**Oral Liquids-**

Oral Liquids are homogeneous liquid preparations, usually consisting of a solution, an emulsion or a suspension of one or more medicaments in a suitable vehicle. Liquid dosage forms are either monophasic or biphasic. A monophasic liquid dosage form is one which contains only one phase. A biphasic liquid dosage form contains two phases.

Liquid preparations for oral use are either supplied in the finished form or, with the exception of Oral emulsions, may also be prepared just before issue for use by dissolving or dispersing granules or powder in the vehicle stated on the label.

The vehicle for any liquid preparation for oral use is chosen having regard to the nature of the active ingredient(s) and to provide organoleptic characteristics appropriate to the intended use of the preparation. Liquid preparations for oral use may contain suitable antimicrobial preservatives, antioxidants and other excipients such as dispersing, suspending, thickening, emulsifying, buffering, wetting, solubilizing, stabilizing, flavouring and sweetening agents and authorized colouring matter.

**Classification of Liquid Orals**

Liquid dosage forms are broadly classified into two groups:

a) Monophasic liquid dosage forms b) Biphasic liquid dosage forms

1.Monophasic liquids dosage forms are mixtures, elixirs, syrups, linctuses, draughts and drops etc.

2. Biphasic liquids dosage forms are suspensions and emulsions.

**Advantages of Liquid Dosage Forms**

i) They are the most suitable dosage form for infants, children and geriatric patients.

ii) The unpleasant taste of the drugs can be masked by adding sweetening and flavouring agents.

iii) It is attractive in appearance and gives beneficial psychological effects.

iv) The drug is rapidly available for absorption.

**Disadvantages of Liquid Dosage Forms**

i) The liquid dosage forms have less stability when compared to solid dosage forms.

ii) Liquids are bulky and therefore inconvenient to transport and store

iv) Accidental breakage of the container results in loss of whole dosage form.

**Formulation consideration:**

The common excipients used in liquid formulation are

(1) Vehicles

(2) Solubilizers

(3) Preservatives

(4) Stabilizers

(5) Organoleptic agents

**(1)Vehicles**

**Solvents:** In liquid pharmaceutical formulations, vehicles are major components used as a base in which drugs and other excipients are dissolved or dispersed. They function by breaking of bond and reducing effective charge on ions thus increasing solute-solvent forces of attraction which are eventually greater than solute-solute and solvent-solvent forces of attraction. Eg: water, hydro-alcoholic liquid systems, polyhydric alcohols, acetic acid, ethyl acetate and buffers. These may be thin liquids, thick syrupy liquids, mucilage or hydrocolloid bases. The oily vehicles include vegetable oils, mineral oils, organic oily bases or emulsified bases etc.

**Co-solvent:** are defined as water- miscible organic solvents that are used in liquid drug formulations to increase the solubility of poorly water soluble substances or to enhance the chemical stability of a drug. Co-solvent increases the solubility of a drug. An ideal co-solvent should possess values of dielectric constant between 25 and 80. The most widely used system that will cover this range is a water/ethanol blend. It should not cause toxicity or irritancy when administrated for oral or parental use. Other co-solvents are sorbitol, glycerol, propylene glycol and syrup.

**Water :** They contain large number of dissolved and suspended particles as impurities like inorganic salts sodium, potassium, calcium, magnesium and iron as chlorides, sulfates and bicarbonates, organic impurities are either soluble or insoluble state. Microorganism is other impurities present in water. Drinking water contains less than 0.1 % of total solid. For the preparation in pharmaceutical formulation IP refers water as clear, odorless, colorless and neutral with slight deviation in pH due to dissolved solids and gases. Purified water IP is commonly used as vehicle or as a component of vehicle for aqueous liquid formulations but not for those intended for parenteral administration. Ethanol, frequently referred as alcohol is the most commonly used solvent in liquid pharmaceutical formulation next to water. It is generally used as hydro-alcoholic mixture to dissolve water and soluble drugs and excipients. Diluted ethanol is prepared by mixing equal volumes of ethanol IP and purified water IP is a most useful solvent in various pharmaceutical processes and formulations to dissolve poorly soluble substances Glycerol is called glycerin is a clear, colorless liquid with thick, syrupy consistency, oily to the touch, odorless, very sweet and slightly warm to taste. They are prepared by the decomposition of vegetable or animal fats or fixed oils and containing not less than 95% of absolute glycerin. It is soluble in all proportions, in water or alcohol; also soluble in a mixture of 3 parts of alcohol and 1 part of ether, but insoluble in ether, chloroform, carbon di-sulphide, benzene, benzol, and fixed or volatile oils.

**(2) Solubilizers:** To increase the solubility of the drug

**pH adjustment :** By addition of buffer to the formulation .buffers act by binding hydrogen formulations to control potential changes in the pH. Buffers act by binding hydrogen ions in acids and donating hydrogen ions in bases. The selection of as suitable buffer should be based

on suitability of acid-base form for use in oral liquids, stability of the drug and excipients in the buffer, and compatibility between the buffer and container. The stabilizing effect of buffers determines the potential reaction between excipients and drug. For example, buffers containing carbonate, citrate, tartarate and phosphate salts may precipitate with calcium ions by forming sparingly soluble salts. The other factors that may affect the solution pH include temperature, ionic, strength, dilution and the amount and the type of co-valents presents. For example the pH of acetate buffers is known to increase with temperature, whereas the pH of boric acid buffers decreases with temperature. It is important to know that the drug in solution may itself act as a buffer. If the drug is a weak electrolyte such as salicyclic acid or ephedrine, the addition of base or acids, respectively will create system in which the drug can act as a buffer Eg: phosphate buffers, acetate buffers, citric acid phosphate buffers etc.

**Co-solvency:** By addition of water miscible solvent in which drug has good solubility. The solvent known as co-solvent.

**Complexation:** Drug-complexing agent complexation formed when complexing agent is added to solution. It increase solubility of drug on the basis of Le Chatelier's principle or " The equilibrium law". Eg disodium EDTA, dihydroxy ethyl glycine, citric acid.

**Micronization:** The processes involve size reduction of drug particle 1 to 10microns either by spray drying or fluid energy mill.

**Hydrotrophy :** Drug dissolve in the cluster of hydrotropic agent. Also there is drug-hydrotrophy agent complexation formation to increase drug solubility.

**Wetting agents and surfactants:**

In pharmaceutical formulations wetting agents are routinely used, they air adsorbed at solid particles surfaces keep them away from vehicles which ultimately promotes penetration of the vehicle into pores and capillaries of the particles. For non-aqueous based formulations mineral oils are commonly we use wetting agents because hydrophobic drug particles are difficult to wet even after the removal of adsorbed air. In such cases it is necessary it is necessary to reduce the surface tension between the particles and the liquid vehicles. Surface active agents that work as wetting agents, comprises of branched hydrophobic chains with central hydrophilic groups or short hydrophobic chains with hydrophilic end groups.

For example- Sodium lauryl sulphate is one of the most commonly used surface-active agents as a wetting agent. When dissolved in water, it lowers the contact angle of water and support in spreading of water on the particles surface to remove the air layer at the surface and replace it with the liquid phase.

**(3) Preservatives**

Microbial contamination is major problem encountered by aqueous based liquid dosage forms. Use of preservatives becomes unavoidable in such cases to prevent the growth of micro-organisms during production and over storage time. In fact, it is desirable to develop a preservative-free formulation to avoid unwanted effects of these excipients. The majorities of preservatives are of both acid and non-acid types and are bacteriostatic rather than bactericidal.

Preservatives must have following criteria: Effective against broad spectrum of microorganisms. Physically, chemically and microbiologically stable for lifetime of the product. Non toxic, non sensitizing, soluble, compatible and with acceptable taste and odour.

**Types of Preservatives**

**Acidic:** phenol, benzoic acid, sorbic acid

**Neutral preservatives**: Chlorobutanol, benzyl alcohol

**Quarternary ammonium compounds**: Benzalkonium chloride

**(4) Stabilizers**

Oxidation, photolysis, solvolysis and dehydration are common transformations taking place in liquid dosage forms. Amongst them for oxidation and photodecomposition of drug are very common pathways of drug decomposition and are very difficult to control due to low activation energies. Trace amounts of impurities, which are invariably present in the drug or excipient intitates the oxidation reaction. Drugs exists in reduced form show increased susceptibility when it is consistently exposed an open environment. The pH of the solution may contribute in the oxidation of drugs because ionized forms of these drugs at particular pH are very prone oxidation

**Physical stability**: A stable formulation retains its viscosity, color, calarity, taste and odour throughout its shelf life Color can be measured spectrophotometrically. Clarity can be determined by measurement of its turbidity or light scattering equipment. Viscosity can be measured by use of viscometers. Taste and odour can be determined either by pharmaceutical investigator or by a panel of unbiased, taste sensitive individuals.

**Chemical stability** of the formulation is affected by pH, temperature, Ionic Strength, Solvent effects, Light, Oxygen. Instability can be prevented by use of: Buffering agents, Antioxidants, Proper packaging (eg: use of amber bottle for light sensitive products)

**Antioxidants** act as chain terminators where it reacts with free radicals in solution to stop the free-radical propagation cycle. A combination of chelating agents with antioxidants is often used to exert synergistic effect. This is because many of these agents act at differing steps in the oxidative process. Oxidation of formulation component leads to products with an unpleasant odor taste appearance, ppt, discoloration or even a slight loss of activity. Some substances prone to oxidation include unsaturated oils/fats, compounds with aldehyde or phenolic groups, colors, flavors, sweeteners, plastics and rubbers, the latter being used in containers for products. Eg: acetone sodium bisulfite, acetylcysteine, ascorbic acid, thiourea.

Emulsifying agents which prevent coalescence of the dispersed globules. Forms barriers at interface, and reduce interfacial tension Eg sodium lauryl sulphat, cetrimide, macrogols

**Antifoaming agents:** the formation of foams during manufacturing processes or when re constituting the liquid dosage forms can be undesirable and disruptive. Antifoaming agents are effective at discouraging the formation of stable foams of stable foams by lowering surface

tension and cohesive binding of the liquid phase. Eg: Simethicone, organic phosphates, alcohols, paraffin oils etc.

**Suspending and Viscosity Enhancing Agents:** The selection of an appropriate suspending agent is one of the most crucial factors in formulating a pharmaceutical suspension. Suspending agents impart viscosity and thus regard particle settling. Other factors considered in the selection of the appropriate suspending and viscosity enhancing agent include desired reheological property supendability in the system, chemical compatibility with other excipients, pH stability, hydration time, reproducibility, and the cost. Eg: clays, natural gums, synthetic gums In many formulations these excipients are employed in combination for enhanced effects.

**Humectants:** are hygroscopic substances that help to retard evaporation of aqueous vehicles from dosage forms. These excipients are used at 5% strength in aqueous suspension and emulsion for external application. They are also used to prevent drying of the product after application to the skin as well as prevent drying of product from the container upon opening. It also helps to prevent cap-locking caused by condensation onto neck of container-closure at first opening Eg propylene glycol, glycerol, polyethylene glycol.

**Flocculating agents:** prevent caking. Addition of an electrolyte reduces the magnitude of zeta potential of dispensed particles Eg: Starch, sodium alginate.

**Chelating agents:** are substances that form complexes with metal ion in activating their catalytic activity in oxidation of medicaments. These agents are capable of forming complexes with the drug involving more than one bond it's a complex compound contains one or more ring in its structure. Protect drug from catalysts that accelerate the oxidative reaction. Eg Disoium EDTA, dihydroxy ethyl glycine, citric acid and tartaric acid

**(5) Organoleptic properties**

**Flavouring agents**: are agent in liquid pharmaceutical products is added to the solvent or vehicle component of the formulation in which it is most soluble or miscible. That is water soluble flavors are added to the aqueous component of a formulation and poorly water soluble flavors are added to the alcoholic or other non-aqueous solvent component of the formulation. In a hydro-alcoholic or other multi-solvent system, care must be exercised to maintain the flavorants in solution. This is accomplished by maintaining a sufficient level of the flavorants solvent.

**Sweetening agents:** Sucrose enhances viscosity of liquids and also gives a pleasant texture in the mouth. The term sugar free solution include sweetening agents such as sorbitol, mannitol, saccharin and aspartame as alternative to sugar such as sucrose, fructose. In addition to sucrose, a number of artificial sweetening agents have been used in food and pharmaceuticals over the years. Some of these including asparatame, saccharin, and cyclamate have faced challenges over the safety by the FDA and restriction to their use and sale in fact in 1969, FDA banned cyclamates from use in US. Sucralose is most popular due to its excellent sweetness, non-cariogenic, low calorie wide and growing regulatory acceptability but is relatively expensive

**Coloring agent:** A distinction should be made between agents that have inherent color and those that are employed as colorants. Colors used in liquid dosage form must be certified by FDA as per D&C Act 1940. Certain agents- sulphur (yellow), riboflavin (yellow), cupric sulfate (blue), ferrous sulfate (bluish green) cyanocobalamin (red) and red mercuric iodide (vivid red) have inherent color and not thought of as pharmaceutical colorants in the usual sense of the term. Although most pharmaceutical colorants in use today are synthetic, a few are obtained from natural mineral and plant sources. For example, red ferric oxide is mixed in small proportions with zinc oxide powder to give calamine its characteristic pink color, which is intended to match the skin tone upon application. The age of the intended patient should also be considered in the selection of the flavorings agent, because certain age groups seem to prefer certain flavors. Children prefer sweet candy-like preparations with fruity flavors, but adults seem to prefer less sweet preparation with a tart rather than a fruit flavor.

**Manufacturing Consideration-**

The manufacturing process for liquid preparations for oral use should meet the requirements of Good Manufacturing Practice (GMP). The following information is intended to provide broad guidelines concerning the critical steps to be followed during production of liquid preparations for oral use.

In the manufacture of liquid preparations for oral use, measures are taken to:

- ensure that all ingredients are of appropriate quality
- minimize the risk of microbial contamination
- minimize the risk of cross-contamination

**Steps of Liquids Manufacturing Process**

**1. Planning of Material Requirements**: Research and development of protocols and selection of materials; acquisition and analysis of raw materials; physical plant design, building, and installation; equipment selection and acquisition; personnel selection and initial training; and monitoring information system.

Raw Materials : Incoming raw materials should be tested as per specifications that is identity, purity, uniformity and microbial contamination .

Equipments : The following types of equipments may be used in the manufacture of liquid formulations:

1. Mixing tanks (SS 316 Stainless Steel) equipped with an agitator.

2. Measuring devices for large and small amount of solids and liquids. 3. Afiltration system e.g. filter press

Cleaning of equipments

- All equipments must be thoroughly cleaned and sanitized before use.
- Disinfectants used: Dilute solutions of $H_2O_2$, phenol derivatives.
- Sterilized by:Alcohol, boiling water, autoclaving, steam or dry heat.

**2. Liquid Preparation**: Research and development of protocols concerning liquid compounding; scale - up of the bulk product compounding; physical plant control and maintenance; equipment maintenance and renovation; continuous training of personnel and personnel compensation plan; and supervision of system reports.

**3. Filling and Packing**: Research and development of protocols concerning filling and packing; scale-up of the finished drug product filling and packing; physical plant control and maintenance; equipment maintenance and renovation; continuous training of personnel and personnel compensation plan; and supervision of system reports.

**Filling and Packing**

| Gravimetric | Volumetric | Constant Level |
|---|---|---|
| Containers are filled with liquids to a given weight.<br><br>Usually limited to large container filling or highly viscous products.<br><br>Cannot be used in high speed, automatic equipment | Containers are filled with liquids to a given volume.<br><br>Filled amount is measured by the stroke of the piston and cylinder assembly.<br><br>Problems may arise when containers used are not dimensionally uniform. | Filled amount is verified by adjusting the height to which the container is to be filled.<br><br>Variation in container dimension may result in variations in the net fill per unit. |

**Techniques of Filling**

| Vacuum filling | Gravity vacuum filling | Pressure vacuum filling |
|---|---|---|
| Vacuum developed within the container causes liquid to flow from tank to container. | Bulk liquid tank is placed above filling stem so that liquid flows to the container due to force of gravity. | Pressure applied to bulk liquid tank and vacuum developed in the container results in pressure difference so that liquid flows to the container. |

**4. Sales of Drug Products**: Research and development of protocols concerning product storage; distribution process; continuous training of personnel and personnel compensation plan; and supervision of system reports.

**5. Vendor Handling**: Research and development protocols concerning precautions to maintain product stability; control of vendor stock; and sales system reports.

**6. Customer Service**: Research and development of protocols concerning home storage and handling to maintain product stability; relations with health insurance companies and health care professionals; educational materials for patient counseling; and customer service system reports.

**Elixirs**

Elixirs are clear, flavoured, sweetened, hydroalcoholic preparations for oral administration. They are more stable than mixtures. Elixirs are classified into two classes.

a) Non medicated elixirs: These elixirs do not contain any medicament but contain some aromatic or pleasantly flavoured substances. These are used as solvents for other liquid preparations.

b) Medicated elixirs: These elixirs contain some medicinal substance along with other ingredients.

**Syrups**

Syrups are liquid oral preparations in which the vehicle is a concentrated solution of sucrose or other sugars in water. The concentration of sugar in syrup is 66.7 % W/W. Syrups are further classified into 2 classes.

a) Simple syrups: The simple syrups do not contain any medicament, but contains some pleasantly flavoured substances. These syrups are used as a medium for other liquid preparations.

b) Medicated syrups: These syrups contain some medicinal substance along with other ingredients.

**Advantages of syrups**

• Syrups prevent oxidation and decomposition of drugs.

• Syrups are sweet in taste and therefore bitter taste of drugs can be reduced.

**Disadvantages of syrups**

• Syrups are not preferred for diabetic patients.

• On continuous take syrup promote dental decay.

**Suspensions**

Suspensions are the biphasic liquid dosage form of medicament in which the finely divided solid particles are suspended or dispersed in a liquid or semisolid vehicle with the help of suspending agent.The solid particle is the ‘dispersed phase’ or ‘discontinuous phase’ whereas the liquid vehicle is the ‘continuous phase’.

The solid particles act as disperse phase whereas liquid acts as a continuous phase. The medicaments that are insoluble or poorly soluble are formulated as suspensions. Suspensions contain a suspending agent. A suspending agent is a substance that is added to the preparation to suspend the insoluble particles in the preparation. It can be classified into four groups.

a) Oral suspensions: These suspensions are to be consumed by oral route.

b) Parenteral suspensions: The suspensions which are administered by parenteral route are called parenteral suspensions.

c) Ophthalmic suspensions: These are used for instilling into the eye.

d) Suspensions for external use: These are used for external applications.

Advantages:

- Can improve chemical stability of certain drugs.
- Higher rate of bioavailability, as order of bioavailability is: Solution>Suspension>Capsules>Compressed tablets

Disadvantages:

- Physical stability, sedimentation and compaction.
- Bulky, handling require care.
- Uniform drug delivery cannot be achieved sometimes.

**Ideal properties of suspensions:**

1. The dispersed particles should not settle readily and the settled particles should redisperse immediately on shaking.

2. The particles shouldn‘t form a cake on settling.

3. The viscosity should be such that the preparation can be easily poured.

4. It should be chemically stable.

5. Suspensions for internal use must be palatable and suspension for external use must be free from gritty particles.

**Types of suspensions:**

Depending upon particle nature/dispersed particle nature the suspensions are of two types:

1. Flocculated suspensions

2. Non-flocculated/deflocculated suspensions.

**Flocculated suspensions:**

Suspension in which particles are weakly bonded, settle rapidly, don’t form a cake and are easily resuspended with a minimum of agitation.

**Deflocculated suspensions:**

Suspension in which particles settle slowly and eventually form a sediment in which aggregation occurs with the resultant formation of a hard cake which is difficult to resuspend.

**Stability of suspensions:**

A stable suspension can be redispersed homogenously throughout its shelf life.The more stable pharmaceutical suspensions are flocculated i.e.,the suspended particles are bonded together physically to form a loose cake.

**Packing of Suspensions**

Suspensions can be packed in narrow mouth screw caped colour less plain bottle. Suspensions that are very thick require a container with wide mouth. Suspensions should be stored in a cool place.

**Evaluation of suspension stability:**

The following are commonly used for evaluating the physical stability of suspensions:

1.Sedimentation method.

2.Rheological method.

3.Electrokinetic method.

4.Micromeritic method.

**1.Sedimentation method:**

It is determined by keeping a measured volume of suspension in a graduated cylinder in an undisturbed position for a definite period of time, the ultimate volume (V0) and the initial volume (Vu) of the sediment is to be noted. Sedimentation volume is a ratio of the ultimate volume of sediment (V0) to the original volume of the sediment (VU) before settling. Sedimentation volume F=V0/VU

**2.Rheological method:**

- It provides information about settling behaviour.
- The arrangement of the vehicle and the particle structural features.
- Brookfield viscometer is used to study the viscosity of the suspension. If viscosity of the suspension increases, the stability of the suspension increases.

**3.Electrokinetic method:**

The determination of surface electric charge or zeta potential is helpful to find out the stability of suspension. Zeta potential can be calculated from the migration of particle measured by the electrophoretic method.

**4.Micromeritic method:**

The stability of suspension depends on the particle size of the disperse phase. The size of the particle in a suspension may grow and ultimately leads to the formation of clumps or caking.

So, any change in particle size distribution with reference to time gives a stable suspension. The particle size can be studied by microscopy or coulter countered method.

**Emulsions**

An emulsion is defined as a dibasic or heterogenous liquid preparation immiscible liquids which is dispersed as a minute globules in another liquid by adding emulsifying agent.

Medicines having an unpleasant taste and order can be made more palatable for oral administration in the form of an emulsion. Emulsions protect drugs against oxidation or hydrolysis.

• Emulsions are less stable.

• They are susceptible to microbial growth.

**Classification of emulsions:**

Emulsions can be classified into the following types:

1. Oil in water (o/w) type of emulsion.

2. Water in oil (w/o) type of emulsion.

3. Microemulsions

4. Multiple/double emulsion.

**Advantages:**

- Mask the unpleasant taste.
- Sustained release medication.
- Inert and chemically non-reactive.
- Reasonably odourless & cost effective.

**Disadvantages:**

- Packing, handling & storage is difficult.
- Thermodynamically unstable & have short shelf life.
- Leads to creaming & cracking.
- Leads to phase inversion.

**Packing of Emulsions**

Emulsions can be packed in narrow mouth screw caped colourless plain bottle. Emulsions that are very thick require a container with wide mouth. Emulsions should be stored in a cool place.

**a) Oil in water type**: This type of emulsion is the one in which the oil is dispersed in the water

**b) Water in oil type:** This type of emulsion is the one in which the water is dispersed in the oil. Emulsions may be liquid or semi-solid. Liquid emulsions can be classified as i) emulsions for oral administration, ii) emulsion for external uses, iii) emulsion for parenteral uses, and iv) emulsion for rectal use.

i) Emulsions for oral administration

Some medicaments are unpleasant in taste. For example fish liver oil, we can mask this unpleasant taste by converting it into an emulsion and can be given orally.

ii) Emulsions for external use

The external preparation of emulsion consists of three classes. Applications, lotions and liniments, these emulsions can be either oil in water or water in oil.

iii) Emulsions for parenteral use

Some patients are unable to ingest food in the normal way. We can administer oil in water emulsions of nutritive oils and fats to these patients. Vitamin K that prevents blood clotting is injected in this form.

iv) Emulsions for rectal use

Some emulsions are given by rectal route. Semi-solid emulsions are water in oil or oil in water type. The water in oil type semi-solid emulsions are oily creams while the oil in water semi-solid emulsions are aqueous creams. Creams are easy to apply and are less greasy.

**Preparation of emulsions:**

The emulsions are prepared by two methods:

1. Small scale method

a) Dry gum method

b) Wet gum method

c)Bottle method.

2. Large scale method.

**Identification tests:**

The type of emulsion can be determined by the following tests:

1. Dilution test.

2. Conductivity test.

3. Dye test.

4. Fluorescence test.

5. Cobalt chloride test (CoCl2).

**1.Dilution test:** This test is based on the solubility of external phase of emulsion.

- o/w emulsion can be diluted with water.
- w/o emulsion can be diluted with oil.

**2.Conductivity test:** The basic principle of this test is that water is a good conductor of electricity. Therefore in case of o/w emulsion this test will be +ve as water is the external phase. In this test, an assembly is used in which a pair of electrodes connected to an electric bulb is dipped into an emulsion. If the emulsion is o/w type, the electric bulb glows.

**3.Dye test**: When an emulsion is mixed with a water soluble dye such as amaranth and observed under the microscope.

- If the continuous phase appears red, then it means that the emulsion is o/w type as water is the external phase.
- If the scattered globules appear red and continuous phase is colourless, then it is w/o type.

**4.Fluorescence test:**

Oil gives fluorescence under UV light, while water doesn't. Therefore, o/w emulsion shows spotty pattern when observed under UV, while w/o emulsion fluoresces.

**5.Cobalt chloride test:**

When a filter paper soaked in cobalt chloride solution is dipped into an emulsion and dried, it turns from blue to pink, indicating that the emulsion is o/w type.

**Evaluation of emulsions:**

1. Size distribution analysis.

2. Rate of phase separation.

3. Viscosity & rheological study.

4. Measurement of dielectric constant.

5. Conductivity measurement.

6. Influence of temperature.

7. Microwave radiation.

8. Microelectrophoretic measurement.

**Stability of emulsions:**

The following three changes usually occurs during the storage of emulsion:

1. Creaming.

2. Cracking.

3. Phase inversion.

**1.Creaming:**

Creaming may be defined as the upward movement of dispersed globules to form a thick layer at the surface of emulsion. The creaming depends on "Stokes law", the rate of creaming depends on the various factors. V=2r2(d1-d2)g/9n

**2.Cracking:**

Cracking means the separation of two layers of dispersed phase and continuous phase due to coalescence of dispersed phase globules. Cracking may be due to the following reasons:

a) By addition of emulsifying agent of opposite type.

b) By decomposition of emulsifying agent.

c) By addition of common solvent.

d) By microorganisms.

e) Changes in temperature.

**3. Phase inversion:**

Phase inversion means change of one type of emulsion into the other type i.e., o/w emulsion changes into w/o type and vice versa. It may be due to following reasons:

a) By the addition of an electrolyte. b) By changing the phase volume ratio. c)By temperature change. d)By changing the emulsifying agent.

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