Unit – III

Coarse dispersion

* Suspension and emulsion are (2) types of Coarse dispersion.

* The size of coarse dispersion ranges from 1 μm to 100 μm.

Suspension → A suspension may be defined as a heterogenous (biphasic system) comprising of a solid phase (dispersed phase) uniformally dispersed in a liquid phase (continuous phase).

* A suspension is a coarse dispersion which supply insoluble and distastefull substance in the form of pleasant taste.

Ex-: ① Chloramphenical is very bitter and can not be given in liquid form to children.

(ii) Chloramphenicol palmitate, an insoluble salt can be formulated in suspension for paediatric use.

Interfacial properties of suspended particles

There are 2 factors in suspended particles -

① Surface free energy -:

* In formulation of a suspension, work is done to reduce the particle size (↑ the surface area).

* This makes the system thermodynamically unstable.

* In order to ↑ the stability, particles

flocculate by Wander wall's forces.

* The ↑ in free energy due to reduction of particle size is given by the equation —

$$\Delta G = \gamma_{SL} \Delta A$$

Where → ΔG = Surface free energy change

γ_{SL} = Interfecial tension b/w solid and liquid.

ΔA = Change in surface area of solid.

* The system try to stable by reducing free energy to zero.

* The interfecial tension can be reduced by wetting agent. which adsorb on the surface of particle.

* wetting agent can not reduce the interfecial tension to zero, hence

suspension particle tend to flocculate.

(ii) Electrical properties :-

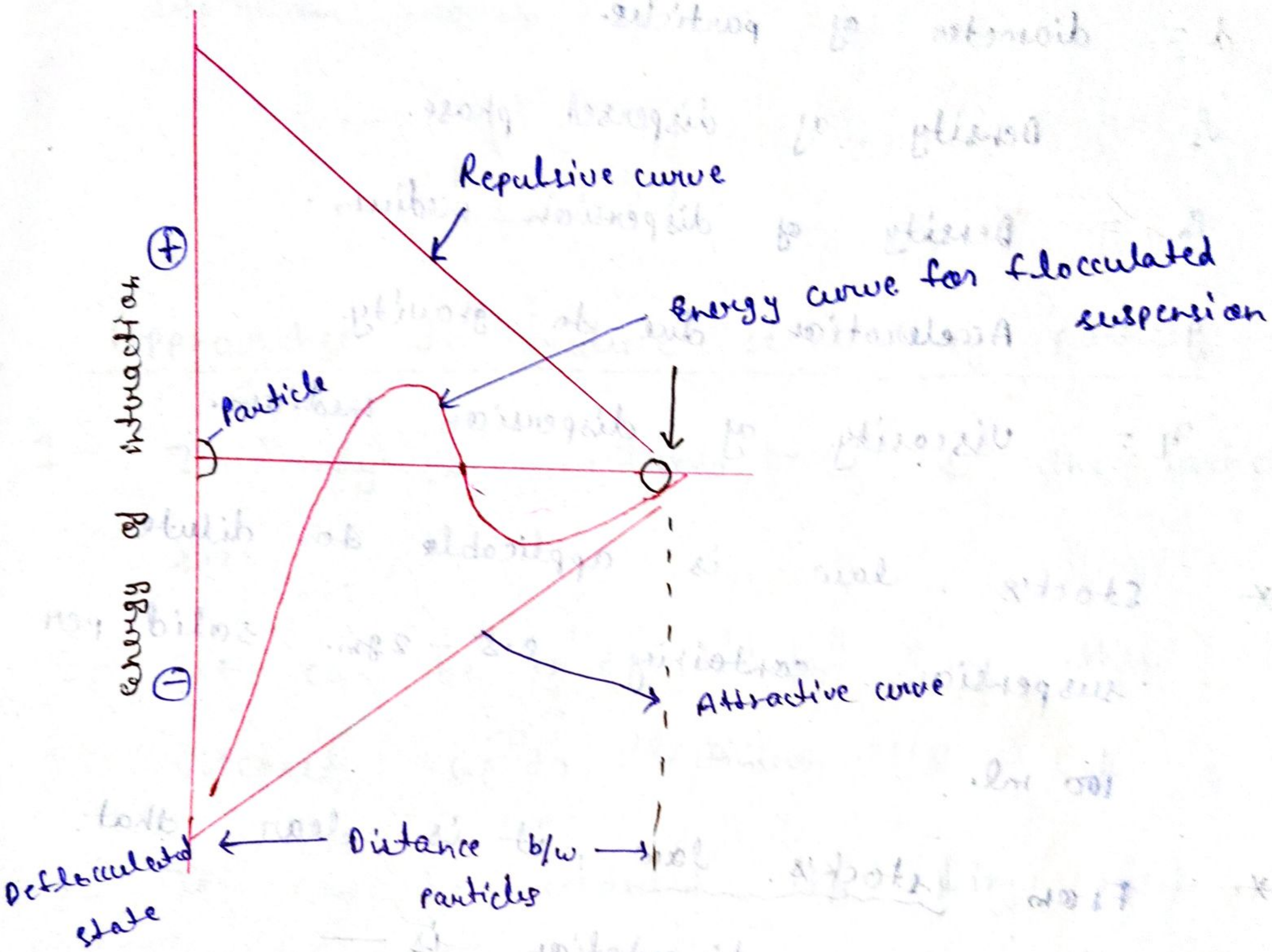
* Force acting on the surface of the suspended particles affect flocculation in a suspension.

* Force of attraction arise from vander wall's forces.

* Force of repulsion results from electrical double layer.

* When the repulsive energy is high, it prevent collision of particles and they remains deflocculated.

* When deflocculated particles settles, they form closed packing.



Settling in suspensions

The sedimentation velocity of suspended particle is given by stock's law.

According to this

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

v = Rate of settling in cm/s.

d = diameter of particles.

ρ_s = Density of dispersed phase.

ρ_o = Density of dispersion medium.

g = Acceleration due to gravity.

η = Viscosity of dispersion medium.

* Stock's law is applicable to dilute suspension containing 0.5 - 2 gm. solid per 100 ml.

* From stock's law, it is clear that rate of sedimentation is —

(I) Directly proportional to difference b/w the densities of both phase.

$$V \propto (\rho_s - \rho_o)$$

(II) Directly proportional to square of diameter of particles.

$$V \propto d^2$$

(iii) Inversaly proportional to the viscosity of the dispersion medium.

$$V \propto \frac{1}{\eta}$$

Approaches to reduce settling of particles -!

1- It may be reduced by ↓ the particle size.

2- It can be reduced by ↑ ing the viscosity up to optimum.

3- It can be reduced by ↓ ing the difference in the density of the dispersed phase and dispersion medium

(By adding PEG, Glycerine, sugar etc.)
↓
(Poly ethylene glycol)

Formulation of flocculated and deflocculated suspension

* There are two approaches for preparation of stable suspension.

* These are —

(i) Use of structured vehicle to maintain deflocculated particles.

(ii) Application of flocculation to produce flocs which settle rapidly and easy to redisperse.

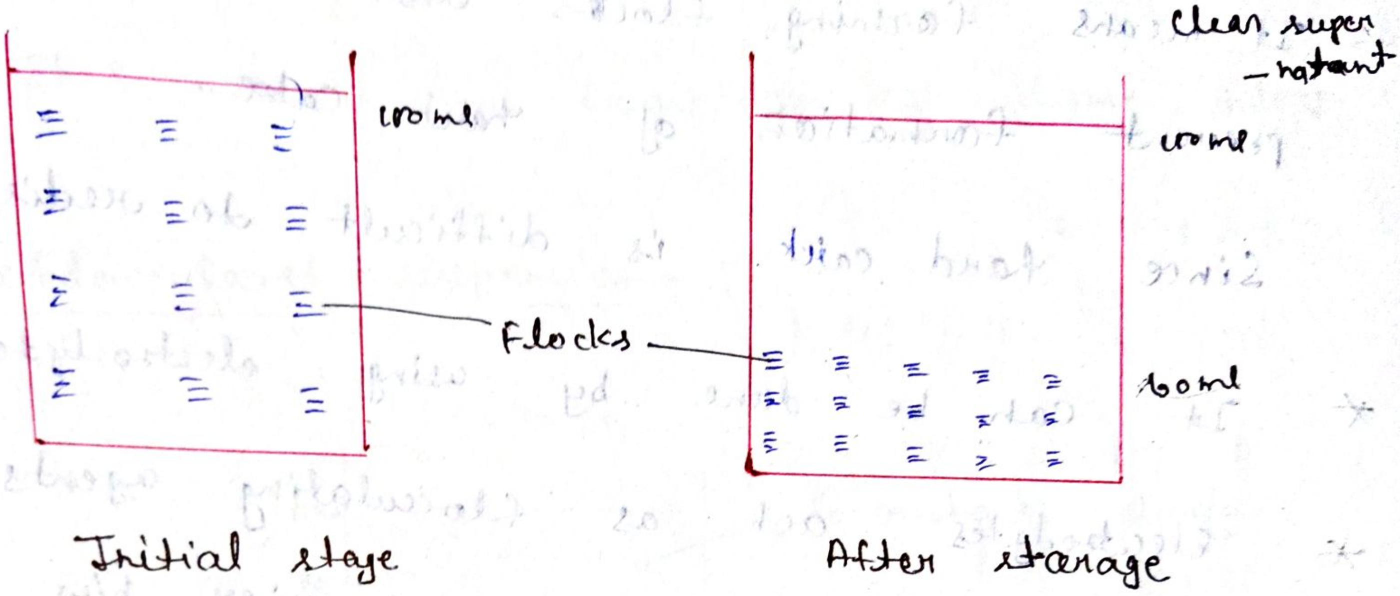
Wetting of particles :-

* This is the first step in formulation of suspension.

* The insoluble powder dispersion in vehicle is difficult due to adsorbed air and grease.

* Wetting agents such as poly sorbate -80 help to reduce interfecial tension b/w solid and vehicles.

Flocculated suspension :-



* In this suspension, group of particles are aggregated into flocs and the flocs tend to fall together.

* Settling results in clear boundary b/w the sediment and the super natant liquid.

* The supernatant liquid is clear.

Controlled flocculation :-

* It means forming flocks under controll to prevent formation of hart cake. Since hard cake is difficult to redisperse.

* It can be done by using electrolytes

* Electrolytes act as flocculating agents by reducing electrical barrier. b/w the particles that is (i.e.) by ↓ing charge.

* Ex :-

→ Bismuth subnitrate in water, the particles possess a +ve charge.

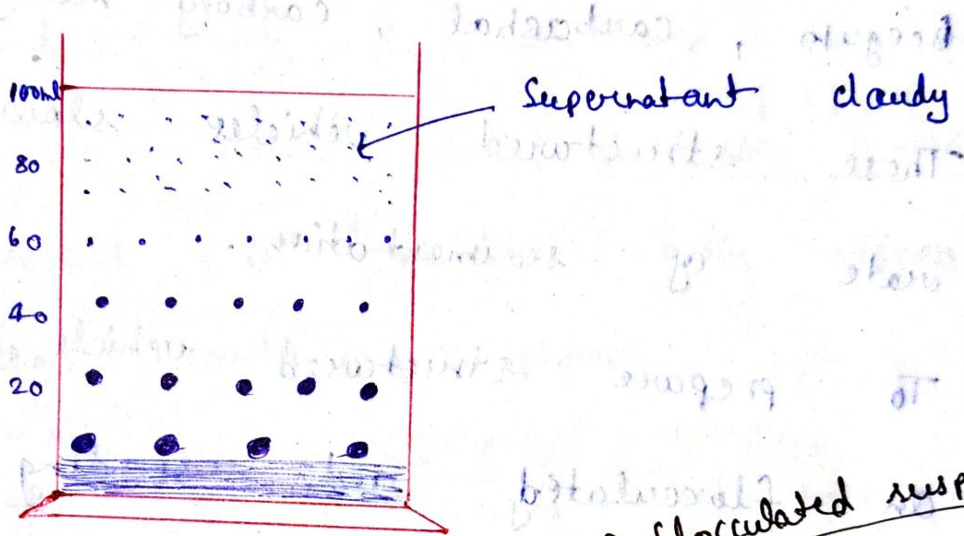
→ Due to repulsion b/w particles, the system is deflocculated and well settle form cake.

→ If monophasic potasium phosphate is added, the +ve charge will ↓ by phosphate ions.

→ On continuous, addition of mono phasic potasium phosphate, the +ve charge reduced to zero.

→ This result in formation of loose flocs.

Deflocculated suspension :-



Deflocculated suspension

* In deflocculated suspension, the larger particles settles faster rate than the smaller particles.

* As a result a clear boundary b/w the sediment and the dispersion medium can not be easily distinguished.

* The supernatant liquid remains cloudy for a definite period of time.

Use of structured vehicle :-

* Structured vehicle are those vehicle which are used to reduce the degree of sedimentation
* Structured vehicle can be prepared by using thickening agents such as tragacanth, Beegum, carbachal, carboxy methyl cellulose etc
* These structured vehicles slow down the rate of sedimentation.
* To prepare structured vehicle, the charge on flocculating and suspending agent should be kept in mind.

Ex :- (i) +vely charged particle flocculate in -vely charge (anionic) electrolyte (gum).

(ii) The +vely charged particle will be destablised by +vely charged gelatine.

* (iii) Like wise, -vely charged particles flocculated with +vely charged electrolyte.

Emulsion

* An emulsion is a biphasic liquid preparation containing two immiscible liquids, one of which is dispersed uniformaly as minute globules into the other continuous phase.

* The liquid which is converted into minute globules are called the dispersed phase and the liquid in which it is dispersed are called continuous phase.

* The size range of globules may be 0.1 - 100 μm in diameter.

Types of emulsion

1 → Oil in water emulsion (o/w) -:

A system in which oil is dispersed phase and water is continuous phase are k/as oil in water emulsion.

Ex -: Lotion, liniments, creams etc.

2- water in oil emulsion (w/o) -:

The system in which water is dispersed phase and oil is the continuous phase are k/as water in oil (w/o) emulsion.

Ex -: Moisturising cream, cleansing cream.

3- Multiple emulsion (w/o/w, o/w/o) -:

* Multiples emulsion are those emulsion in which the oil in water or water in oil emulsion are dispersed in another liquid medium such as oil or water.

* Finally system forms o/w/o or w/o/w emulsion.

Eg → Sustained released dosage form.

4 - Micro-emulsion -:

Micro-emulsions are emulsions that contain globule diameter less than 0.1 μm and are invisible to necked eye.

* micro emulsions are transparant solutions.

Eg → Bath external as well as internal preparat^n.

Theorise of emulsion

* If one liquid is broken into small particles as globules, the surface area of liquid ↑es.

* Thus surface free energy also ↑es due to ↑ in surface area.

* Hence the system becomes thermodynamically unstable.

* Emulsifying agents are added to stablized the system.

* Emulsifying agent reduces interfecial tension

* There are fallowing theories of emulsions

1- Mono molecular adsorption theory –

* surfactant form a single layer at the interphase.

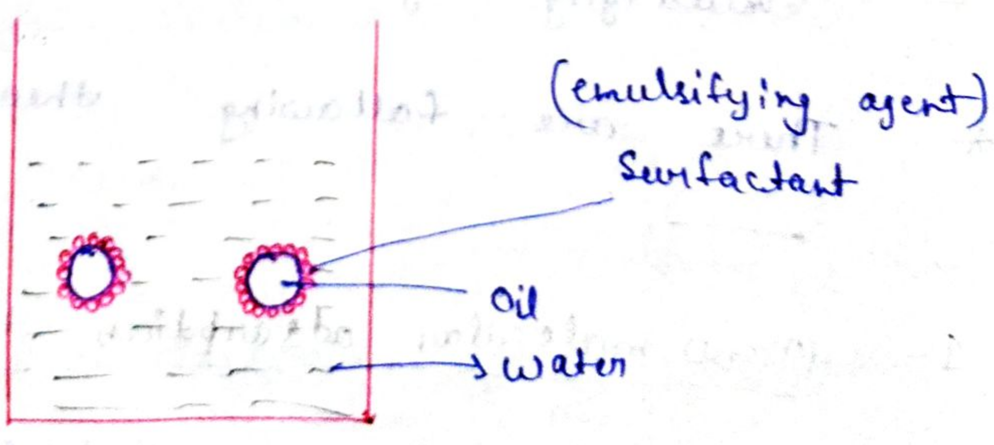
* Surfectant have both hydrophillic and lipophillic regions.

* Surfectants adsorbe at the oil - water interphase such that lipophillic groups orient towards oil and hydrophillic groups orient towards water.

* This film also act as mechanical barrier to coalescence of globules.

* Emulsifying agent reduces interfecial tension, surface free energy also.

* An additional effect is presence of surface charge which cause repulsion b/w globules.



Mono molecular

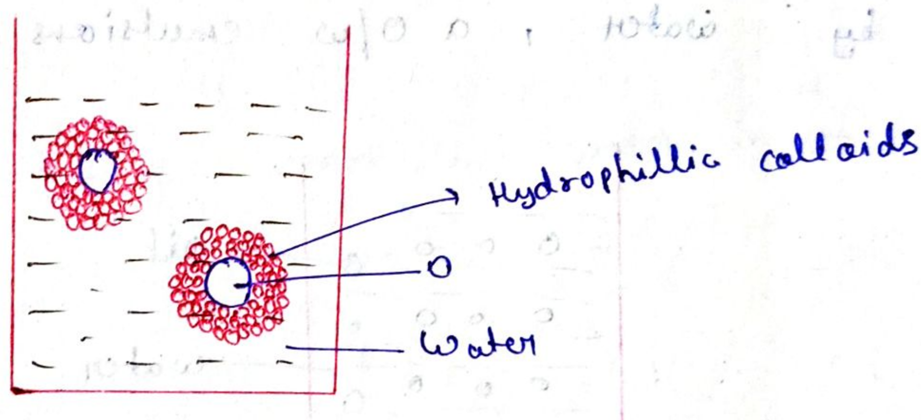
2 – Multimolecular adsorption theory –

* Hydrophillic colloids act by forming multimole-cular layer at the interphase.

* The layer are strong and resist coalescence.

* Hydrophillic colloids cause ↑ in viscosity of the medium which also ↓es coalescence.

* Since they are hydrophillic, they form only O/W emulsion.



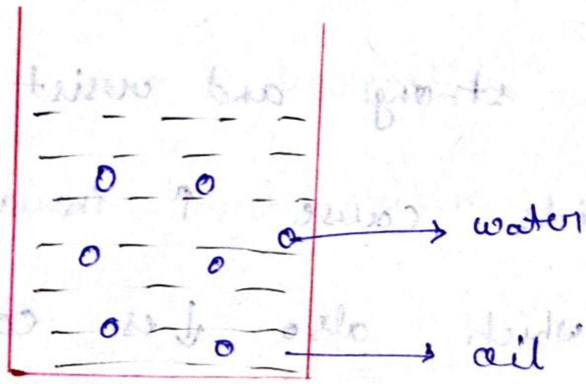
Multimolecular adsorption

3 – Solid particles adsorption theory –

* Some fine solids have balanced hydrophillic and lipophillic properties.

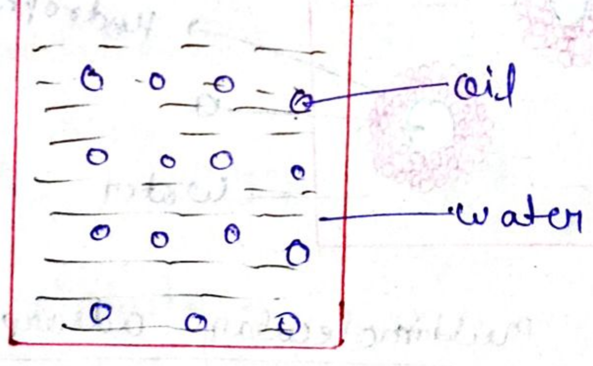
* They accumulate at the W/O interphase and prevent coalescence.

* If the solid particles are initially wetted by oil, a water/oil (w/o) emulsion results.



w/o emulsion

* If the solid particle are initially wetted by water, a O/w emulsions results.



O/w emulsion

Ex → A number of colloidal plays and several in organic substances are used in emulsifying agent.

Stability of emulsion

Causes of instability :-

(i) **Flocculation** :- It is a condition where neighbouring globules come in contact with each other and form aggregates in the external phase.

(ii) **Creaming** :- Creaming is the concentration of globules at the top or bottom of the emulsion

* Upward creaming occurs in oil in water (o/w) emulsion.

* Downward creaming occurs in water in oil (w/o) emulsion.

(iii) **Coalescence** :- The coalescence of dispersed phase results in breaking up of emulsion and it can not be reformed.

(iv) **Phase inversion** :- The changes of emulsion type from oil in water (o/w) to w/o or vice-versa.

(v) Physical and chemical charges :-

* Natural gums used as emulsifying agent may contain bacterial growth.

* This may cause change in pH and breaking down of emulsion.

Factors which improve stability of emulsion :-

(i) Particle size :- It is necessary to choose the optimum size of globules.

(ii) Particle size distribution :- Globules are uniform size impart maximum stability.

(iii) Viscosity :- As viscosity ↑es flocculation of globules will be reduce.

An optimum viscosity is desirable for good stability.

(iv) Phase volume ratio :-

74% concentration of dispersed phase is called critical point beyond which phase inversion takes place.

50:50 phase volume ratio give most stable emulsion.

(v) charge of globules (vi) pH of emulsion

Preservation of emulsion

1- Preservation from micro-organism :-

Micro-organism cause change in colour, taste, odour, pH, hydrolysis and even cause breaking of emulsion.

Character of ideal preservative :- Are as follows

→ It should be non-toxic, non-irritant.

→ It should not impart any colour or taste to the emulsion.

→ It should have bactericidal rather than bacteriostatic activity.

→ It should be highly water soluble.

→ It should be effective over wide range of pH.

Ex. of preservative :- methyl paraben, ethyl paraben, butyl paraben, benzoic acid, sorbic acid.

2- Preservation from oxidation :-

* Vegetable oils and mineral oils are susceptible to atmospheric oxygen.

* These get oxidized and leads to spoilage of emulsion.

* To avoid oxidation, antioxidants must be added.

Ideal antioxidants :- Are as follows –

→ Non-toxic and non-irritant.

→ Soluble in media.

→ Colourless and tasteless.

→ Stable over wide range of pH.

→ Should be effective at low concentration.

Ex. of anti oxidants :-

Butylated hydroxy toluen (BHT),
Butyled hydroxy anisole (BHA)
Ethyl gallate and propyl gallate.

Rheological properties of emulsion

* Emulsions such as lotion and creams, most of them are non-newtonian except few with newtonian behaviour.

* Emulsion such as lotions containing 20%-50% of dispersed phase exhibit pseudoplastic behaviour.

* Semisolid behaviour such as cosmetic cream containing 50%-74% of dispersed phase are plastic in nature.

* Shear thinning emulsion are preferred such as creams.

* They can be easily spread on skin and removed from the body.

* Thixotropic lotions have consistency when allowed to stand at rest in the bottle Once bottle is shaking they loose their consistency and pour from the bottle.

* Proper rheological character are required for stable emulsion. and problems like creaming, coalescence and breaking can be avoided.

Emulsion formulated by HLB method

* HLB means hydrophillic, lipophillic balance.

* Emulsifier with high HLB value are soluble in water and produce oil in water emulsion (Ex- Tween-80, sodium oleate).

* Emulsifier having low HLB value are more oil soluble, they form water in oil emulsion (Ex- Span-80 glyceryl).

HLB Range	Applications
3 – 6	Emulsifying agent (w/o)
7 – 9	Wetting agent.
8 – 18	Emulsifying agent (o/w)
13 – 15	Detergent.
15 – 18	Solubilising agent

Preparation of emulsion

1- dry gum method :-

The formula for primary emulsion are given below —

		oil	gum	water
P. E →	Fixed oil Liquid paraffin Caster oil	4	1	2
S. E →	Valatile oil Terpentine oil	2	1	2

* Measured quantity of oil is triturated with acacia in the mortar.

* Twice as much as gum, aqueous vehicle is added in the mortar and rapidly triturated

* This product is k/as primary emulsion with clicking sound.

* Remaining quantity of aqueous vehicle is then added to the primary emulsion.

2- Wet gum method :-

The proportion of oil : gum : water for primary emulsion remains same as in dry gum method.

* Acacia or gum is triturated with water to form mucilage.

* Oil is added with constant trituration.

* The trituration is continue after the addition of entire amount of oil.

3 - <u>Battle method</u> :-

For valatile ail and non-viscous oils this method is used.

* The emulsion is prepared in a large ~~water~~ bottle by dry gum ar wet gum method.

* The primary emulsion is formed by vigarous shaking and then diluted with external phase.