented by:

*Reducing the particle size by homogenization.

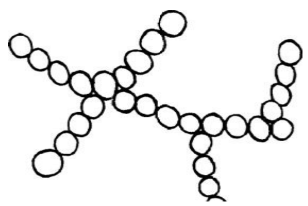
*Increasing the viscosity of external phase by adding the thickening agents.

*Reducing the difference in densities between dispersed phase and dispersion medium.

9) DISTINGUISH BETWEEN FLOCCULATED AND DEFLOCCULATED SYSTEM

Flocculated Suspensions

In flocculated suspension, formed flocs (loose aggregates) will cause increase in sedimentation rate due to increase in size of sedimenting particles.



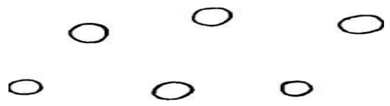
Hence, flocculated suspensions sediment more rapidly.

Deflocculated suspensions

In deflocculated suspension, individual particles are settling.

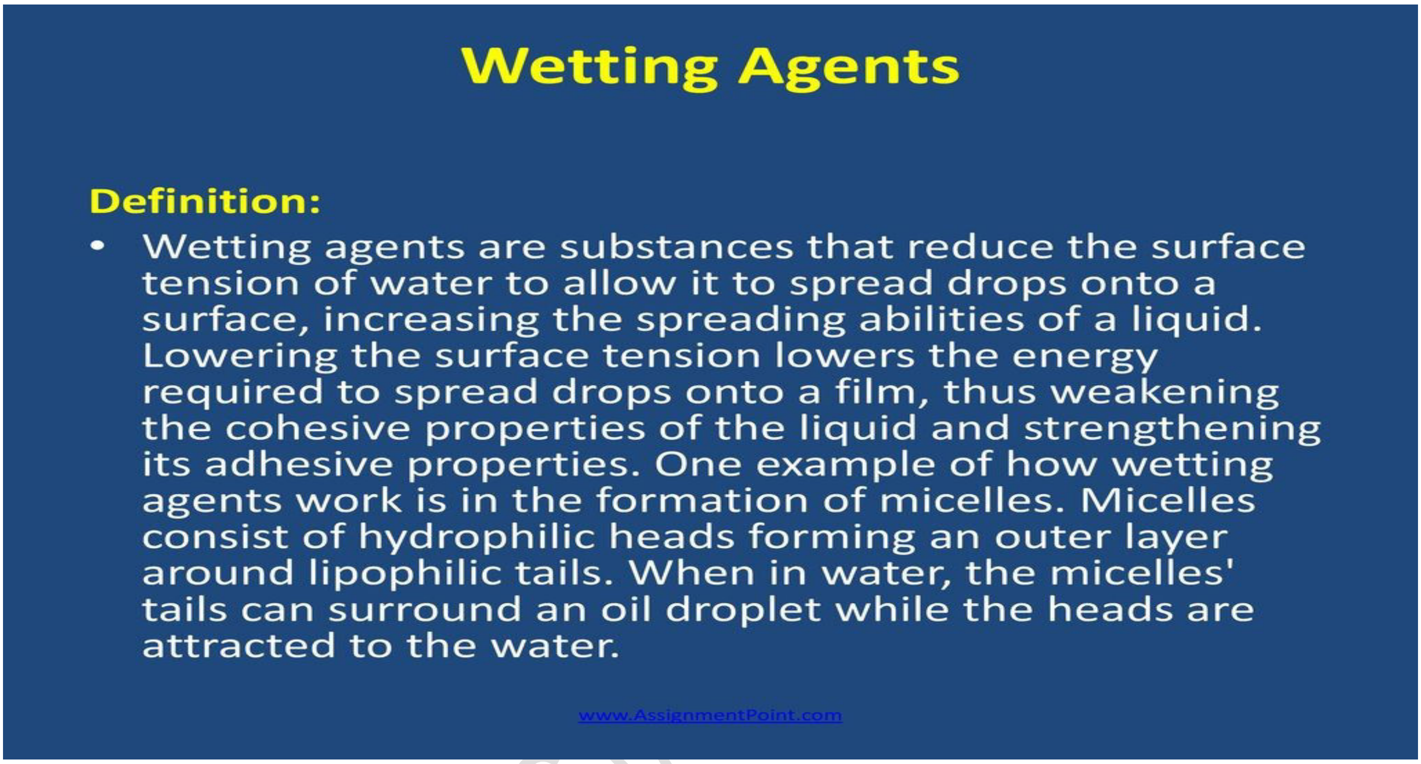
Rate of sedimentation is slow , which prevents entrapping of liquid medium which makes it difficult to re-disperse by agitation.This phenomenon called ‘caking’

In deflocculated suspension larger particles settle fast and smaller remain in supernatant liquid so supernatant appears cloudy.



Deflocculated	Flocculated
Particles exist in suspension as **separate entities.**	Particles form **loose aggregates.**
Rate of sedimentation is **slow**, since each particle settles separately and particle size is minimal.	Rate of sedimentation is **high**, since particles settle as a floc, which is a collection of particles.
A sediment is formed **slowly.**	A sediment is formed **rapidly.**
The sediment eventually becomes very **closely packed**, due to weight of upper layers of sedimenting material. Repulsive forces between particles are overcome and a hard cake is formed which is **difficult, if not impossible, to redisperse.**	The sediment is **loosely packed** and possesses a scaffold-like structure (**large volume of final sediment**). Particles do not bond tightly to each other and a hard, dense cake does not form. The sediment is **easy to redisperse**, so as to reform the original suspension.
The suspension has a **pleasing appearance**, since the suspended material remains suspended for a relatively long time. The supernatant also remains cloudy, even when settling is apparent.	The suspension is somewhat **unslightly**, due to rapid sedimentation and the presence of an obvious, clear supernatant region. This can be minimized if the volume of sediment is made large. Ideally, volume of sediment should encompass the volume of the suspension.

10) WETTING AGENTS



Contact angle is the angle between liquid droplet and surface over which it spreads.

Important action of wetting agent is to reduce the value of contact angle.

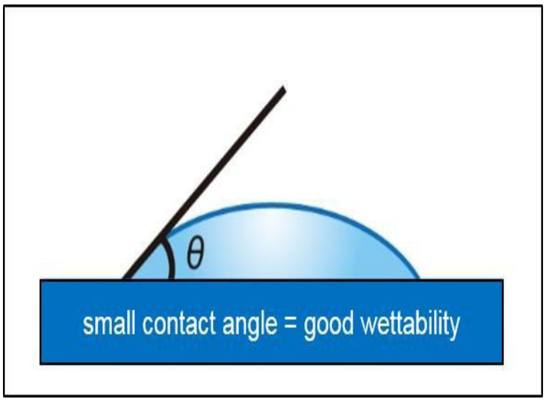
CLASSIFICATION OF WETTING AGENTS

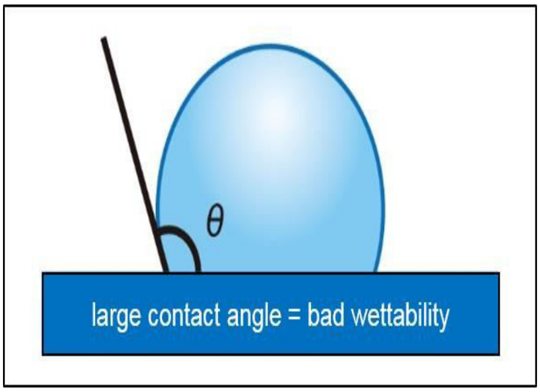
Surfactant type	Example	Use
Anionic	Alkyl sulfates, soaps, Calsoft®, Texapon®	50 % of overall industrial production, laundry detergent, dishwashing liquids, shampoos
Cationic	Quaternary ammonium salts	Used together with nonionic surfactants but not with anionic, softeners in textiles, anti-static additives
Nonionic	Ethoxylated aliphatic alcohol, polyoxyethylene surfactants, Triton™ X-100, Span®, Tergitol™	45 % of overall industrial production, a wetting agent in coatings, food ingredient
Zwitterionic	Betaines, amphoacetates	Expensive, special use e.g. cosmetics

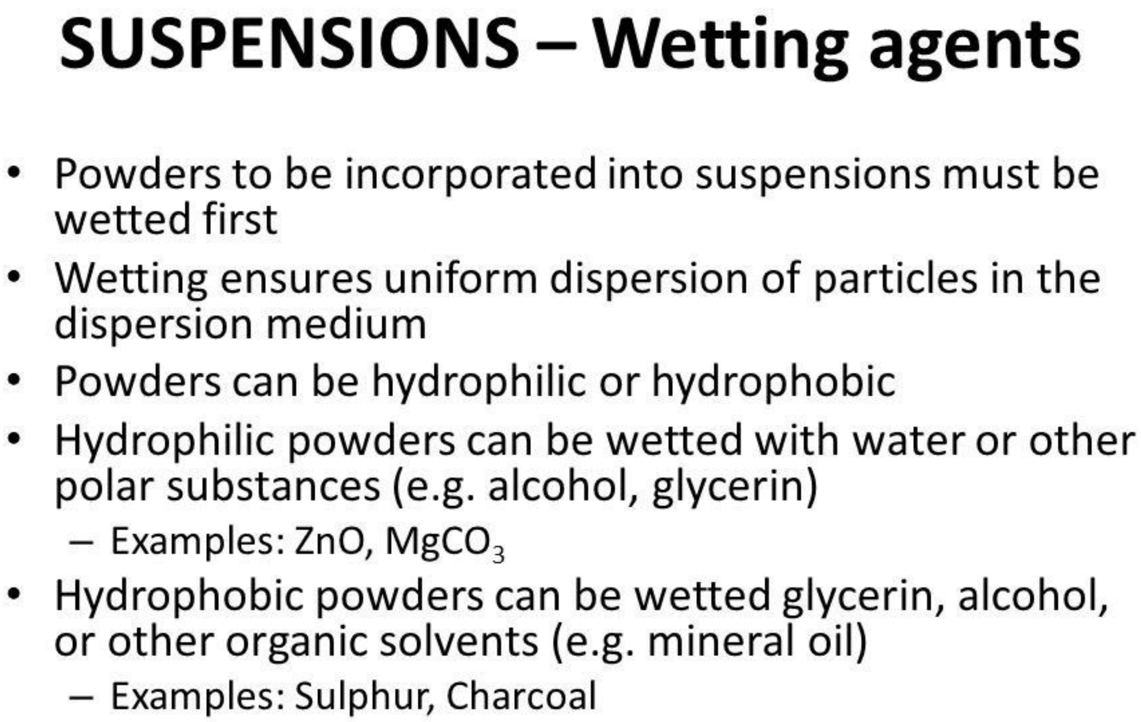
11)SIGNIFICANCE OF WETTING IN SUSPENSION

Wetting reduces the contact angle between liquid droplet and surface over which it spreads.

Important action of wetting agent is to reduce the value of contact angle.







12) CONTROLLED FLOCCULATION

Need of Controlled Flocculation

Assume the powder is properly wetted and dispersed.

In order to prevent compact sediment (hard cake) we need controlled flocculation

Controlled Flocculation can be achieved through following methods:

1)Effect of Electrolytes (ionic substance)

2) Effect of Surfactant

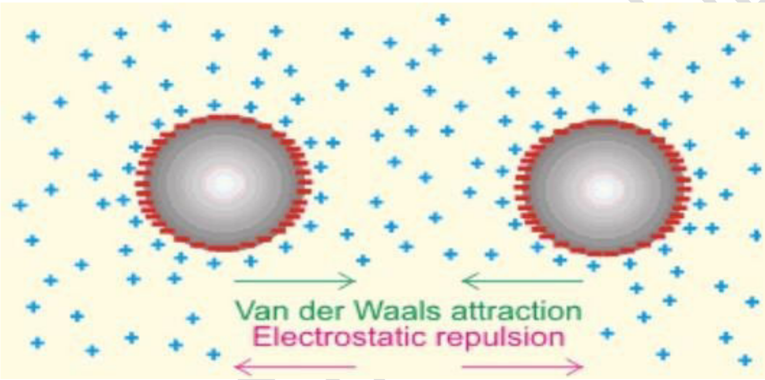
3) Effect of Polymer

1) Effect of electrolytes

It act as flocculating agents by reducing electrical barrier between particles and forming bridge between adjacent particles

At low electrolyte conc --Repulsive force predominate

At high electrolyte conc -- Repulsive force reduce and cause coagulation

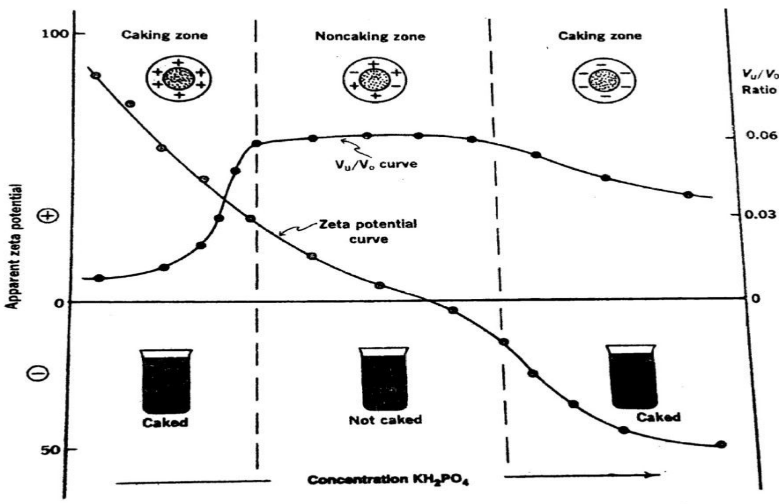


Bismuth subnitrate suspension

Bismuth sub nitrate particles posses +ve charge

If we add monobasic potassium phosphate (KH2PO4) then positive zeta potential decrease to zero because of adsorption of -ve phosphate ions then increase in negative direction

At certain +ve zeta potential, maximum flocculation occur



2) Effect of Surfactant

Concentration of (cationic/anionic) surfactant as flocculating agent is critical because

they act as wetting and deflocculating agent

Surfactant improve dispersion by reducing surface tension

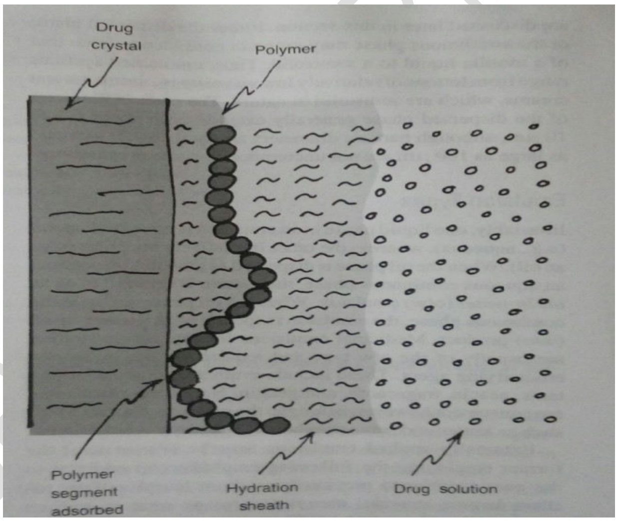
Ionic surfactant (SLS) sometime cause flocculation

3) Effect of Polymer

Hydrophilic polymer act as protective colloids and flocculating agent.

Chain of polymer adsorb on multiple particles

Ex. Xanthum gum increase sedimentation volume by polymer-bridging phenomenon for bismuth sub-carbonate



13) CLASSIFY AND DESCRIBE TYPES OF EMULSIONS WITH EXAMPLE

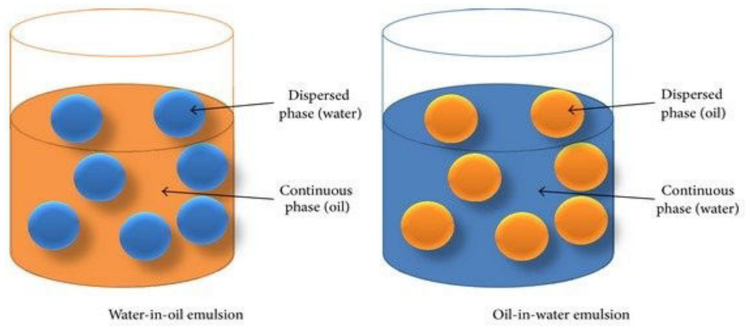
Emulsions are classified as:-
i) o/w type: oil is the dispersed phase and water is the continuous phase.

Eg: liquid paraffin emulsion, milk

ii) w/o: water is the dispersed phase and oil is the continuous phase

Eg: butter, cold cream

iii) Multiple emulsion:

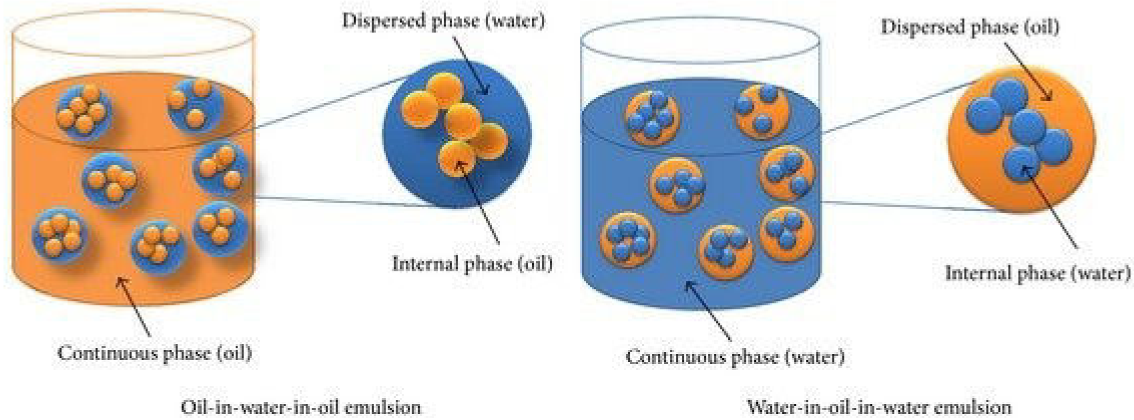


Use for subcutaneous and Intravenous injection.

Sub-divided as:

a) o/w/o type

b) w/o/w type



iv) Macro emulsion: particle size in the range of 0.1µm – 5µm

v) Micro emulsion: particle size in the range of 140 nm-5µm