MARRI LAXMAN REDDY INSTITUTE OF PHARMACY

(Approved by AICTE & PCI, New Delhi and Affiliated to JNTUH)

Dundigal - Gandimaisamma (V) &(M), Medchal (Dt), Hyderabad, Telangana - 500 043.

PHYSICAL PHARMACEUTICS – II

LAB MANUAL

B. PHARMACY II-II

About MLRIP

VISION

To be an educational Institute of par excellence and produce competent pharmacy professionals to serve the community through research and the ever-increasing needs of Industry.

MISSION

1. Imparting quality education and innovative research for various career opportunities.
2. Creating conducive academic environment to produce competent pharmacy professionals.
3. Indoctrination of students adorned with high human values and make them aware of their responsibility as health care professionals.

Program Educational Objectives

PEO 1: To produce graduates with sound theoretical knowledge and technical skills required for their career opportunities in various domains.

PEO 2: To incite the students towards research and to address the challenges with their innovative contributions for the benefit of the mankind.

PEO 3: To instill the essence of professionalism, ethical commitment to become a health care professional with sound integrity and adherence to the core human values in the service of the society.

PROGRAM OUTCOMES

1. **Pharmacy Knowledge:** Possess knowledge and comprehension of the core and basic knowledge associated with the profession of pharmacy, including biomedical sciences; pharmaceutical sciences; behavioral, social, and administrative pharmacy sciences; and manufacturing practices.

2. **Planning Abilities:** Demonstrate effective planning abilities including time management, resource management, delegation skills and organizational skills. Develop and implement plans and organize work to meet deadlines.

3. **Problem analysis:** Utilize the principles of scientific enquiry, thinking analytically, clearly and critically, while solving problems and making decisions during daily practice. Find, analyze, evaluate and apply information systematically and shall make defensible decisions.

4. **Modern tool usage:** Learn, select, and apply appropriate methods and procedures, resources, and modern pharmacy-related computing tools with an understanding of the limitations.

5. **Leadership skills:** Understand and consider the human reaction to change, motivation issues, leadership and team-building when planning changes required for fulfillment of practice, professional and societal responsibilities. Assume participatory roles as responsible citizens or leadership roles when appropriate to facilitate improvement in health and well-being.

6. **Professional Identity:** Understand, analyze and communicate the value of their professional roles in society (e.g. health care professionals, promoters of health, educators, managers, employers, employees).

7. **Pharmaceutical Ethics:** Honour personal values and apply ethical principles in professional and social contexts. Demonstrate behavior that recognizes cultural and personal variability in values, communication and lifestyles. Use ethical frameworks; apply ethical principles while making decisions and take responsibility for the outcomes associated with the decisions.

8. **Communication:** Communicate effectively with the pharmacy community and with society at large, such as, being able to comprehend and write effective reports, make effective presentations and documentation, and give and receive clear instructions.

9. **The Pharmacist and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety and legal issues and the consequent responsibilities relevant to the professional pharmacy practice.

10. **Environment and sustainability:** Understand the impact of the professional pharmacy solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

11. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. Self-assess and use feedback effectively from others to identify learning needs and to satisfy these needs on an ongoing basis.

PS407: PHYSICAL PHARMACEUTICS – II LAB

B. Pharm. II Year II Sem   **L T P C**
                                                              0 0 4 2

List of Experiments:

1. Determination of surface tension of given liquids by drop count and drop weight method

2. Determination of HLB number of a surfactant by saponification method

3. Determination of Freundlich and Langmuir constants using activated charcoal

4. Determination of critical micellar concentration of surfactants

5. Determination of viscosity of liquid using Ostwald's viscometer

6. Determination sedimentation volume with effect of different suspending agent

7. Determination sedimentation volume with effect of different concentration of single suspending agent

8. Determination of viscosity of semisolid by using Brookfield viscometer

9. Determination of reaction rate constant of first order.

10. Determination of reaction rate constant of second order

11. Accelerated stability studies

Recommended Books: (Latest Editions)

1. Physical Pharmacy by Alfred Martin, Sixth edition

2. Experimental pharmaceutics by Eugene, Parott.

3. Tutorial pharmacy by Cooper and Gunn.

4. Stocklosam J. Pharmaceutical calculations, Lea & Febiger, Philadelphia.

5. Liberman H.A, Lachman C., Pharmaceutical Dosage forms, Tablets, Volume-1 to 3, Marcel Dekkar Inc.

6. Liberman H.A, Lachman C, Pharmaceutical dosage forms. Disperse systems, volume 1, 2, 3. Marcel Dekkar Inc.

7. Physical Pharmaceutics by Ramasamy C, and Manavalan R

1. DETERMINATION OF SURFACE TENSION OF GIVEN LIQUIDS BY DROP COUNT AND DROP WEIGHT METHOD

Aim: To determine surface tension of given liquids by Drop count method and drop weight method.

Requirements: Stalagmometer, burette stand, beaker, acetone, benzene,

Principle:

Surface tension arises on the surface of the liquid due to the intermolecular forces among the molecules of liquid. Molecules in the interior of the liquid are pulled in all directions equally but the molecules in the surface of the liquid are pulled in three directions only i.e. side wards and downwards. This downward force pulls the molecules of the liquid to come inside which is called surface tension and this is the reason why a drop of water takes spherical shape. Hence, on this concept surface tension is defined as the force in dynes acting on the surface of liquid at right angles to a line one centimeter in length. In CGS system the unit of surface tension is **dyne/cm** and in SI system the unit of surface tension is **Newton/meter.** Stalagmometer is the apparatus which is used for the determination of surface tension. There are two-line marks on the stalagmometer top line above the wide part and bottom line below it. The volume between these two lines is V, and liquid with density ρ contained in this volume has a mass [m]

$$m = V \rho$$

Such a volume V corresponds to 'n' drops, which are released from the stalagmometer upon the decrease of liquid level from top to bottom line mark**.** For a given volume of liquid, the surface tension, as measured with a stalagmometer, is proportional to the density of the solution and inversely proportional to the number of drops, the equation becomes as follows

$$\gamma_1 / \gamma_2 = n_2 d_1 / n_1 d_2$$

Where

γ_1 = Surface tension of sample liquid

γ_2 = Surface tension of reference liquid (water = 72.75 dyne / cm)

n_1 = Number of drops of sample liquid

n_2 = Number of drops of reference liquid

d_1 = Density of sample liquid

d_2 = Density of reference liquid (water = 1.0 g/ml)

Similarly, to determine the surface tension for given liquids by drop weight method the equation becomes as follows

$$\gamma_1 / \gamma_2 = m_1 / m_2$$

Where

γ_1 = surface tension of sample liquid

γ_2 = surface tension of reference liquid

m_1 = weight of one drop of sample liquid

m_2 = weight of one drop of reference liquid

Procedure (Drop count method)

A cleaned and dried stalagmometer was taken and it was filled with the sample liquid. Now the number of drops of sample liquid was counted from mark A to B. The same above steps were repeated for the reference liquid (water). Density of the sample liquid was determined by using the specific gravity bottle.

Observations

Weight of empty specific gravity bottle (a) =

Weight of specific gravity bottle with the sample liquid (b) =

Mass of the sample liquid (M) = b-a

Volume of sample liquid (V) =

Density (d_1) = Mass / Volume = M / V =

Number of drops of sample liquid (n_1) =

Number of drops of reference liquid (n_2) =

Procedure (Drop weight method)

For sample liquid

A cleaned and dried stalagmometer was taken and it was filled with the sample liquid say toluene or benzene. Twenty drops of the sample liquid from the stalagmometer was taken in specific gravity bottle. Now the specific gravity bottle was weighed. From the obtained weight of Twenty drops of sample liquid, weight of one drop of sample liquid (m_1) was calculated.

For reference liquid

A cleaned and dried stalagmometer was taken and it was filled with the reference liquid say water. Twenty drops of the reference liquid from the stalagmometer was taken in specific gravity bottle. Now the specific gravity bottle was weighed. From the obtained weight of Twenty drops of reference liquid, weight of one drop of reference liquid (m_2) was calculated.

Observations for sample liquid

Weight of empty specific gravity bottle (a) =

Weight of specific gravity bottle with the twenty drops of sample liquid (b) =

Mass of the twenty drops of sample liquid (c) = b-a

Mass of one drop of sample liquid (m_1) = c / 20

Observations for reference liquid

Weight of empty specific gravity bottle (a) =

Weight of specific gravity bottle with the twenty drops of reference liquid (b) =

Mass of the twenty drops of reference liquid (c) = b-a

Mass of one drop of reference liquid (m_2) = c / 20

Report: The surface tension of given sample liquid was carried out by drop weight method and drop count method and found ----------dyne /cm and ---------dyne /cm respectively.
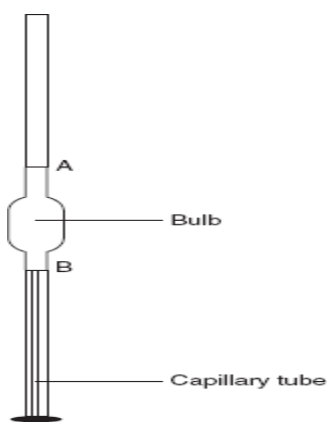
STALAGMOMETER

2. DETERMINATION OF HLB NUMBER OF A SURFACTANT BY SAPONIFICATION METHOD

Aim: To determine the hydrophilic lipophillic balance (HLB) value of a given surfactant by saponification method.

Requirements: Conical flasks, Reflux condenser, water bath, Burette, Pipette, Iron stand, surfactants (Tweens or spans), Potassium hydroxide, Hydrochloric acid, Phenolphthalein indicator, Porcelain chips, ethanol.

Principle: Surfactant or surface-active agent is usually described as a substance that lowers the surface tension of water. However, it requires a more precise definition. In physical sense, surfactant is defined as a substance, which gets preferentially adsorbed at the interface and exhibits self-association in the bulk of the solution at a specific concentration. Chemically surfactant is defined as a substance of fairly high molecular weight and possesses a polar region and a non polar region in the molecular structure. For this reason, surfactants are also called amphiphiles. Hydrophilic lipophilic balance (HLB) is an arbitrary scale device to measure the polar and non polar nature of the surfactant.HLB is a number system, which denotes the optimum efficiency for each class of surfactants. Based on this scale, surfactants are classified as emulsifiers, wetting agents, detergents, solubilizing agents etc. Higher HLB values indicate more hydrophilic nature (e.g.: Tween20, HLB is 16.7). Lower HLB values indicate higher lipophilic nature (example is Span 80, HLB is 14.3). The numbers 20, 40, 60, 80 are related to the fatty acid component. The HLB value of a surfactant like glycerol-monostearate (containing ester functional group) can be determined based on the saponification (alkali hydrolysis) reaction. The formula for the determination of HLB is

$$HLB = 20(1-S/A)$$

Where S= saponification number

A= acid number of the fatty acid

Acid number is defined as the number of milligrams of potassium hydroxide required to neutralize the free fatty acid in one gram of substance.

Saponification number is defined as the number of milligrams of potassium hydroxide required to neutralize the fatty acid, resulting from the complete hydrolysis of one gram of the surfactant. The principle involved in the determination of HLB is illustrated using an example of Tween 80. Chemically, Tween 80 is polyoxyethylene derivative of sorbitan mono-oleate. In other words, it is an ester containing fatty acid portion (oleic acid), which represents the lipophillic nature. The other part of the structure is alcohol portion (polyoxyethylene derivative of sorbitol), which represents the hydrophilic nature. Therefore, hydrolysis of this ester (saponification) gives fatty acid portion and alcohol portion. Analysis of these parts permits the estimation of HLB of such surfactants.

ESTER ⟶ ACID + ALCOHOL

Tween 80 ⟶ Fatty acid + Alcohol portion

(Lipophilic) (Hydrophilic)
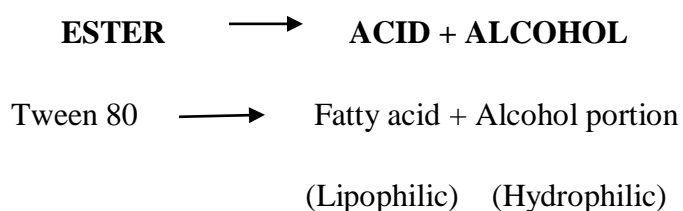
The liberated fatty acid is estimated by a suitable titration method. The extent of hydrolysis is related to saponification number. Estimation of alcohol portion can be made by extracting it into a suitable solvent and an appropriate analytical method. Alternatively, acid numbers may be considered. Acid numbers are related to the fatty acid and remain constant, because here fatty acid has to be considered. These relationships are incorporated into an empirical equation.
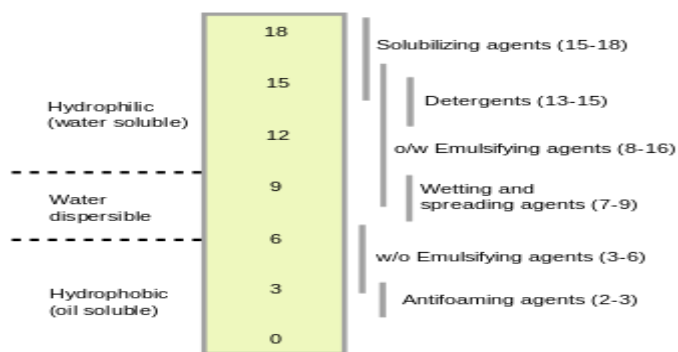
HLB Scale

Procedure:

Preparation of alcoholic potassium hydroxide solution (0.5N): Dissolve 35-40g of potassium hydroxide in 20ml of water, and add sufficient alcohol to make 1,000 ml (use volumetric flask). Allow it to stand overnight and transfer the clear liquid into a bottle. This clear liquid is used. (Note: Aqueous potassium hydroxide cannot be used. Alcoholic potassium hydroxide is used because surfactants are freely soluble in alcohol and hydrolysis will be effective). This solution must be standardized.

Preparation of hydrochloric acid solution (0.5N): Measure 850ml of distilled water into a 1,000 ml volumetric flask. Add 42.5ml of concentrated hydrochloric acid slowly to the water. Finally make up the volume to the mark.

A. Alkaline hydrolysis of surfactant solution

1. Weigh accurately about 2.0 ml of the given surfactant into empty 250ml conical flask.

2. Pipette 25ml of 0.5N alcoholic potassium hydroxide solution to the same flask. Shake the mixture so that surfactant gets dissolved. If necessary, warm the mixture to dissolve the surfactant.

3. Add porcelain chips (2 or 3) to the mixture.

4. Fix the air reflux condenser to the flask.

5. Place the apparatus in a water-bath and fix firmly to the iron stand.

6. Reflux the mixture in a boiling water-bath for one-hour. (Note: Do not allow the alcohol to evaporate).

7. Cool the reaction mixture.

8. Add 1ml of phenolphthalein indicator.

9. Titrate the reaction mixture against 0.5N hydrochloric acid solution.

10. Note the number of ml required **(a).**

B. Blank titration

Repeat the experiment with the same quantities of the same reagents in the same manner omitting the substance. Note the number of ml required **(b).**

C. Determination of saponification Number:

Calculate the saponification value from the following formula

$$S = \frac{(b\text{-}a) \times 0.02804 \times 1000}{W}$$

Where W = weight of the substance taken in grams, S= Saponification number

D. Acid number: Acid number can be taken from table

E. Calculation of HLB of the surfactant: Calculate the HLB value of the given surfactant using the equation i.e., **HLB= 20(1-S/A)**

Observations:

Initial weight of the surfactant with bottle w1 =

Final weight of the surfactant with bottle w2   =

Weight of the surfactant sample taken W= w1- w2 =

Table: Determination of saponification value

Nature of sample	Volume of HCL consumed(ml)		Volume of HCL consumed(ml)	Saponification number
	Initial volume	Final volume		
Sample **(a)**				
Blank **(b)**				

Report: The HLB value of the given surfactant is-------------.

Table: Standard data of surfactants

Surfactant	HLB value	Acid number
Span 20	8.6	276
Span 40	6.7	235
Span 60	4.7	207
Span 80	4.3	190
Tween 20	45.6	276
Tween 40	51.7	235
Tween 60	52.8	207
Tween 80	47.5	190

3. DETERMINATION OF FREUNDLICH AND LANGMUIR CONSTANTS USING ACTIVATED CHARCOAL

Aim: To study the adsorption behavior of acetic acid on charcoal

Requirements: Iodine flask, conical flask, burette, pipette, beakers, graduated pipette, funnels, measuring cylinder, glacial acetic acid (1.0N), iron stand, charcoal, sodium hydroxide solution (0.05N), phenolphthalein indicator.

Principle: Adsorption is an interfacial phenomenon that involves the deposition of gas or solute (present in solution) on a solid. The material that offers a site for adsorption is called adsorbent. The solute that is being adsorbed is called adsorbate. Adsorption is of two types namely; Physical adsorption means the reversible interaction of adsorbent and adsorbate that is associated with vanderwaals forces. Chemical adsorption is one in which the adsorbate is attached to the adsorbent primarily by chemical bonds irreversibly.

Adsorption phenomenon at solid liquid interfaces can be studied using acetic acid and charcoal when a solution of acetic acid in water is shaken in presence of charcoal, a part of acetic acid is adsorbed on the charcoal. As a result, the concentration of acetic acid in solution decreases. As the concentration of acid is increased, the magnitude of adsorption also increases, at a given temperature this relationship is expressed by Freundlich adsorption equation

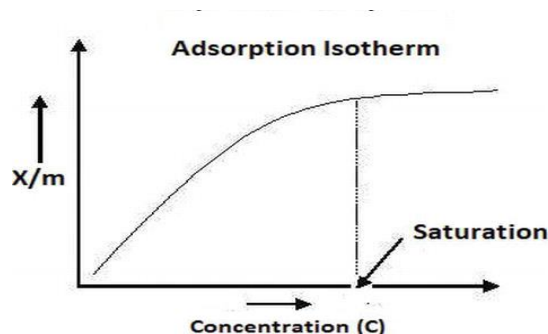$$\frac{x}{m} = KC^{(1/n)}$$

Where x= concentration of acetic acid adsorbed.

m= weight of adsorbent used.

c= concentration of acetic acid in solution.

K, n = constants

Above equation gives a plot when x/m and concentration(C) is taken on Y-axis and X-axis respectively as shown in the following figure:
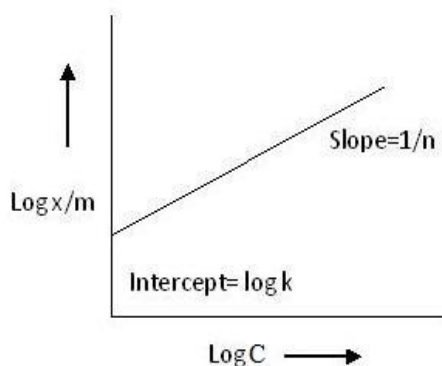
Adsorption Isotherm

The above equation can be converted into a linear expression by taking on logarithms.

$$\text{Log}\frac{x}{m} = \log K + 1/n \log C$$

Thus, plotting $\log \dfrac{x}{m}$ on Y –axis and equilibrium concentration on X-axis gives a straight line.

The constants k and n can be obtained from the slope and intercept of the line respectively that is shown in the figure.

Procedure:

Preparation of acetic acid solution (1.0N): The molecular weight of acetic acid is 60. The density of acetic acid is 1.05gm/cc. Pipette out 57.2ml of glacial acetic acid into a 1000ml volumetric flask and make up the volume with distilled water.

Preparation of sodium hydroxide solution (0.05N): Weigh 2 grams of sodium hydroxide and transfer into 1000 ml volumetric flask, add water slowly with continuous stirring, while cooling the flask under running tap water. Add sufficient water to make 1000ml. Allow it to stand overnight and decant the clear liquid. Use this clear liquid for titration.

Prepare different concentrations of acetic acid as shown in the table below. Transfer them into conical flasks

Label	Glacial acetic acid Stock solution (ml)	Distilled water (ml)	Concentration of acetic acid (N)
A	5	95	0.05
B	10	90	0.1
C	20	80	0.2
D	30	70	0.3
E	40	60	0.4
F	50	50	0.5

Weigh about 2 gm of activated charcoal and note the exact weight. Prepare six such packets. Transfer the activated charcoal samples carefully into the acetic acid solution bottles. Cork the bottles securely.

Keep the bottles in a constant temp water bath and shake them in a shaker bath for half an hour (ordinary water bath can also be used with intermittent shaking for half an hour. Normally equilibrium is attained after shaking the mixtures for several hours).

After equilibrium is attained; remove the bottles from the constant temperature water bath. Filter the acetic acid solution using whatmann paper no.1.Pipette out 10ml of filtrate into two conical flasks.

Titrate them against 0.05N sodium hydroxide solution using phenolphthalein indicator. Determine the equilibrium concentration and other parameters as indicated in table. Plot a graph by taking log x/m+2 on y- axis and log C+2 on x-axis.

Observations:

Y intercept = log K=

Slope = (1/n) =

K= Antilog (intercept) =

n = 1/slope =

Flask number	Volume of sodium hydroxide Consumed(ml)		Volume of sodium hydroxide Consumed (Mean) ml	Equilibrium Concentration of acetic acid (C*)	Log C+2	X#	x/m	Log x/m +2
	Initial volume	Final volume						
A 1								
2								
B 1								
2								
C 1								
2								
D 1								
2								
E 1								
2								
F 1								
2								

Report: In the study of adsorption behavior of acetic acid on charcoal according to Freundlich adsorption equation, the values of constants are K = ---------------- and n = -----------.

4. DETERMINATION OF CRITICAL MICELLAR CONCENTRATION OF SURFACTANT

Aim: To determine the critical miscellar concentration (CMC) of sodium lauryl sulfate (surfactant).

Requirements: Stalagmometer, beaker, specific gravity bottle, measuring cylinder, sodium lauryl sulfate.

Principle: Critical micelle concentration (CMC) is the surfactant concentration at which an appreciable number of micelles are formed and thus remove dirt. Critical micelle concentration (CMC) is a measure of surfactant efficiency. A lower CMC indicates less surfactant is needed to saturate interfaces and form micelles. These micelles solubilizing and disperse soils leading to detergency. At lower concentration surfactant reduce the surface tension of water, as the concentration of surfactant increases then surface tension of water decreases at different miscellar concentration. For a given volume of liquid, the surface tension, as measured with a stalagmometer, is proportional to the density of the solution and inversely proportional to the number of drops, the equation becomes as follows

$$\gamma_1 / \gamma_2 = n_2 d_1 / n_1 d_2$$

Where

γ_1 = Surface tension of sample liquid

γ_2 = Surface tension of reference liquid (water = 72.75 dyne / cm)

n_1 = Number of drops of sample liquid

n_2 = Number of drops of reference liquid (60 drops)

d_1 = Density of sample liquid

d_2 = Density of reference liquid (water = 1.0 g/ml)

Procedure:

Preparation of stock solution: 2gm of SLS was taken in 100ml of volumetric flask and add water slowly to get a final volume of solution without air bubbles.

Preparation of surfactant solution: Solutions of various concentrations having surfactant such as 0, 1, 2, 3, 4, 5% [w/v] using appropriate volume of stock solution are prepared.

Determination of surface tension:

1. Drop count method is employed using stalagmometer for the determination of surface tension. Select a clean stalagmometer rinse the apparatus with acetone and dry it using a hot air dryer, fix the stalagmometer to a stand firmly in a vertical position.

2. Dip stalagmometer in a beaker of water and suck the water up through the rubber tube which is attached up to a level higher than upper mark. Leave the rubber tube and allow the water to flow down.

3. Start counting of drops of water and repeat the same for all concentrations of surfactant solutions and note the number of drops.

Determination of CMC:

Plot a graph by taking various percent concentrations of surfactant solutions on X-axis and surface tension of solutions on Y-axis. Sudden change in the trends of surface tension corresponds to the CMC of the surfactant.

Determination of densities of surfactant solutions:

Select an empty specific gravity bottle having a capacity of 25 ml. Rinse the bottle with a 5ml of acetone and dry it in a hot air oven. Weigh the dry, clean specific gravity bottle (W1). Weigh the specific gravity bottle with distilled water (W2). Weigh the specific gravity bottle with surfactant sample solution (W3). Density of surfactant solution ($\rho2$) is calculated by using the equation as follows.

Density of surfactant solution (d) = $\underline{\text{Weight of the surfactant solution}}$ X density of water
                                               Weight of the distilled water

$$= \underline{\text{W3-W1}} \quad \text{X d2}$$
$$\text{W2-W1}$$

Conc. of surfactant % [v/v].	Number of drops		Average number of drops (n1)	Density gm/cc (d_1)	Surface tension dyne/cm (γ_1)
	Trail I	**Trail II**			

Report: The critical micellar concentration (CMC) of surfactant was found to be----------% v/v.

5. DETERMINATION OF VISCOSITY OF LIQUID USING OSTWALD VISCOMETER

Aim: To determine the viscosity of glycerin using Ostwald viscometer.

Requirements: Ostwald viscometer, beaker, pipette, stopwatch, glycerin, and water.

Principle: The viscosity of liquid is a resistance to flow of a liquid. All liquids appear resistance to flow change from liquid to another, the water faster flow than glycerin, subsequently the viscosity of water less than glycerin at same temperature. Viscosity occurs as a result of contact liquid layers with each other. The viscosity is measuring by Ostwald viscometer. Relative Viscosity is the ratio of the absolute viscosity of the fluid on the viscosity of water at a certain temperature. The viscosity coefficient is force (dyne) necessary to move the layer of liquid 1 cm^2 in speed 1 cm/sec on another layer of liquid and the distance between them is 1cm. The SI unit of viscosity is the Pascal-second (Pa·s), or equivalently kilogram per meter per second (kg·m^{-1}·s^{-1}). The CGS unit (g·cm^{-1}·s^{-1} = 0.1 Pa·s) is called the poise (P) named after Jean Léonard Marie Poiseuille. When fluid is forced through a tube, the fluid generally moves faster near the axis and very slowly near the walls therefore some stress (such as a pressure difference between the two ends of the tube) is needed to overcome the friction between layers and keep the fluid moving. For the same velocity pattern, the stress required is proportional to the fluid's viscosity. A liquid's viscosity depends on the size and shape of its particles and the attractions between the particles. A liquid whose viscosity is less than that of water is sometimes known as a mobile liquid, while a substance with a viscosity substantially greater than water is called a viscous liquid. For two different liquids viscosity of unknown liquid can be determined using the following equation:

$$\frac{\eta_2}{\eta_1} = t_2\rho_2/t_1\,\rho_1$$

Where

η_1= Viscosity of reference liquid (water = 0.91**centi poise** at 25 °C)

t1 =time taken by reference liquid

ρ1=density of reference liquid (1.0 gm/ml)

$\eta2=$ Viscosity of sample liquid (glycerin)

t2= time taken by sample liquid

$\rho2=$ density of sample liquid (1.26 gm/ml)

Procedure: Ostwald viscometer was taken and cleaned with water and acetone. Viscometer was fixed to a stand in a vertical position. Known quantity of water (15ml or 20ml) was transfer with the help of pipette through wide limb. Now water was sucked through the other limb up to a level higher than the upper mark 'A' and clamp the rubber tube with finger to stop the flow of water. Release the rubber tube and water was allowed to flow down. Stop clock was started when the water level first passes the upper mark 'A' when the water level pass down lower mark 'B' then the clock was stopped and note down the time taken for the flow of water between 'A' and 'B' Repeat this process for the given sample twice and calculate the average time of flow.

Observations:

Room temperature = 30°C
Time of flow of water (t1) =..........................sec
Time of flow of Sample liquid (t2) =......................sec
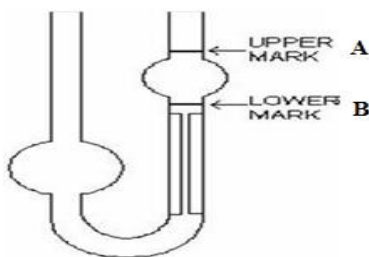
OSTWALD VISCOMETER

Solvents	Flow Time (sec)		
	I	II	Mean
Water			
Sample liquid (Glycerin)			

Report: The viscosity of the given sample by using Ostwald viscometer was found to be--------centi poise.

6. DETERMINATION OF SEDIMENTATION VOLUME WITH EFFECT OF DIFFERENT SUSPENDING AGENTS

Aim: To determine the influence of different suspending agents on the sedimentation volume in a suspension

Requirements: Aluminum hydroxide, Bentonite, Tragacanth, Acacia, Sodium benzoate, Mortar and pestle, beaker, measuring cylinder, spatula, and digital balance.

Principle: Suspension is a heterogeneous system containing solid drug particles dispersed in a liquid. One of the major problems with suspensions is settling. The drug particles settle rapidly and it becomes difficult to take a dose. Hence a suspending agent like sodium alginate, bentonite and sodium carboxy methyl cellulose is used. They increase the viscosity of the vehicle and reduce the settling of drug particles in suspensions. The stability of the suspension can be found by measuring its sedimentation volume.

$$\text{Sedimentation Volume} = F = V_u / V_o$$

V_u = Ultimate volume of the sediment, V_o = Initial volume of the sediment

The greater the **F value,** the better the physical stability of the suspension.

Procedure: Take bentonite and sodium benzoate in a mortar, add water (40 ml) to it in small quantities and triturate to get a smooth dispersion. Now take aluminum hydroxide in a mortar and add the above vehicle in small amounts and triturate to get a suspension without any lumps. Transfer to a measuring cylinder and make it up to 50 ml with distilled water. Similarly prepare the suspensions by remaining suspending agents like acacia and tragacanth. Shake all the suspensions at once and measure the volume of sediment at different time intervals as given in table. Calculate F value for all suspensions at different time intervals and plot a graph of sedimentation volume (F) on Y-axis and time on X-axis. Find the best stable suspension from the graph.

Formulae of Suspensions:

A	Aluminum hydroxide – 2.5 gm	Sodium Benzoate – 100 mg	Bentonite – 50 mg	Distilled Water q.s.to 50 ml
B	Aluminum hydroxide – 2.5 gm	Sodium Benzoate – 100 mg	Acacia – 50 mg	Distilled Water q.s.to 50 ml
C	Aluminum hydroxide – 2.5 gm	Sodium Benzoate – 100 mg	Tragacanth – 50 mg	Distilled Water q.s.to 50 ml

Observations:

S.NO	Time (min)	Volume of sediment (F) in ml					
		A		B		C	
		V_o	V_u	V_o	V_u	V_o	V_u
1	0						
2	15						
3	30						
4	45						
5	60						

Report: The order of stability of suspensions is as follows_____.

7. DETERMINATION OF SEDIMENTATION VOLUME BY USING SINGLE SUSPENDING AGENT WITH DIFFERENT CONCENTRATIONS

Aim: To determine the influence of single suspending agent with different concentrations on the sedimentation volume in a suspension

Requirements: Aluminum hydroxide, Bentonite, Sodium benzoate, Mortar and pestle, beaker, measuring cylinder, spatula, and digital balance.

Principle: Suspension is a heterogeneous system containing solid drug particles dispersed in a liquid. One of the major problems with suspensions is settling. The drug particles settle rapidly and it becomes difficult to take a dose. Hence a suspending agent like sodium alginate, bentonite and sodium car boxy methyl cellulose is used. They increase the viscosity of the vehicle and reduce the settling of drug particles in suspensions. The stability of the suspension can be found by measuring its sedimentation volume.

$$\text{Sedimentation Volume} = F = V_u / V_o$$

V_u = Ultimate volume of the sediment, V_o = Initial volume of the sediment

The greater the **F value,** the better the physical stability of the suspension.

Procedure: Take bentonite and sodium benzoate in a mortar, add water (40 ml) to it in small quantities and triturate to get a smooth dispersion. Now take aluminum hydroxide in a mortar and add the above vehicle in small amounts and triturate to get a suspension without any lumps. Similarly prepare different concentrations of bentonite as suspending agent and labeled them as A, B, C and D. Transfer these suspensions into a measuring cylinder and make up to 50 ml with distilled water. Shake all the suspensions at once and measure the volume of sediment at different time intervals as given in table. Calculate F value for all suspensions at different time intervals and plot a graph of sedimentation volume (F) on Y-axis and time on X-axis. Find the best stable suspension from the graph.

Formulae of Suspensions:

S.NO	Ingredient	A	B	C	D
1	Aluminum hydroxide	2.5 g	2.5 g	2.5 g	2.5 g
2	Sodium Benzoate	100 mg	100 mg	100 mg	100 mg
3	Bentonite	0mg	50 mg	100 mg	200 mg
4	Distilled Water	50 ml	50 ml	50 ml	50 ml

Observations:

S.NO	Time (min)	Volume of sediment (F)							
		A		B		C		D	
		V_o	V_u	V_o	V_u	V_o	V_u	V_o	V_u
1	0								
2	15								
3	30								
4	45								
5	60								

Report: The order of stability of suspensions is as follows _____.

8. DETERMINATION OF VISCOSITY OF SEMISOLID BY USING BROOKFIELD VISCOMETER

Aim: To determine the viscosity of gels (semisolid) by using Brookfield viscometer.

Requirements: Brookfield viscometer, beaker, gel forming agent such as gelatin or tragacanth or Carbopol

Principle:

Brookfield viscometers are often used within the food processing sectors where accurate bench-top analysis of product viscosity is needed. These viscometers use the principle of 'rotational viscometry', i.e. their measurement of product viscosity is based upon immersing a specifically selected spindle within a sample of the product followed by measurement of the torque required to rotate the spindle at a set speed whilst immersed within the product sample. As the torque required will be proportional to the quantity of viscous drag upon the spindle, this provides an assessment of the product viscosity, reported in centipoise units (cP).

Procedure:

Prepare the gel by using the suitable gel forming agent like gelatin or tragacanth or Carbopol. Level the viscometer by adjusting the feet and/or rotate the viscometer on the mounting shaft until the bubble is centered before each use. Set the speed control to 60 rpm. Place the sample container under viscometer. Select a spindle appropriate for the viscosity to be measured. The number of the spindle is engraved at the top of each spindle.

Screw the spindle onto the viscometer.
a. This is a left-handed thread.
b. Spindle should be finger tightened only, holding onto the shaft to prevent movement of the gauge needle, and gently lifting upward.
c. NEVER pull down on the spindle.

Using the adjustment knob on the viscometer stand, carefully lower the spindle into the sample to the immersion mark engraved into the spindle shaft. With one hand depress and hold the brake, found on the back of the viscometer head, firmly down while turning on the viscometer. Release the brake once the viscometer is rotating smoothly and time for 60 seconds.

Read and record the value of viscosity on the viscometer gauge. Also record the number of the spindle used. After completion of recording the value of viscosity, turn off the viscometer and clean it properly.

Precautions:

Prepare homogeneous gel and keep aside for 24hrs for homogenization. Take care for selecting proper spindle.

Start the instruments at low speed and rotate for at least 20 minutes till the dial reading is have constant.

After usage of the instrument, it has to be cleaned (cover it or keep in wooden box)

Determine the viscosity at constant electric supply as well as constant temperatures.

Report: The viscosity of prepared gel at room temperature was found to be ------------ poise or centipoises.

9. DETERMINATION OF REACTION RATE CONSTANT OF FIRST ORDER

Aim: To determine the first order reaction rate constant of an ethyl acetate in 0.5N hydrochloric acid at room temperature.

Requirements: Conical flasks, test tube, pipette, water bath, burette,0.5N hydrochloric acid, ethyl acetate, sodium hydroxide solution, phenolphthalein indicator, ice-cold water.

Principle: First order reaction is defined as a reaction in which the rate of reaction is directly proportional to the concentration of one reactant. According to the definition the rate is expressed as

$$-dc/dt = K1\ C$$

Where K1 is a first order reaction rate constant, C is the concentration of one reactant.

The minus sign in equation indicates the concentration of reactant decreases as the reaction proceeds. The unit for K1 is reciprocal of time. i.e, sec^{-1}. The exponential form of the first order equation is $\qquad C_t = C_0 e^{-k1t}$

Where C_t is a concentration of reactant at any time, C_0 is initial concentration of the reactant. The integral form of the equation is given by

$$K1 = 2.303/t\ X\ \log C_0/C_t$$

Half life is defined as the time required for the concentration of the reactant to reduce to half of its initial concentration. Half life can be given by

$$t_{1/2} = 0.693/k1.$$

The units of half life are seconds, minutes, hours, days.

Procedure:

Preparation of 0.5N HCl solution: Add 4.25 ml of concentrated hydrochloric acid to 85ml of water and shake. Finally make up the volume to the mark of 100ml.

Preparation of 0.25N sodium hydroxide solution: Add one gm of sodium hydroxide to 100 ml of water and stir it. Finally make up the volume to the mark of 100ml. Allow it to stand for overnight and transfer the clear supernatant solution into a bottle. An example for first order reaction is acid hydrolysis of an ester

$$CH3COOCH3 + H20 \leftrightarrow CH3COOH + CH3OH$$

Methyl acetate   Water   Acetic acid   Methyl alcohol

Procedure: [KINETIC METHOD]

- Measure the 100ml of 0.5N of hydrochloric acid in a stopper conical flask and kept in water bath for equilibrium for 10 minutes. Measure 10ml of given ester (methyl acetate or ethyl acetate) into a clean test tube and kept in water bath for equilibrium for 10 minutes.

- Mix the acid solution and ester sample thoroughly and keep in same water bath with occasional stirring. Immediately after mixing withdraw 5ml of mixture with pipette and transfer into a conical flask containing 10ml of ice-cold water.

- Add few drops of phenolphthalein indicator and titrate the mixture against 0.25N of sodium hydroxide solution. This value represents the alkali consumed at C_0.

- Withdraw samples (5ML) periodically at 10, 20, 30, 40-minute timings and carry the titration with 0.25N of sodium hydroxide solution.

- The volume of alkali consumed at each interval represents C_t at respective timings. The reaction rate constant can be determined by substituting the values in the equation.

- Calculate the average values of K1. The reaction rate constant can be estimated by graphic method. Plot a graph by taking log C_0 on Y-axis and time on X-axis. From the graph the following are calculated.

| Time [min]	Burette reading		Volume of NaOH consumed [ml]	Initial Concentration [C_0]	Concentration of reactant at any time [C_t]	C_0/C_t	Log C_0/C_t	K1= 2.303/t X log C_0/C_t
	Initial	Final						
0					--	--	---	--
10								
20								
30								
40								

Report: The first order reaction rate constant of an ethyl acetate in 0.5N hydrochloric acid at room temperature is-------------- min^{-1}. The half-life of the given ethyl acetate in 0.5N hydrochloric acid at room temperature is--------min.

10. DETERMINATION OF REACTION RATE CONSTANT OF SECOND ORDER

Aim: To determine the second order reaction rate constant of an ethyl acetate in 0.05N sodium hydroxide solution at room temperature.

Requirements: Conicalflasks250ml(stoppered), pipette(10ml,50ml), water bath, burette(50ml), ice cold water, phenolphthalein indicator,0.05N ethyl acetate, 0.05Nsodium hydroxide solution,0.02N hydrochloric acid solution.

Principle: The alkaline hydrolysis of an ester is irreversible and follows the second order reaction kinetics.

$$CH_3COOC_2H_5 + NaOH \text{ ---------} \rightarrow CH_3COONa + C_2H_5OH$$
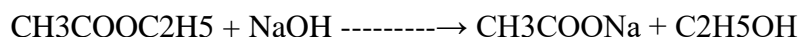
Ethyl acetate   Sodium hydroxide   Sodium acetate   Ethyl alcohol

Second order reaction is defined as a reaction in which the rate of reaction in which the rate of reaction depends upon the concentration of two reactants. According to the definition the rate is expressed as $K_2 = 1/t * x/a (a-x)$

Where K_2 is a second order reaction rate constant, 'a' is the initial concentration of alkali.

't' is the time at which the concentration is measured; 'x' is the concentration of reactant consumed.

A graph can be plotted by taking $x/a (a-x)$ on Y-axis and time on X-axis. For second order the slope is positive. Slope is equal to K_2 value. The units for K_2 are $lit.mol^{-1}sec^{-1}$. Half-life can be given by $t_{1/2} = 1/a K_2$.

The units of half life are minutes, hours, and days.

Procedure:

Preparation of 0.02N HCl solution: Add 1.7 ml of concentrated hydrochloric acid to 850ml of water in a 1000ml volumetric flask slowly and shake. Finally make up the volume to the mark of 1000ml.

Preparation of 0.05N of NaOH solution: Add 2 gm of sodium hydroxide to 1000 ml of water and stir it. Finally make up the volume to the mark of 1000ml.Allow it to stand for overnight and transfer the clear supernatant solution into a bottle.

Preparation of 0.05N of ethyl acetate solution: The molecular weight of ethyl acetate is 88.10gm and density is 0.90 g/ml. Measure 5ml of ethyl acetate in 1000ml of volumetric flask and dilute with distilled water up to 1000ml mark.

Procedure:

- Measure the 50ml 0.05N of sodium hydroxide solution in a conical flask and kept in water bath for equilibrium for 10 minutes. Measure 50ml of given ester (methyl acetate or ethyl acetate) into a clean test tube and kept in water bath for equilibrium for 10 minutes.

- Mix the alkali solution and ester sample thoroughly and keep in same water bath with occasional stirring. Immediately after mixing withdraw 10ml of mixture with pipette and transfer into a conical flask containing 10ml of ice-cold water.

- Add few drops of phenolphthalein indicator and titrate the mixture against 0.02N of hydrochloric acid solution. This value represents the alkali consumed at time (t=0) corresponds to the original concentration (a).

- Withdraw samples (10ML) periodically at 5, 10, 15, 20, 25, 30-minute timings and carry the titration with 0.02N of hydrochloric acid solution. The volume of alkali unreacted, i.e., (a-x) at time 't'.

- The reaction rate constant can be determined by substituting the values in the equation and calculate the average values of K2. Plot a graph by taking a/a(a-x) on Y-axis and time on X-axis.

Time [min]	Volume of HCl consumed [ml]		Volume of HCl [ml]	Initial Concentration a or (a-x) = V1xN1/V2	X=a-(a-x)	X/a(a-x)	K2=1/t * X/a (a-x)
	Initial volume	Final volume					
0				a=			
5				(a-x)			
10				(a-x)			
15				(a-x)			
20				(a-x)			
25				(a-x)			
30				(a-x)			

V1=Titer value, N1= Normality of HCl solution (0.02), V2= reaction mixture sample (10ml)

Report: The second order reaction rate constant of an ethyl acetate in 0.05N of sodium hydroxide at room temperature is-------------- $lit.mol^{-1}sec^{-1}$. The half-life of the given ethyl acetate in 0.05N of sodium hydroxide at room temperature is ------min.