Shree H. N. Shukla Institute of Pharmaceutical Education and Research, Rajkot

B. Pharm
Semester-III

HNSIPER

Subject Name: Physical pharmaceutics-I
Subject Code: BP302TP

CHAPTER-2 - SURFACE AND INTERFACIAL PHENOMENON

SYLLABUS:

Surface and interfacial phenomenon:

Liquid interface, surface & interfacial tensions, surface free energy, measurement of surface & interfacial tensions, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB Scale, solubilisation, detergency, adsorption at solid interface.

- The course deals with the various physical and physicochemical properties, and principles involved in dosage forms/formulations.
- Theory and practical components of the subject help the student to get a better insight into various areas of formulation research and development, and stability studies of pharmaceutical dosage forms.

Learning objectives

- Understand the nature of the intra and intermolecular forces that are involved in stabilizing molecular and physical structure.
- Understand the differences in these forces and their relevance to different types of molecules.
- Appreciate the differences in the strengths of the intermolecular forces that are responsible for the stability structures in the different states of matter.
- Understands properties of gaseous states.

HNSIPL

SURFACE & INTERFACIAL PHENOMENON

TOPIC: What is Interface?

Ans:

INTERFACE

When phases exist together, the boundary between two of them is known as an *interface*.

The term *surface* is used when referring to either a gas–solid or a gas–liquid interface.

The properties of the molecules forming the interface are often sufficiently different from those in the bulk of each phase.

Liquid Interfaces Surface and Interfacial Tensions

Molecules in the bulk liquid are surrounded in all directions by other molecules for which they have an equal attraction.

Molecules at the surface (i.e., at the liquid–air interface) can only develop attractive cohesive forces with other liquid molecules that are situated below and adjacent to them.

Detailing:

Interfaces:

- When phases exist together, the boundary between two of them is known as an ***Interface***.
- The properties of the molecules forming the interface are often sufficiently different from those in the bulk of each phase.
- The term *Surface* is used when referring to either a gas–solid or a gas–liquid interface.

Types of Interface

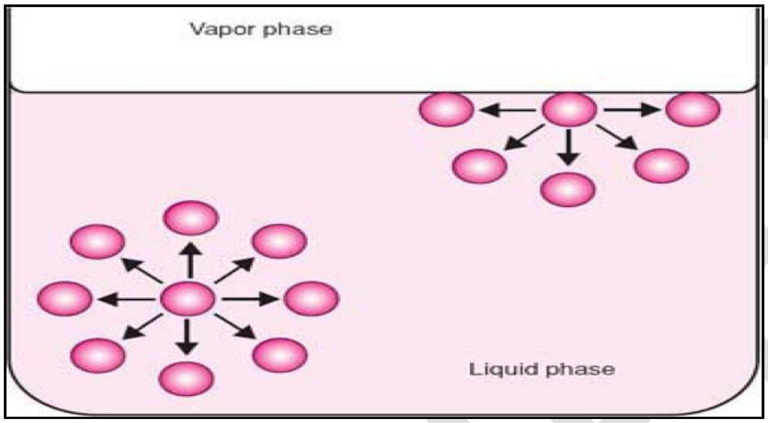
Phase	Interfacial Tension	Types and Examples of Interfaces
Gas–Gas	—	No interface possible
Gas–liquid	γ_{LV}	Liquid surface, body of water exposed to atmosphere
Gas–solid	γ_{SV}	Solid surface, table top
Liquid–liquid	γ_{LL}	Liquid–liquid interface, emulsion
Liquid–solid	γ_{LS}	Liquid–solid interface, suspension
Solid–solid	γ_{SS}	Solid–solid interface, powder particles in contact

Liquid Interfaces

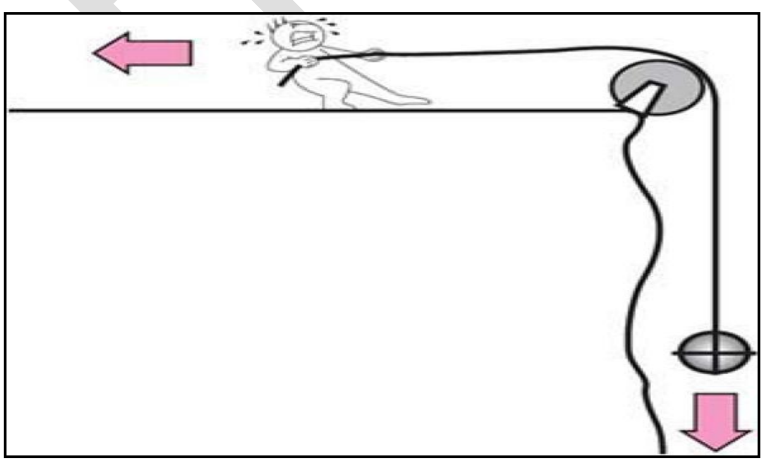
Surface and Interfacial Tensions

- The molecules in the bulk liquid are surrounded in all directions by other molecules for which they have an equal attraction.

- Molecules at the surface (i.e., at the liquid–air interface) can only develop attractive cohesive forces with other liquid molecules that are situated below and adjacent to them.
- They can develop adhesive forces of attraction with the molecules constituting the other phase involved in the interface, although, in the case of the liquid–gas interface, this adhesive force of attraction is small.



- The net effect is that the molecules at the surface of the liquid experience an inward force toward the bulk.
- Such a force pulls the molecules of the interface together and, as a result, contracts the surface, resulting in a *surface tension*.
- This "tension" in the surface is the force per unit length that must be applied *parallel* to the surface to counterbalance the net inward pull.
- *Interfacial tension* is the force per unit length existing at the interface between two immiscible liquid phases and.
- The surface and interfacial tensions, have the units of dynes/cm or N/m.



One Word Question Answer

SR NO.	QUESTION	ANSWER
1	When phases exist together, the boundary between two of them known as?	Interface
2	When referring a gas–solid or a gas–liquid interface.	Surface
3	A force pulls the molecules of the interface together and, as a result, contracts the surface called?	Surface tension
4	The force per unit length existing at the interface between two immiscible liquid phases	Interfacial tension
5	Surface and interfacial tensions, have the units of	dynes/cm or N/m

HNSIPER

Table 15-2 Surface Tension and Interfacial Tension (Against Water) at 20°C*

Substance	Surface Tension (dynes/cm)	Substance	Interfacial Tension (dynes/cm)
Water	72.8	Mercury	375
Glycerin	63.4	*n*-Hexane	51.1
Oleic acid	32.5	Benzene	35.0
Benzene	28.9	Chloroform	32.8
Chloroform	27.1	Oleic acid	15.6
Carbon tetrachloride	26.7	*n*-Octyl alcohol	8.52
Caster oil	39.0	Caprylic acid	8.22
Olive oil	35.8	Olive oil	22.9
Cottonseed oil	35.4	Ethyl ether	10.7
Liquid petrolatum	33.1		

- The surface tensions of most liquids decrease almost linearly with an increase in temperature, that is, with an increase in the kinetic energy of the molecules.
- In the region of its critical temperature, the surface tension of a liquid becomes zero.
- The surface tension of water at 0°C is 75.6, at 20°C it is 72.8, and at 75°C it is 63.5 dynes/cm.

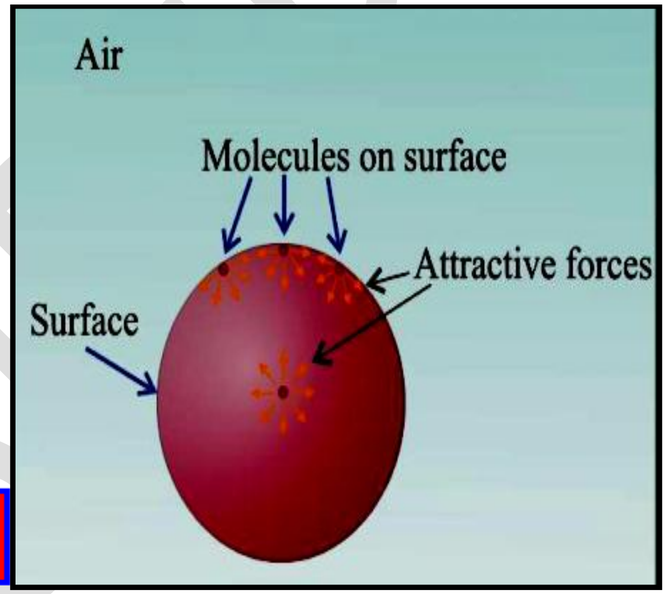
Surface Free Energy and Surface Tension

- The surface layer of a liquid possesses additional energy as compared to the bulk liquid.

- This energy increases when the surface of the same mass of liquid increases and is therefore called ***surface free energy.***
- The work W required to create a unit area of surface is known as <u>*SURFACE FREE ENERGY/UNIT AREA* (ergs/cm^2)</u>

  Erg = dyne . cm
- Its equivalent to the surface tension γ.
- Thus the greater the area A of interfacial contacts between the phases, the greater the free energy.

$$\mathbf{W = \gamma \, \Delta A}$$



- For equilibrium, the surface free energy of a system must be at a minimum.
- Thus, Liquid droplets tend to assume a spherical shape since a sphere has the smallest surface area per unit volume.

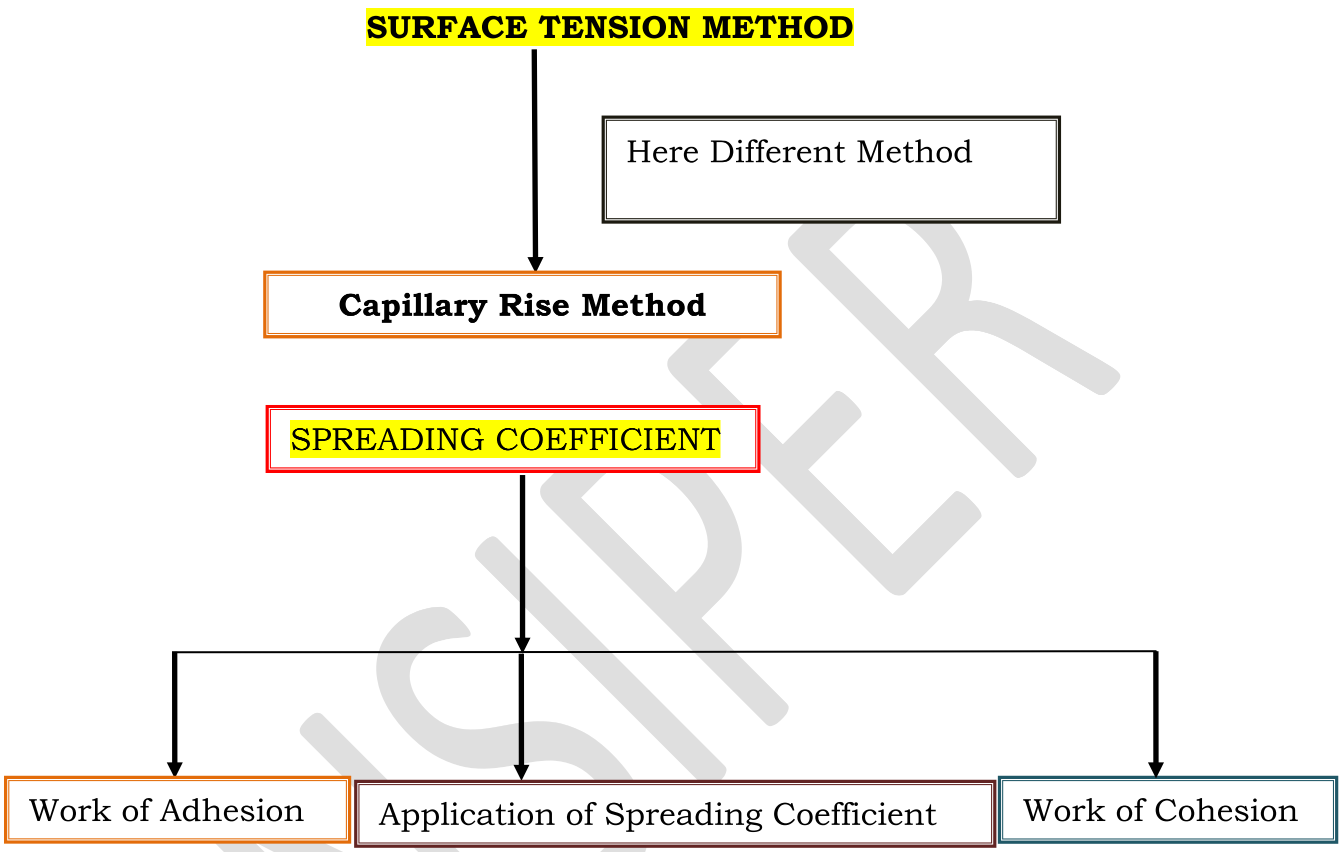
One Word Question Answer

SR NO.	QUESTION	ANSWER
1	The temperature at which the surface tension of a liquid becomes zero.	Critical Temperature
2	The surface tension of water at 0°C is?	75.6
3	The energy that increases when the surface of the same mass of liquid increases?	Surface free energy
4	The work W required to create a unit area of surface is known as?	Surface free energy
5	The greater the area (A) of Interfacial contacts between the phases indicating?	Greater energy

HNSIPER

TOPIC: What is Surface Tension Measurement Method?

Ans



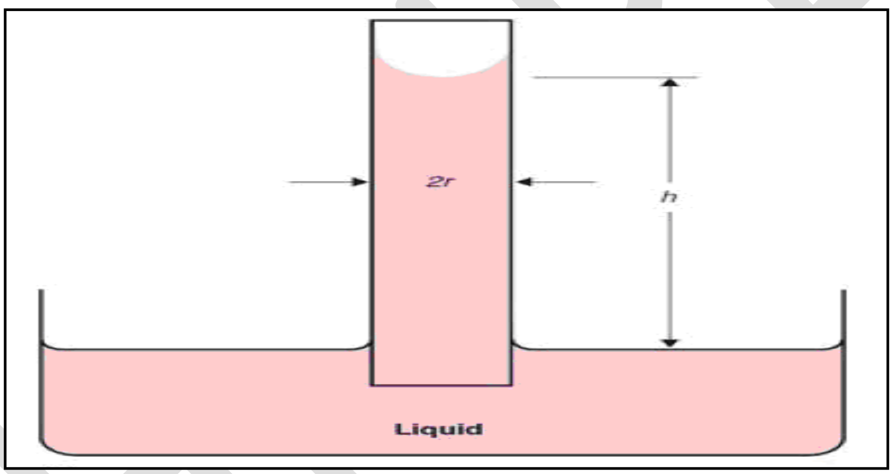
HNSIPER

Detailing:

Capillary Rise Method

- When a capillary tube is placed in a liquid contained in a beaker, the liquid generally rises up the tube a certain distance.
- By measuring this rise in a capillary, it is possible to determine the surface tension of the liquid. It is not possible, however, to obtain interfacial tensions using the capillary rise method.
- Because of the surface tension, the liquid continues to rise in the tube, but because of the weight of the liquid, the upward movement is just balanced by the downward force of gravity.

$$\gamma = \frac{1}{2} r h \rho g \qquad (15\text{–}12)$$



Spreading Coefficient

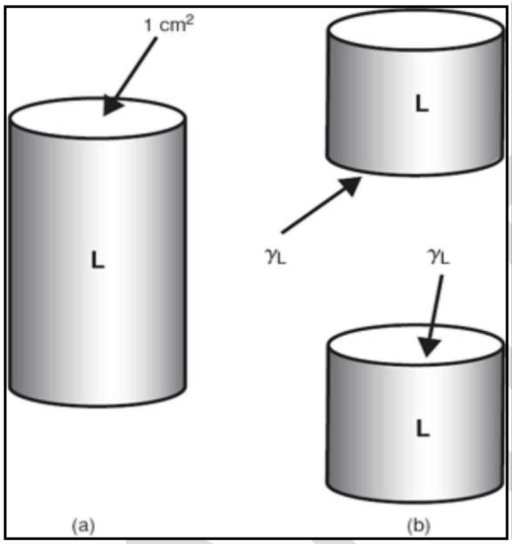
- When a substance such as oleic acid is placed on the surface of water, it will spread as a film if the force of adhesion between the oleic acid molecules and the water molecules is greater than the cohesive forces between the oleic acid molecules themselves.
- The term *film* used here applies to a *duplex film* as opposed to a monomolecular film. Duplex films are sufficiently thick (100 Å or more) so that the surface (boundary between oleic acid and air) and interface (boundary between water and oleic acid) are independent of one another.

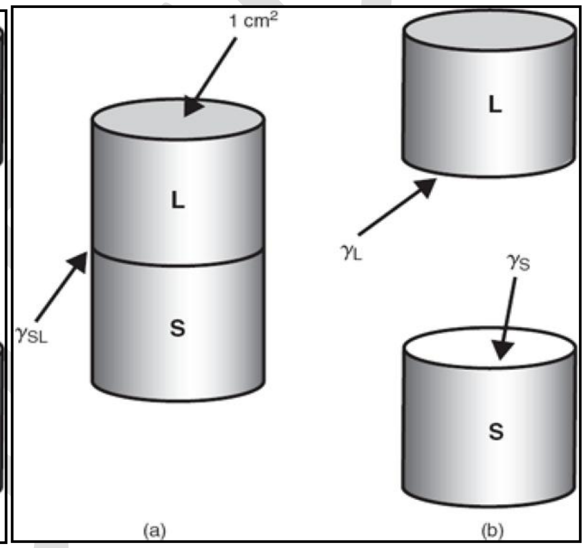
- The *work of adhesion*, is the energy required to break the attraction between the unlike molecules.

$$W_a = \gamma_L + \gamma_S - \gamma_{LS} \qquad (15\text{–}16)$$

- The *work of cohesion*, required to separate the molecules of the spreading liquid so that it can flow over the sub layer,

$$W_c = 2\gamma_L \qquad (15\text{–}17)$$





- The term (*W*a - *W*c) is known as the *spreading coefficient*, *S*;
- if it is positive, the oil will spread over a water surface.

$S = \gamma_S - (\gamma_L + \gamma_{LS})$

- γ_S is the surface tension of the sublayer liquid,
- γ_L is the surface tension of the spreading liquid,
- γ_{LS} is the interfacial tension between the two liquids.
- spreading occurs (*S* is positive) when the surface tension of the sublayer liquid is greater than the sum of the surface tension of the spreading liquid and the interfacial tension between the sublayer and the spreading liquid.
- If ($\gamma_L + \gamma_{LS}$) is larger than γ_S, the substance forms globules or a floating lens and fails to spread over the surface. An example of such a case is mineral oil on water.

One Word Question Answer

SR NO.	QUESTION	ANSWER
1	A liquid contained in a beaker, the liquid generally rises up the tube a certain distance is called?	Capillary rise method
2	The energy required to break the attraction between the unlike molecules.	Work of Adhesion
3	The energy required to separate the molecules of the spreading liquid so that it can flow over the sublayer,	Work of Cohesion
4	The term (Wa - Wc) is known as?	*Spreading coefficient, S*
5	Spreading coefficient equation?	$S = \gamma_S - (\gamma_L + \gamma_{LS})$
6	the substance forms globules or a floating lens and fails to spread over the surface when?	$(\gamma_L + \gamma_{LS})$ is larger than γ_S

ANSIPER

TOPIC: What is Surface Active Agent?

Ans

SURFACE ACTIVE AGENT

Definition

A surfactant molecule is depicted schematically as a cylinder representing the hydrocarbon (hydrophobic) portion with a sphere representing the polar (hydrophilic) group attached at one end.

It is the amphiphilic nature of surface-active agents that causes them to be absorbed at interfaces.

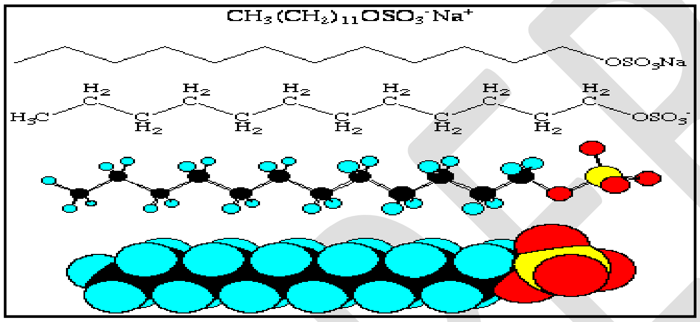
- Low HLB Value, SA
- High HLB Value, SA

SURFACE ACTIVE AGENT

- Cationic SA
- Anionic SA
- Amphiphilic SA

Detailing:

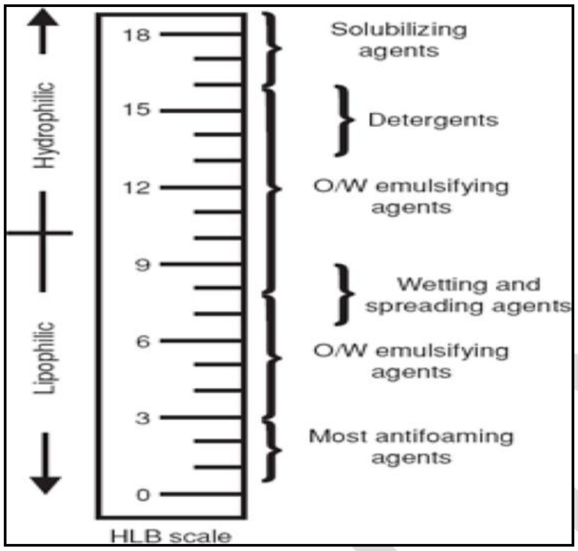
- A surfactant molecule is depicted schematically as a cylinder representing the hydrocarbon (hydrophobic) portion with a sphere representing the polar (hydrophilic) group attached at one end.
- *The hydrocarbon chains are straight because rotation around carbon-carbon bonds bends, coils and twists them.*



- It is the amphiphilic nature of surface-active agents that causes them to be absorbed at interfaces,
- Thus, in an aqueous dispersion of amphiphile, the polar group is able to associate with the water molecules. The nonpolar portion is rejected,
- As a result, the amphiphile is adsorbed at the interface.
- The situation for a fatty acid at the air–water and oil–water interface:
- At the oil–water interface, the lipophilic chains are directed upward into the air; at the air–oil interface, they are associated with the oil phase.
- For the amphiphile to be concentrated at the interface, it must be balanced with the proper amount of water- and oil-soluble groups.
- If the molecule is too hydrophilic, it remains within the body of the aqueous phase and exerts no effect at the interface.
- if it is too lipophilic, it dissolves completely in the oil phase and little appears at the interface

SYSTEMS OF HYDROPHILE–LIPOPHILE CLASSIFICATION

- The higher the HLB of an agent, the more hydrophilic it is.
- The Spans, sorbitan esters , are lipophilic and have low HLB values (1.8–8.6);
- The Tweens, polyoxyethylene derivatives of the Spans, are hydrophilic and have high HLB values (9.6–16.7).



- When present in a liquid medium at low concentrations, the amphiphiles exist separately.
- As the concentration is increased, aggregation occurs. These aggregates, which may contain 50 or more monomers, are called *micelles*
- The concentration of monomer at which micelles form is termed the *critical micelle concentration* (*CMC*).
- The surface tension decreases up to the CMC .
- When the surface tension, γ, of a surfactant is plotted against the logarithm of the surfactant activity or concentration, log c_2, the plot takes on the shape shown in Figure.
- The initial curved segment A–B is followed by a linear segment, B–C, along which there is a sharp decrease in surface tension as log c_2 increases. The point C corresponds to the critical micelle concentration (CMC), the concentration at which micelles form in the solution.
- Beyond the CMC, the line becomes horizontal because further additions of surfactant are no longer being accompanied by a decrease in surface tension. It is the ability of the micelles to increase the solubility of materials that are normally insoluble, or only slightly soluble, in the dispersion medium used. This phenomenon, known as *solubilization.*

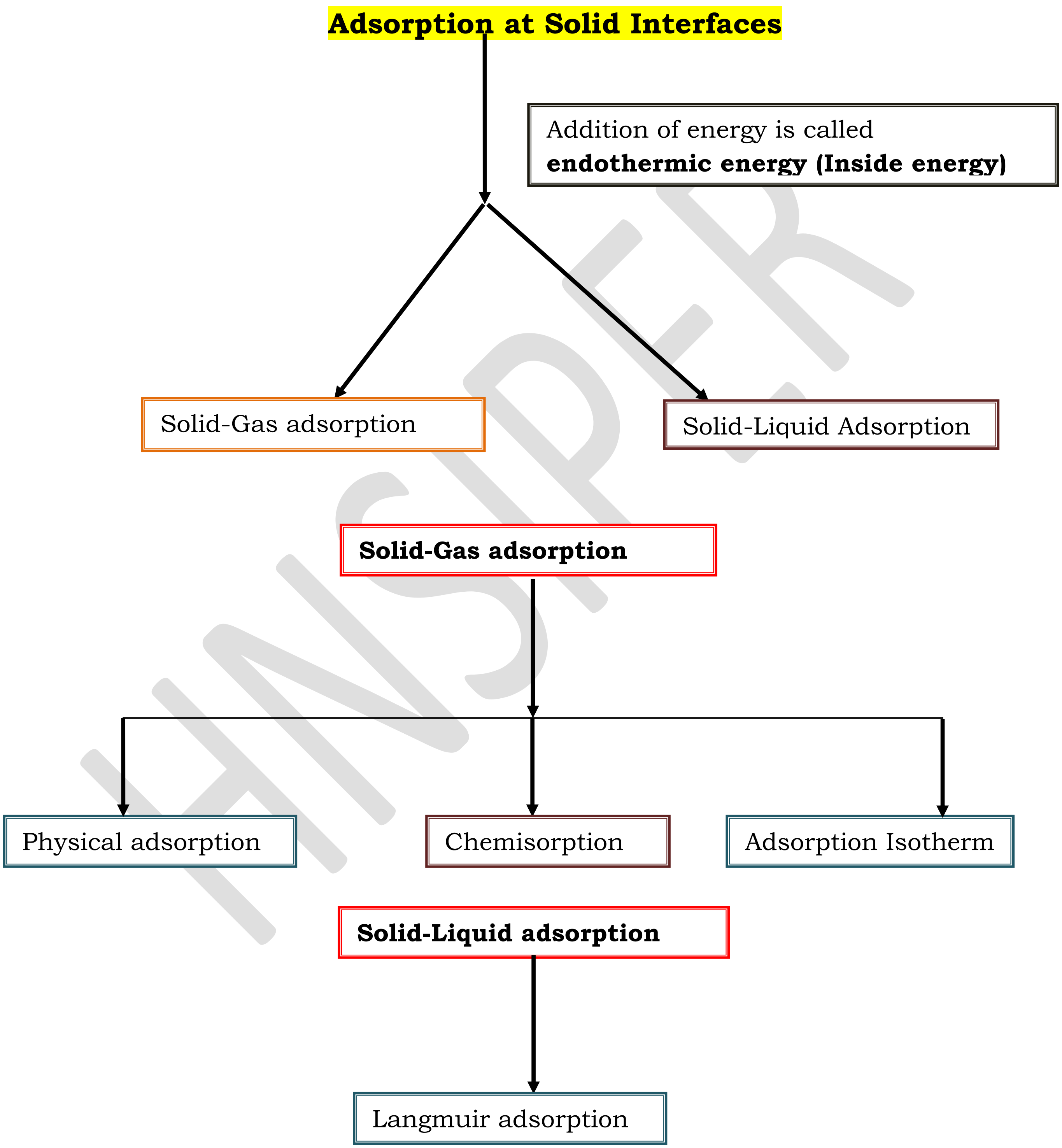
One Word Question Answer

SR NO.	QUESTION	ANSWER
1	Which surface-active agents that causes them to be absorbed at interfaces?	Amphiphilic
2	Which molecules remains within the body of the aqueous phase and exerts no effect at the interface.	Hydrophilic molecule
3	Which molecule dissolves completely in the oil phase and little appears at the interface	Lipophilic
4	Higher the HLB Value of agent indicates.	Hydrophilic
5	The concentration of monomer at which micelles form is termed as?	*Critical micelle concentration*
6	the micelles to increase the solubility of materials that are normally insoluble, or only slightly soluble, in the dispersion medium used is known as?	Solubilization

HNSIPER

TOPIC: Adsorption at different Interfaces?

Ans:



HNSIPER

Detailing:

Adsorption at Solid Interfaces

- solid–gas adsorption:
- the removal of objectionable odors from rooms and food,
- the operation of gas masks,
- the measurement of the dimensions of particles in a powder.
- solid–liquid adsorption:
- decolorizing solutions,
- adsorption chromatography,
- detergency, wetting.

The Solid–Gas Interface

- the *adsorbent* : the material used to adsorb the gas)
- the *adsorbate*: the substance being adsorbed
- types of adsorption:

1. Physical adsorption:

- associated with van der Waals forces,
- reversible, the removal of the adsorbate from the adsorbent being known as *desorption*. A physically adsorbed gas can be desorbed from a solid by increasing the temperature and reducing the pressure.

2. Chemical adsorption or chemisorption

- The adsorbate is attached to the adsorbent by primary chemical bonds,
- Irreversible unless the bonds are broken.
- The degree of adsorption of a gas by a solid depends on:

1. the chemical nature of the *adsorbent* and the *adsorbate*
2. the surface area of the adsorbent,
3. the temperature,
4. the partial pressure of the adsorbed gas.
5. The relationship between the amount of gas physically adsorbed on a solid and the equilibrium pressure or concentration at constant temperature yields an *adsorption isotherm* when plotted.
6. The number of moles, grams, or milliliters, x, of gas adsorbed on, m, grams of adsorbent at standard temperature and pressure is plotted on the vertical axis against the equilibrium pressure of the gas in mm Hg on the horizontal axis,

The Solid–Liquid Interface

- Drugs such as dyes, alkaloids, fatty acids, and even inorganic acids and bases can be absorbed from solution onto solids such as charcoal and alumina.

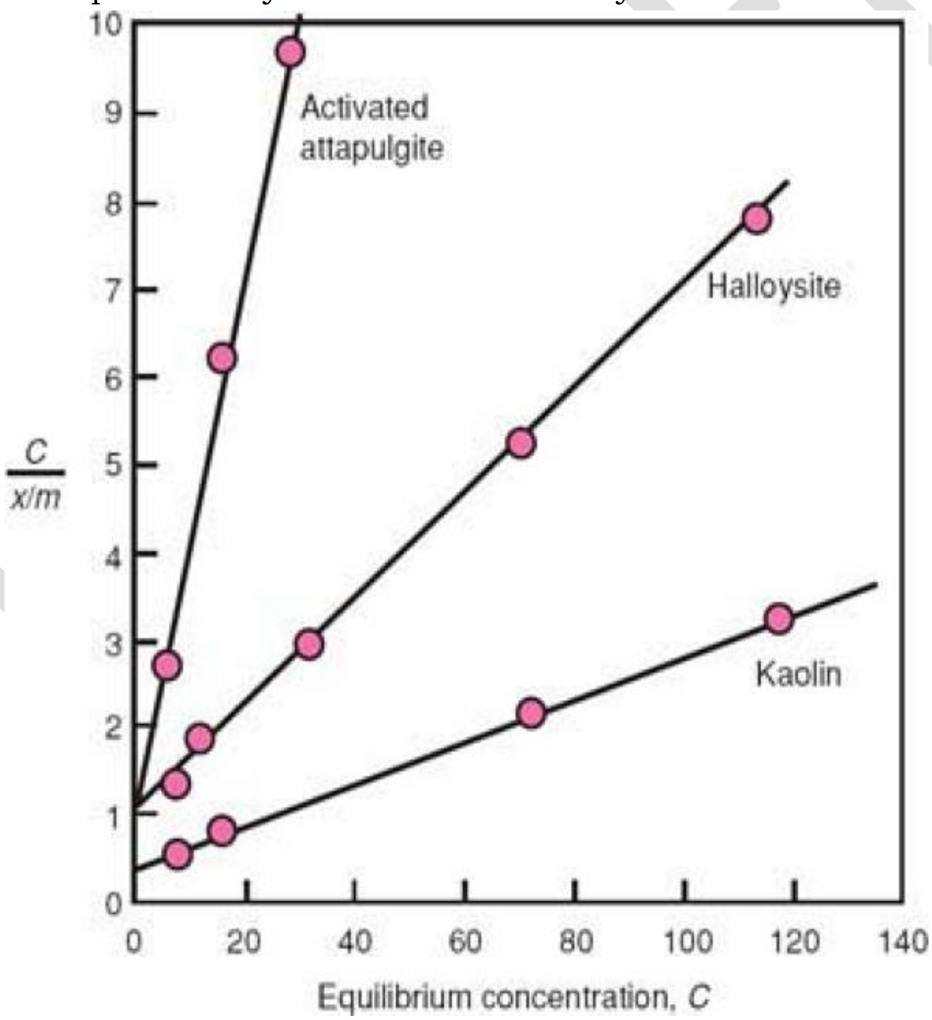
HNSPER

- Isotherms that fit one or more of the equations mentioned previously can be obtained by substituting solute concentration for the vapor pressure term used for solid–gas systems.
- Langmuir equation:

$$\frac{c}{y} = \frac{1}{by_m} + \frac{c}{y_m} \qquad (15\text{–}58)$$

- *c* is the equilibrium concentration in milligrams of alkaloidal base per 100 mL of solution,
- *y* is the amount of alkaloidal base, *x*, in milligrams adsorbed per gram, *m*, of clay (i.e., $y = x/m$)

  Adsorption of strychnine on various clays



- Data for adsorption of timolol from aqueous solution onto kaolin.

- **One Word Question Answer**

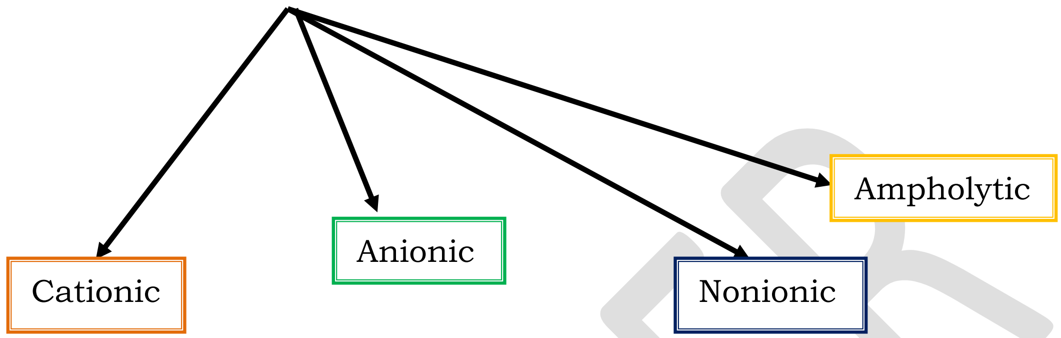
SR NO.	QUESTION	ANSWER
1	The material used to adsorb the gas?	Adsorbent
2	The substance being adsorbed?	Adsorbate
3	Relationship between the amount of gas physically adsorbed on a solid and the equilibrium pressure or concentration at constant temperature yields?	Adsorption isotherm theory
4	Langmuir Adsorption Theory	$\frac{c}{y} = \frac{1}{by_m} + \frac{c}{y_m}$
5	degree of adsorption of a gas by a solid depends on?	Temperature, Pressure, area
6	Which adsorption is associated with van der Waals forces	Physical adsorption
7	In which adsorption, adsorbate is attached to the adsorbent by primary chemical bonds	Chemisorption

HNSIPER

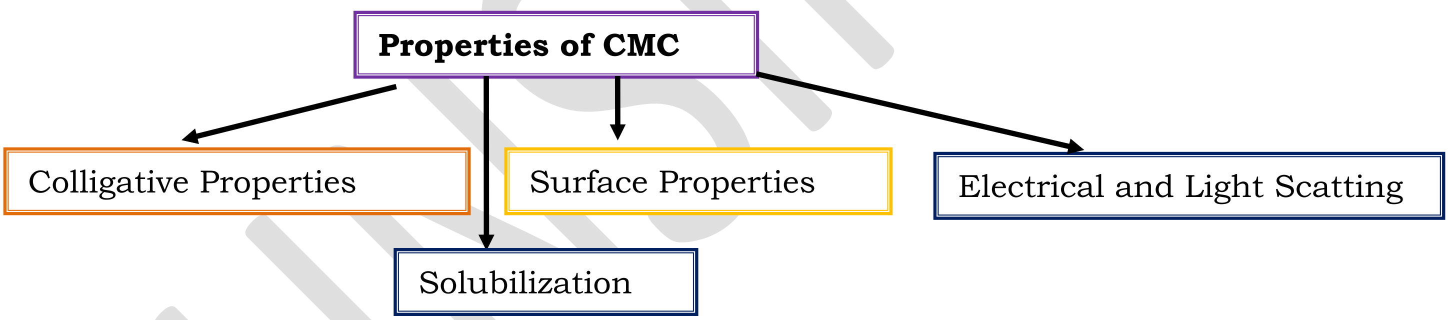
TOPIC: Classification of Surfactant?

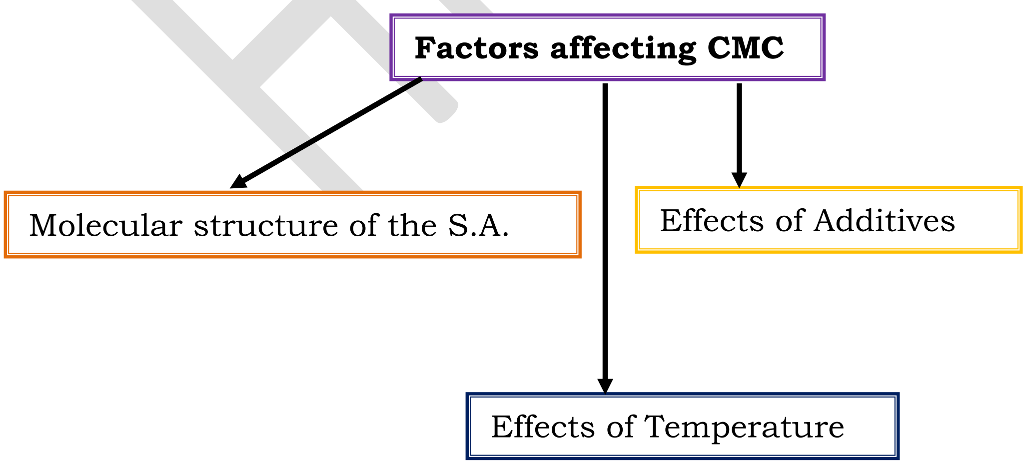
Ans:

CLASSIFICATION OF SURFACTANTS



The process of molecules aggregation begins at a certain characteristics concentration of the surfactant called the **critical micellar concentration**.





Detailing:

CLASSIFICATION OF SURFACTANTS

Anionic Surfactants

- It consists of the soaps of alkali, amine, and metals.
- On dissociation, the long chain anion of these surfactants imparts surface activity, while cation is inactive.
- Not suitable for internal use due to their unpleasant taste and irritant action on intestinal mucosa

Cationic surfactants

- In aqueous sol, it dissociates to form +ve cation which provide emulsify properties.
- Eg. Quaternary ammonium compounds such as cetrimide, benzalkonium chloride.
- Incompatible with anionic surfactants
- Unstable at high pH
- Use as antiseptic or disinfecting agent

Ampholytic Surfactants

- Here Ionic characteristics depend on the pH of the system.
- Eg. Lecithin, N-dodecyl alanine.

Nonionic Surfactants

- Most compatible among cationic and anionic surfactant.
- Resistance to change in pH.
- Low irritant as compare to both.
- It inactivates preservatives having phenolic or carboxylic groups when present in excess quantities.
- Eg. Glycerol, Glycerol esters, macrogol ester such as polyoxyl stearates
- The process of molecules aggregation begins at a certain characteristics concentration of the surfactant called the critical micellar concentration.
- In dilute sol, the micelles are approximate Spherical and of same size and any increase in the surfactant con. only increase the no. of micelles.

Properties of CMC

- **Colligative Properties** Association of monomeric surfactant molecules into micelles at the CMC caused a marked changed in no. of colligative units at or above CMC.
- Osmotic pressure, Boiling point, F.P of the sol show change at or above the CMC.

Surface Properties

- The initial adsorption of S.A. containing impurities at the surface cause lowering of the surface tension to greater degree than that given by the pure surfactant.
- At the CMC, impurity leaches out of the surface and is taken up by the micelle so that the surface tension rises the level of the pure surfactant.

Electrical Conductance

- Generally, molar conductivity of sol containing ionic S.A. decreases at the CMC due to greater retarding effect of the oppositely charged atmosphere of gegenions surrounding the micelles as compare to that experienced by simple ions.
- Reduction of net charge on micelles due to adherence of some oppositely charged gegenions.
- At high field strengths, the micelles move quite rapidly and oppositely charged ions cannot exert their effect.
- Molar conductivity then increases instead of decreasing.
- Due to inherent conducting power of micelles is greater than the conducting power of ions alone.

Solubility

- At low temperature, the solubility of S.A. increases slowly with increase in temperature.
- Beyond a particular temperature when enough material is present to allow the formation of micelles, solubility rapidly increases.
- The point at which occur is known as krafft point.

Light Scattering

- At CMC state colloidal dimension are being formed which cause greater scattering of light than simple molecules.
- This method allows the determination of aggregation no. and also provide information about shape of the micelle.

Solubilisation

- The property of S.A. to cause an increase in the solubility of organic compounds in aqueous systems is called solubilisation.
- Nonpolar material is dissolved in non-polar part of the micelle while polar material sugar & Glycerol get adsorbed at the micellar surface.
- An Amphiphatic compound by nonionic surfactants generally takes place by their orientation the long hydrophilic polyoxyethylene chains.

HNSIPER

One Word Question Answer

SR NO.	QUESTION	ANSWER
1	In aqueous sol, it dissociates to form +ve cation which provide emulsify properties	Cationic surfactant
2	cetrimide, benzalkonium chloride are example of surfactant?	Cationic
3	Which is used as antiseptic or disinfecting agent?	Cationic
4	Which ionic characteristics depend on the pH of the system?	Ampholytic
5	Osmotic pressure, Boiling point, F.P of the sol show change at or above the CMC.	Colligative properties
6	Which is provide information about shape of the micelle	Aggregation no of micelles
7	The property of S.A. to cause an increase in the solubility of organic compounds in aqueous systems is called?	Solubilization

HNSIPER

Factors Affecting CMC

Molecular structure of the S.A.

A. Hydrocarbon chain in the hydrophobic group
  a. Chain Length
  b. Branched hydrocarban chains
  c. Unsaturation

B. Hydrophilic Group

  a. Types of Hydrophilic Group
  b. No. of Hydrophilic groups
  c. Position of hydrophilic group

2. Effect of Additives

- Simple Electrolytes
- Other S.A.
- Alcohols
- Hydrocarbons

3. Effect of Temperature

- With nonionic surfactants, an increase in the temperature causes in the CMC as the Micellar size is increase.
- At certain temperature aqueous sol of many non-ionic surfactants become turbid. This characteristic temperature is called the cloud point.
- But this process is reversible

Application of CMC

Medicinal and Pharmaceutical

Medicinal Application

a. As antimicrobials:

- Quaternary ammonium compounds such as cetrimide shows useful antibacterial properties.
- So these are used as disinfectants for surgical instruments.
- Use in creams and throat lozenges.

b. As expectorants

- In acute and chronic infections the upper respiratory tract eg. Bronchial asthama, T.B.
- Inhalation of sprays or mists containing S.A. loosens the mucus and provides its easy removal and relief.

c. As cleansing Agents

- As surfactants have detergent properties, these are also employed as cleansing agents.
- However, their repeated use should be avoided since this may cause irritation to skin.

2. Pharmaceutical Application

a. As Solubilising Agents:

- S.A. have been extensively used as solubilizing agent for a no. of poorly soluble drugs eg. Vitamin A in the form of o/w emulsion. It resist to oxidation.
- It solubilise many disinfectant compounds such as cresol and chloroxylenol.

b. Wetting Agents:

- Hydrophobic powders are difficult to prepare.
- S.A. get adsorbed at s/l interface and increase the affinity of the hydrophobic powder for water while reducing the attractive forces between particles of the solid.
- Eg. Aerosol OT

c. As flocculating Agents

- Sulfamerazine being a hydrophobic powder can be dispersed by means of Aerosol OT but the particles tend to settle on standing and may eventually form a cake.
- However, if Aerosol OT is added in association with aluminium ions, controlled flocculation of the particle takes place.

d. As emulsifying agents

- Many synthetic and naturally occurring S.A. are widely used as emulsifying agent.
- These act by reducing the interfacial tension between the oil and water phase by forming a stable interfacial film between two.
- Eg. Tweens, Spans, natural acacia, tragacanth.

HNSIPER

One Word Question Answer

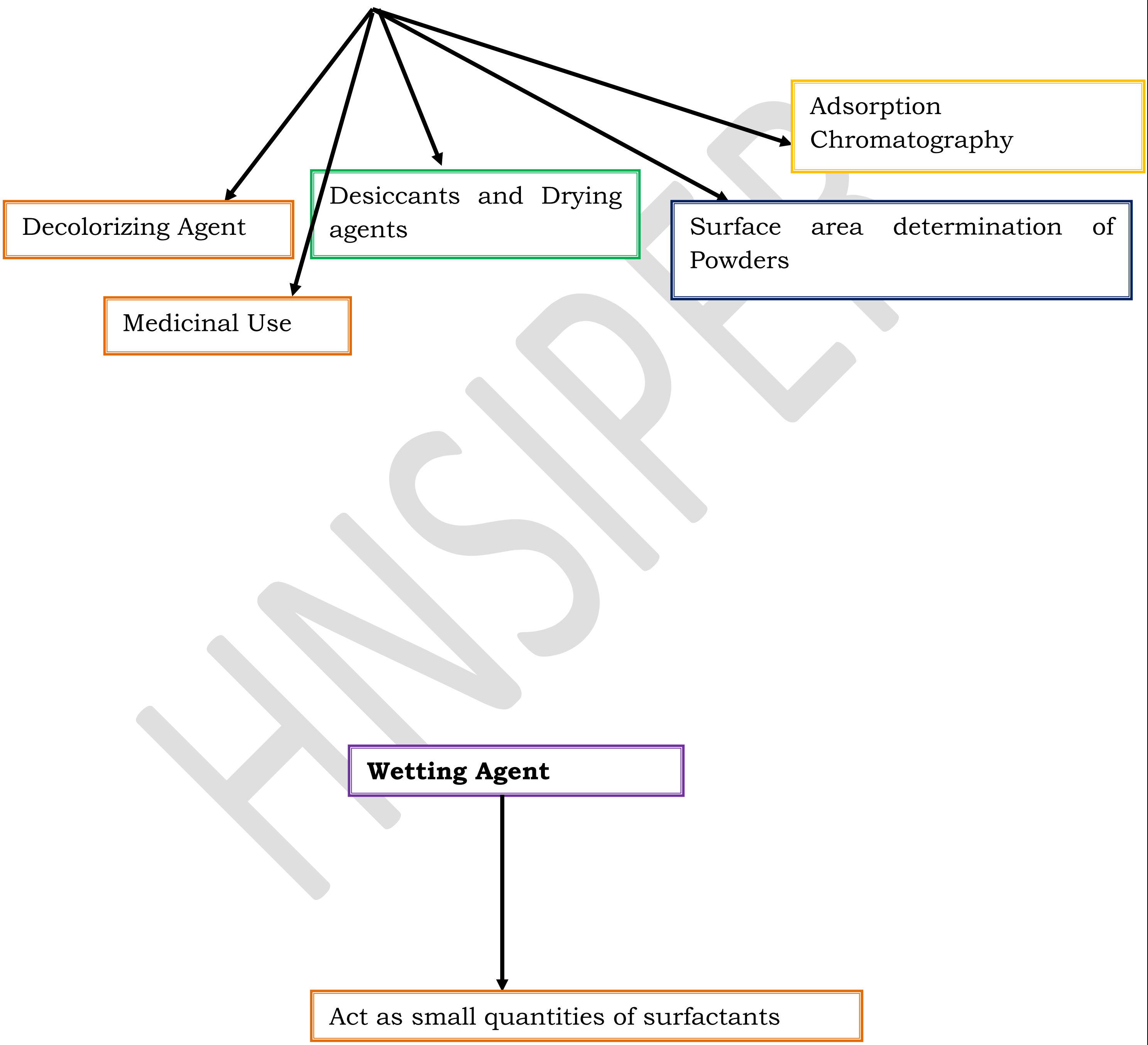
SR NO.	QUESTION	ANSWER
1	Which is used in creams and throat lozenges?	Cetrimide
2	Which is used in acute and chronic infections the upper respiratory tract?	Cationic surfactant
3	Vitamin A in the form of o/w emulsion. It resist to oxidation	Surfactants
4	S.A. get adsorbed at s/l interface and increase the affinity of the hydrophobic powder for water while reducing the attractive forces between particles of the solid.	Aerosol OT
5	Aerosol OT is used as?	Flocculating agent
6	Tweens, Span type surfactants is used as?	Emulsifying agent

HNSIPER

TOPIC: Factors Affecting Adsorption?

Ans:

ADSORPTION APPLICATION



HNSIPER

Detailing:

1. Decolorizing Agents

- Removal of colure of organic compound is usually undertaken by shaking with activated charcoal or animal charcoal.
- The impurities get adsorbed on the surface of charcoal and can be removed by filtration.
- Eg talc is used for clarification of aromatic waters.

2. Desiccants and Drying agents

- Traces of water from organic liquids can be removed by shaking with an adsorbent such as alumina or silica gel.
- It provides a dry atmosphere inside the containers of pharmaceutical solid products and protect them from high humidity.

3. Surface area determination of Powders

- It can be undertaken by adsorption of gases or solutes on the surface of the powder.
- It influences many properties of powders such as flow properties, bulk density & Dissolution Rate.
- So It provides a valuable indication of these properties of powder.

4. Adsorption Chromatography

- A sol containing the different solutes to be separated passed through a stationary column of adsorbent.
- The solute with greater affinity for adsorbent is strongly bound & moves slowly through the column as compare to a solute that as less affinity and which elutes first from solution.

5. Medicinal Use

- Charcoal & Kaolin are used orally to remove toxic materials from GIT an also used as antidote for poisoning like alkaloid.
- Kaolin poultices is used externally for dressing boils, and ulcers. It also used as dusting powders.

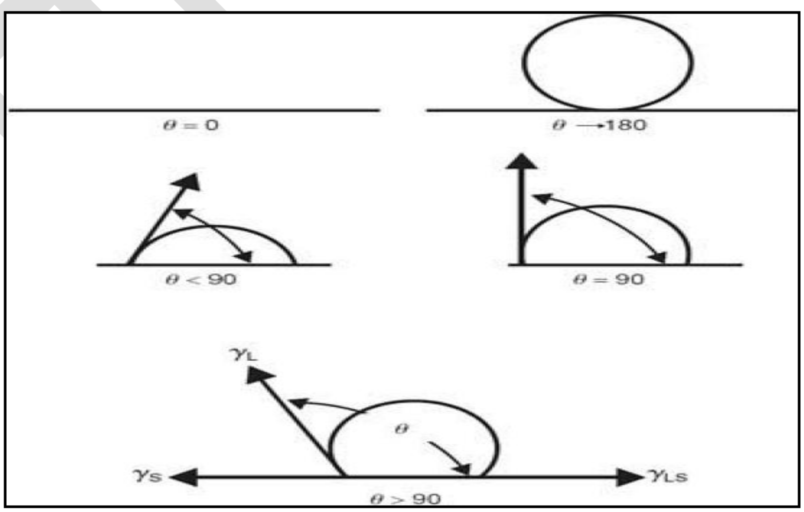
Other Application

- Activated Charcoal has been used for the removal of pyrogens from injectable fluids.
- Protective Colloids
- Emulsifying agent at the oil/water interface.
- Excipients act as adsorbent which may affect the rate of drug release.

HNSIPER

WETTING AGENT

- A wetting agent is generally a S.A. when dissolved in water, lowers the contact angle between the sol and solid surface.
- Wetting Agent adsorbed at air/liquid interface reducing both the surface tension of liquid and interfacial tension between the solid & liquid.
- Eg. Dispersion of Hydrophobic drugs like prednisolon with the aid of Tween 80 during tablet granulation to aid in the wetting.
- Adsorption at solid surfaces is involved in the phenomena of wetting and detergency.
- When a liquid comes into contact with the solid, the forces of attraction between the liquid and the solid phases begin to play a significant role.
- In this case, the behavior of the liquid will depend on the balance between the forces of attraction of molecules in the liquid and the forces of attraction between the liquid and the solid phases.
- In the case of mercury and glass, attractive forces between molecules of mercury and glass are much smaller than the forces of attraction between molecules of mercury themselves.
- As a result, mercury will come together as a single spherical drop.
- In contrast, for water and glass (or mercury and zinc), attractive forces between the solid and liquid molecules are greater than the forces between molecules of liquid themselves, and so the liquid is able to wet the surface of the glass.
- The contact angle is the angle between a liquid droplet and the surface over which it spreads.
- the contact angle between a liquid and a solid may be 0° signifying complete wetting, or may approach 180°, at which wetting is insignificant.



One Word Question Answer

SR NO.	QUESTION	ANSWER
1	Which is used for clarification of aromatic waters?	Talc
2	Which provides a dry atmosphere inside the containers of pharmaceutical solid products?	Desiccants
3	Which properties of powders such as flow properties, bulk density, & Dissolution Rate?	Surface area Property
4	Which is used externally for dressing boils, and ulcers.	Kaolin poultices
5	Which are used orally to remove toxic materials from GIT an also used as antidote for poisoning like alkaloid?	Kaolin, Charcoal
6	Which has been used for the removal of pyrogens from inject able fluids.	Activated Charcoal
7	Which is washing of wounds in order to remove dirt and debris.	Wetting Agent
8	The surfactants gets adsorbed on the particle surface create charge which prevent deposition of dirt again on the solid surface.	Wetting agent
9	The angle between a liquid droplet and the surface over which it spreads?	Contact Angle

Application of Wetting

- The Displacement Of Air From The Surface Of Sulfur, Charcoal, And Other Powders For The Purpose Of Dispersing These Drugs In Liquid Vehicles;

HNSIPER

- The Displacement Of Air From The Matrix Of Cotton Pads And Bandages So That Medicinal Solutions Can Be Absorbed For Application To Various Body Areas;
- The Displacement Of Dirt And Debris By The Use Of Detergents In The Washing Of Wounds;
- The Application Of Medicinal Lotions And Sprays To The Surface Of The Skin And Mucous Membranes.
- Wettability Of Tablet Surfaces Influences Disintegration And Dissolution And The Subsequent Release Of The Active Ingredient(S) From The Tablet.
- The Influence Of Tablet Binders On Wettability Of Acetaminophen Tablets

HNSIPER