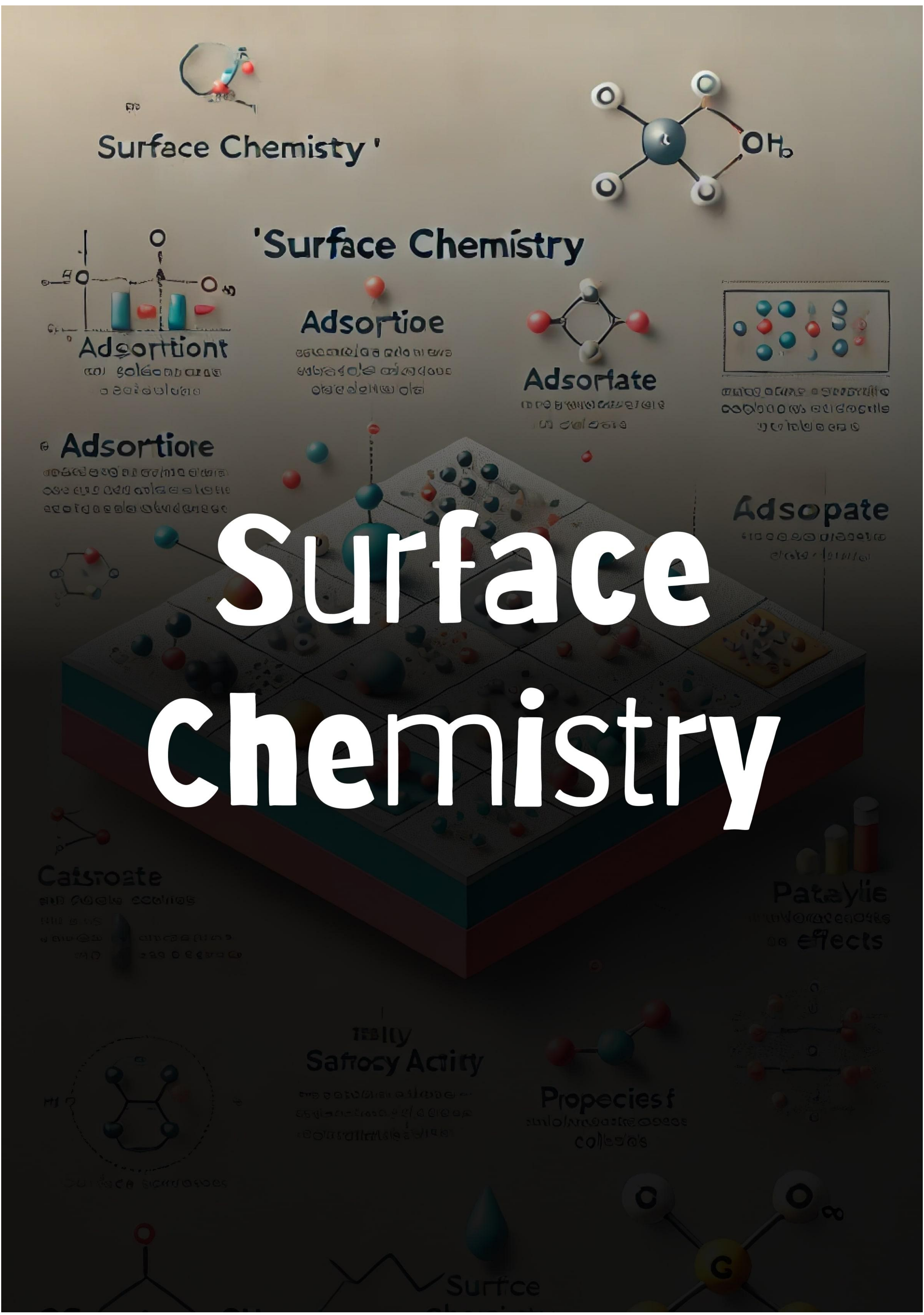
Surface Chemistry



SURFACE CHEMISTRY

It is a branch of chemistry which deals with study of phenomena occuring at surface or interface i.e, at the boundary separating two bulk faces.

In this chapter, we will focus on 3 topics :-

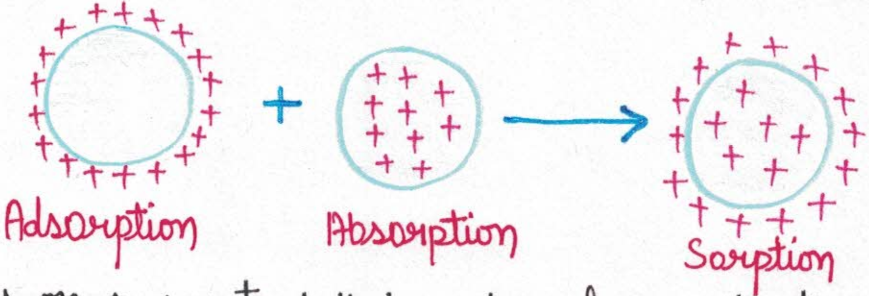
1. ADSORPTION

The phenomena of attracting and retaining the molecules of a substance on the surface of a liquid or the solid resulting into a higher conc^n of molecules on the surface is called adsorption.

The substance on the surface of which adsorption occurs is known as "adsorbent".

The substance that gets absorbed on the solid surface due to inter-molecular attraction are called "adsorbate".

Charcoal, silica, gel, alumina gel are good adsorbents because they have highly porus structures and have large surface area.



Colloids on a count of their extremly small dimensions possess enormous surface area per unit mass. Therefore are good absorbent.

Adsorption, Absorption & Sorption Diagram drawn above.

DIFFERENCE B/W ADSORPTION & ABSORPTION

	ADSORPTION	ABSORPTION
1.	A phenomena in which there is higher conc^n of another substance on the surface than in the bulk.	It is a phenomena in which the molecules of a substance are uniformly distributed throughout the body of other substance.
2.	E.g. when silica gel is placed in the environment of water it adsorbes the water vapour.	E.g. when $CaCl_2$ is placed in the environment of waters, it absorbs water vapour.
3.	It is a phenomena of higher conc^n of gas or liquid on the surface than in the bulk of the substance.	It is phenomena in which particles of gas or liquid get uniformly distributed through out the bulk of solid.
4.	It conc^n on surface is different from that in bulk. Hence it is surface phenomena.	The concentration is same through-out the material. Hence it is bulk phenomena.
5.	It is rapid in beginning and its rate slowly decreases.	It occurs at uniform rate.

THERMODYNAMICS OF ADSORPTION

It is exothermic process. so $\Delta H < 0$. when a gas is adsorbe the entropy of gas will decrease, $\Delta S < 0$.

So, as $\Delta G = \Delta H - T\Delta S$

at high temp, $\Delta G > 0 \longrightarrow$ non spontaneous

at low temp, $\Delta G < 0 \longrightarrow$ spontaneous

Hence, at low temperature, adsorption will be spontaneous.

TYPES OF ADSORPTION

It is of two types –

1. PHYSICAL ADSORPTION (PHYSISORPTION

When a particle of absorbate are held on the surface of adsorbents by physical forces such as vander waal forces, it is called physical adsorption.

CHEMICAL ADSORPTION (CHEMISORPTION

When the molecule of adsorbate are held on the surface of adsorbent by chemical forces (chemical bonding), it is called chemical adsorption.

	PHYSICAL	CHEMICAL
1.	The force b/w adsorbate molecules & adsorbent are weak van der waal forces.	The force b/w adsorbate molecules and adsorbent are strong chemical
2.	Low heat of adsorption of the order (20-40) KJ mol^{-1}	High heat of adsorption of the order (200-400) KJ mol^{-1}
3.	Usually occurs at low temperature and decreases with increasing temperature.	Usually occurs at high temperatures.
4.	It is reversible process.	It is irreversible process.
5.	The extent of adsorption depends upon the ease of liquification of the gas.	There is no co-relations b/w extent of adsorption & ease of liquification of gas.
6.	It is less specific in nature. All gases are adsorbed on the surface of a solid.	It is highly specific in natures and occurs only when there is bond formation b/w adsorbent & adsorbate molecules.
7.	It forms multi molecular layers.	It will form mono molecular layer.
	Extent of adsorption (x/m) increases with pressure.	Extent of adsorption (x/m) also increases with pressure.

ADSORPTION OF GASES ON SOLIDS

The extent of adsorption of gas on solid surface is affected by following factors :-

1. NATURE OF GAS (ADSORBATE)

- The easily liquifiable such as HCL, NH_3 Cl_2 are absorbed more than permanent gases such as H_2, N_2, O_2 liquification of gas is possible below or at critical temperature for any gas.

If we have more gases to adsorb then the gas having high critical temperature will adsorb easily.

E.g.-

GAS	CRITICAL TEMP.
SO_2	330 K
CH_4	190 K
H_2	33 K

Adsorption order :- $SO_2 > CH_4 > H_2$

2. ACTIVATION OF ADSORBENT

a. Metallic adsorbents are activated by mechanical rubbing or by subjecting it to some chemical reactions.

b. To increase the adsorbing power of adsorbents, they are sub divided into small pieces. As a result the surface area will increase and adsorption power of adsorbent will increase.

3. NATURE OF ADSORBENT

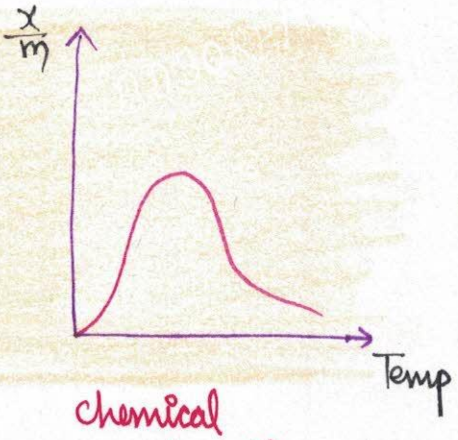
- The extent of adsorption of gas depends upon the nature of adsorbent. Activated charcoal, metal oxides & clay can adsorb gases which are easily liquified. Gases such as H_2, N_2, O_2 are generally adsorbed on finely divided transition metal Nickel and cobalt

↓

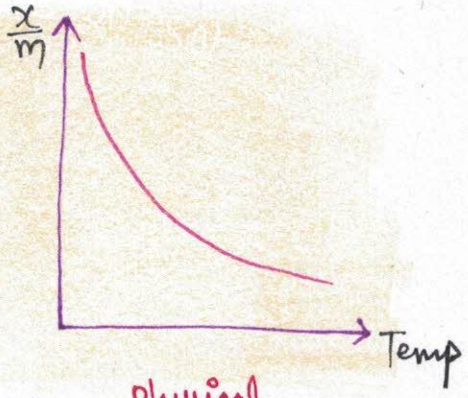
more favoured

EFFECT OF TEMPERATURE

x/m = Extent of adsorption



chemical adsorption

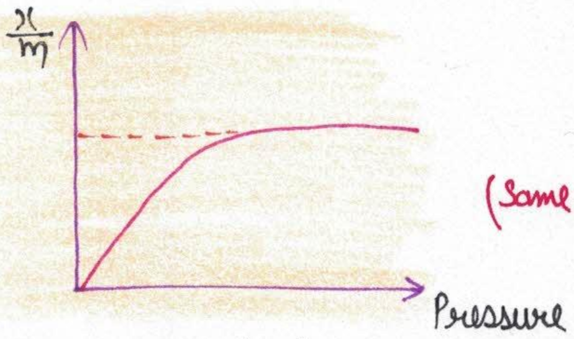


Physical adsorption

$\frac{x}{m}$ = Extent of adsorption

where x = amt. of adsorption (moles)
m = mass of adsorbent

5. EFFECT OF PRESSURE



(Same for both)

At high pressure ⟶ constant
At Low pressure ⟶ increase linearly

This adsorption is occuring at constant temp. This can be explained by "Freundlich & Langmuir Adsorption Isotherm"!

Freundlich Adsorption Isotherm

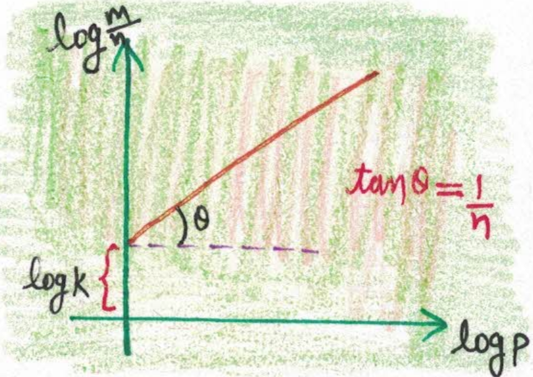
The variation of extent of adsorption with pressure was given by freundlich. At low pressure, the graph is almost straight line which indicates $\frac{x}{m}$ is directly proportional to pressure $(\frac{x}{m} = Kp)$

At high pressure, graph is almost constant, so $\frac{x}{m}$ is constant. $(\frac{x}{m} = K)$

In Intermediate range of pressure, $\frac{x}{m}$ will depend upon the power of pressure which is fractional (n: 0 to 1)

$\frac{x}{m} = Kp^{1/n}$ At Low pressure, $n = 1$ $\frac{x}{m} = pK$
At high pressure, $n = \infty$ $\frac{x}{m} = K$

$$\log \frac{x}{m} = \log k + \frac{1}{n} \log P$$



one of the drawbacks of Freundlich Isotherm is that it fails at high pressure of gas.

This equation is applicable only when adsorbate's surface form unimolecular layer on adsorbent. Hence it is valid only in case of chemical adsorption.

Langmuir Adsorption Theorem

It is based on kinetic theory of gas that every adsorption site is equivalent. The ability of particles to bind there at any site is independent of whether or not nearly sites are occupied.

The mathematical representation is given by :-

$$\frac{x}{m} = \frac{aP}{1+bP}$$

At high pressure, $\frac{x}{m} = \frac{aP}{bP} = \frac{a}{b}$

At Low pressure, $\frac{x}{m} = aP$

CATALYST

The substance which alters the rate of chemical reaction and themselves remain chemically & quantitatevely unchanged after the reaction are called catalyst.

Homogeneous Catalysis

:- when catalyst and reactants are in same phase, it is called Homogeneous catalyst.

E.g. $2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3(g)$

$CH_3COOCH_3(aq) \xrightarrow{HCl\ (aq)} CH_3COOH\ (aq)$

$C_{12}H_{22}O_{11}\ (aq) + H_2O\ (aq) \xrightarrow{H_2SO_4(aq)} \underset{(glucose)}{C_6H_{12}O_6\ (aq)} + \underset{(fructose)}{C_6H_{12}O_6(aq)}$

All solids are in different phase.

All liquids are in different phase.

All gases & aq. are in same phase.

Hetrogeneous Catalysis

:- when catalyst and reactants have two or more than two phase.

E.g.

$2SO_2(g) + O_2(g) \xrightarrow{Pt(s)} 2SO_3(g)$

$N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$

$4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)} 4NO(g) + 6H_2O(g)$

$\text{Vegetable oil}(s) + H_2(g) \xrightarrow{Ni(s)} \text{Vegetable ghee}(s)$

We can classify catalysis into :-

POSITIVE CATALYSIS

- Substance which increases the rate of chemical reaction is called positive catalyst and the process is called Positive catalysis.

E.g.

$2SO_2(g) + O_2(g) \xrightarrow{Pt(s)} 2SO_3(g)$

$N_2(g) \quad 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$

NEGATIVE CATALYSIS

- substance which decreases the rate of chemical reaction is called negative catalyst and the process is called Negative catalysis.

E.g.

$2H_2O_2 \xrightarrow{H_3PO_4 / \text{glycerol}} 2H_2O + O_2$

$CHCl_3 + \frac{1}{2}O_2 \xrightarrow[\text{alchol}]{\text{ethyle}} COCl_2 + HCL$

Tetra ethyle Lead (TEL) in petrol (knocking is reduced)

$2H_2SO_3 + O_2 \xrightarrow{\text{Phenol}} 2H_2SO_4$

$2C_6H_5CHO + O_2 \xrightarrow{\text{quinol}} 2C_6H_5COOH$

AUTO CATALYSIS

- when one of the reaction product behaves as catalyst for the reaction and increases the rate of reaction is called auto catalyst and the process is called auto catalysis.

E.g.

$CH_3COOC_2H_5 + H_2O \longrightarrow \underbrace{CH_3COOH} + C_2H_5OH$

$2KMnO_4 + 5\begin{matrix}COOH\\|\\COOH\end{matrix} + 3H_2SO_4 \longrightarrow K_2SO_4 + \underbrace{MnSO_4} + PH_2O + 10CO_2$

$2AsH_3 \longrightarrow \underbrace{2AS} + 3H_2$

$Co + 3HNO_3 \longrightarrow Co(NO_3)_2 + \underbrace{HNO_2} + H_2O$

All the underlined products act as auto catalysts.

INDUCED CATALYSIS :-

– when one reaction catalyses an other reaction. the phenomena's is called **induced catalysis** and the reaction is called **induced catalyst.**

1. $Na_2SO_3 + O_2 \longrightarrow Na_2SO_4$ ⟶ induced catalyst (reaction)

   $Na_3AsO_3 + O_2 \longrightarrow Na_3AsO_4$

In case 1., Na_2SO_3 is oxidised to Na_2SO_4 but sodium arsenate Na_3AsO_3 does not oxidise to Na_3AsO_4 in air when both are kept together, Both are oxidised in air.

2. The reduction of $HgCl_2$ to Hg_2Cl_2 by oxalic acid is very slow while that of $KMnO_4$ is fast but mixture of $HgCl_2$ & $KMnO_4$ is fast but mixture of $HgCl_2$ & $KMnO_4$ is reduced rapidly by oxalic acid.

$$HgCl_2 \rightarrow Hg_2Cl_2 \text{ (in oxalic acid)} \longrightarrow \text{slow}$$

$$\left.\begin{array}{l} KMnO_4 \rightarrow Mn^{+2} \\ HgCl_2 \rightarrow Hg_2Cl_2 \end{array}\right\} \text{in oxalic acid} \longrightarrow \text{fast}$$

Reduction of $KMnO_4$ ⟶ induced catalyst

PROMOTERS OR ACTIVATORS

substance which themselves are not catalyst but it presence can increase the catalytic activity of catalyst. A promoter increase the no. of active sites on the surface of catalyst.

E.g.

$$N_{2(g)} + 3H_{2(g)} \underset{Mo\ (promoter)}{\overset{Fe\ (catalyst)}{\rightleftharpoons}} 2NH_{3(g)}$$

$$\text{Vegitable} + H_2 \xrightarrow[Cu\ (promoter)]{Ni\ (catalyst)} \text{Vegetable ghee}$$

$$CO + 2H_2 \xrightarrow[Cr_2O_3\ (promoter)]{ZnO\ (catalyst)} CH_3OH$$

CATALYTIC POISON / ANTI CATALYST / CATALYST INHIBITORS

substance which themselves are not catalyst but whose presence will decrease the activity of catalyst.

E.g.

$$N_2 + 3H_2 \xrightarrow[Co/H_2S]{Fe\ (catalyst)} 2NH_3$$

$$2SO_2 + O_2 \xrightarrow[As_2S_3]{Pt} 2SO_3$$

$$2RCOCl + H_2 \xrightarrow[BaSO_4]{Pt} RCHO + HCl$$

$$C_2H_4 + H_2 \xrightarrow[Ag\ vapour]{Ni} C_2H_6$$

$$2H_2O_2 \xrightarrow[HCN]{colloidal\ Pt} 2H_2O + \tfrac{1}{2}O_2$$

CHARACTERISTIC OF CATALYSTS

1. A catalyst remains unchanged in mass and chemical compositions at the end of reactions. Its physical state may be changed.
2. Finelly divided state of catalyst is more efficient for the reactions because surface area will increase and more adorption will take place.
3. A small amt. of catalyst is generally sufficient to catalyse almost unlimited reaction. but in some cases the rate of reaction will depend on amt. of catalyst.

   E.g:- • In friedal craft reactions more amt. of catalyst ($AlCl_3$) is required.
   • In Hydrolysis of ester in acidic and alkaline medium rate of reaction depend on concn of $[H^+]$ and $[OH^-]$.
4. A Catalyst cannot initiate reaction but sometimes the activation energy is so large that practically a reaction may not start untill a catalyst lowers the activation energy significantly.

   E.g:- $H_2 + O_2 \xrightarrow[\text{temp.}]{\text{room}}$ no reaction

   $H_2 + O_2 \xrightarrow{\text{Pt (black)}} H_2O$
5. Catalysts are generally specific in nature. A substance which act as catalysts in a particular reaction fails to catalyse other reactions.
6. Catalyst cannot change equilibrium state but it helps to attain equilibrium state but it helps to attain equilibrium quickly.
7. A catalyst doesnot change the enthalpy, entropy free energy of the reaction
8. **Optimum temperature** - There is a particular temp at which the efficiency of a catalyst will be that temp, is called optimum temperature.

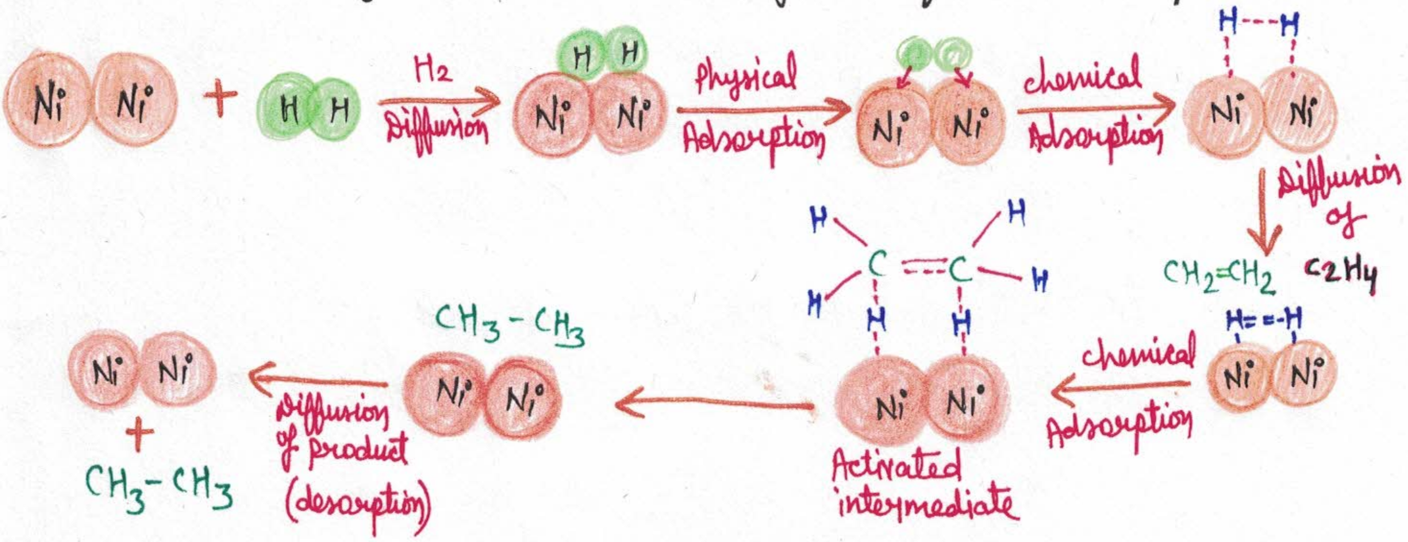
ADSORPTION THEORY OF CATALYSIS

This theory explains the mechanism of heterogeneous catalyst. It is combination of two theories :-

a. Intermediate compound formation theory
b. Old adsorption theory

The catalytic activity is localised on surface of catalyst. The mechanism involves five steps :-

(i) Diffusion of reactant on surface of catalyst.
(ii) Adsorption of reactant on surface of catalyst.
(iii) Formation of activated complex or intermediate.
(iv) Formation of reaction product on catalyst's surface.
(v) Diffusion of product from catalyst surface or desorption.



HYDROGENATION PROCESS

COLLOIDS

Particle size	$>10^{-5}$ cm or 10^{3} A° or 100 cm	10^{-7} to 10^{-5} cm or 10 A° to 10^{4} A° or 1 mu to 100 mu	$<10^{-7}$ cm or 10 A° or 1 mu
Visibility	visible with naked eye	Images are visible under ultra microscope	Not Visible

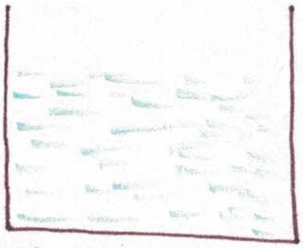
PROPERTY	SUSPENSION	COLLOID	SOLUTION
Seperation			
a. with filter paper	Possible	Not Possible	Not Possible
b. with member one	Possible	Possible	Not Possible
Diffusion	Does not diffuse	Diffuse very slowly	Diffuses readly
Setting or sedimentation	settles under influence of gravity	settle under centrifuge	Does not settle
Nature	Hetrogeneous	Heterogeneous	Heterogeneous
Apperance	opaque	Turbid	clear

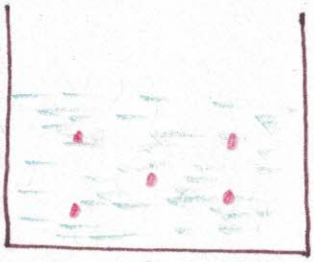
Internal phase or dispersed phase	External phase or dispersion medium	Colloids Name	Exaple.
Solid goldsol ⇒ water = PM Gold = AP	Solid	solid solution	alloys, ruby glass, gems process stones
	Liquid	sol.	muddy water, gold, sol, points
	Gas	Aerosols	smoke, dust silicon, col. alumi. gel.
Liquid	Solid	Gel	
	liquid	emulsion	milk, creams
	Gas	Aerosols	fog
Gas	solid	solid foam	Pumice stons foam formed rubber.
	Liquid	Foam or Froth	Froth, seapsuds, whipped cream.
	Gas	Homogeneous system	Do not exist as colloids

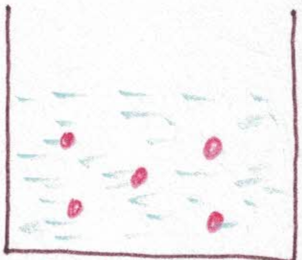
LYOPHILIC & LYOPHOBIC SOLUTIONS

PROPERTY	LYOPHILIC SOL^n	LYOPHOBIC SOL^n
Nature	Dispersed phase has more affinity for dispersion medium.	Less affinity for dispersion medium.
Preparation	Need no special methods Add material in solvent gives sol. e.g adding starch in water gives starch sol.	Simple mixing does not produce sol.^{n} special methods required (dispersion or condensation)
Conc^n	Sol^n have higher conc^n of dispressed phase.	Have Lower conc^n
Stability	Thermodyn-amically more stable.	Less stable coagulate with time.
Solvation	Dispersed phase particles are highly solvated.	Not Solvated
Viscosity	Viscosity of sols are often higher than viscosity of dispersion medium.	Almost same
Surface tension	S.T of sols are much lesser than S.T of dispersion medium.	Almost same
Reversibility	Reversible with temp.	Irreversible
charge	charge on dispersed phase particles depends upon pH of medium.	Independent of pH of medium

PROPERTY	LYOPHILIC SOL^n	LYOPHOBIC SOL^n
Tyndall Effect	Less scattering of Light	More scattering of Light
Coagulation or electro-Lytes	Very high conc^n of salt is required for phase separation.	A small amt. of salt is required for coagulation.


True Solution


Colloidal solution


Suspension

In colloidal solution, particle size is (10A° to 1000A°). All colloidal solution are heterogeneous.

COLLOIDAL SOLUTION

In colloidal sol^n, there will be a dispersion phase (solute) and a dispersion medium (solvent) and the sol^n will be heterogeneous.

Condensation Method :-

Condensation (aggregation of particles) can be done by two methods.

a. Physical

b. chemical

Physical Method for condensation

1. By exchange of solvents
2. By excessive cooling

1. **By exchange of solvents** - A true sol^n of a solute in a solvent when mixed with another liquid, colloidal system will be produced.

E.g:- sulpher is molecularly dissolved in alcohal. An addition of excess of water to this sol^n produces colloidal sol^n of sulpher in water.

2. **By excessive cooling** - Colloidal sol^n of ice in organic solvents like ether, chloroform by freezing a mixture of solvent and water.

Chemical methods :-

A sol can be prepared by hydrolysis, reduction, oxidation, double decomposition.

HYDROLYSIS

- Aqueous sol^n of $FeCl_3$ is boiling with water, it will form $Fe(OH)_3$ sol.

$$FeCl_3 + 3H_2O \longrightarrow \underset{(sol)}{Fe(OH)_3} + 3HCL$$

REDUCTION

- Gald sol can be prepared by reducing gald solution.

$$2AuCl_3 + 3HCHO + 3H_2O \longrightarrow \underset{(sol)}{2Au} + 3HCOOH + 6HCL$$

$$4AuCl_3 + 3NH_2 - NH_2 \longrightarrow 4Au + 3N_2 + 12HCL$$

$$2AuCl_3 + 3SnCl_2 \longrightarrow 2Au + 3SnCl_4$$

Sol → solid in Liquid

solid ↓ solute

Liquid ↓ solvent

OXIDATION

- Sulphur sol are obtained by this method.

$$H_2S + Br_2 \longrightarrow 2HBr + S$$

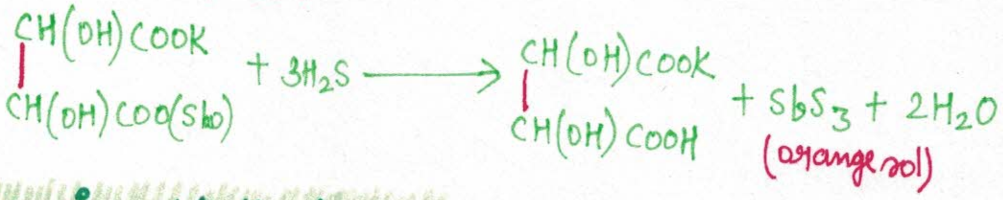
$$H_2S + 2HNO_3 \longrightarrow 2H_2O + 2NO_2 + S$$

$$Na_2S_2O_3 + 2HCL \longrightarrow 2NaCL + SO_2 + H_2O + \underset{(Sol)}{S}$$

DOUBLE DECOMPOSITION

- when a hot, aqueous dilute sol. of arsenous oxide (As_2O_3) is mixed with a saturated sol^n of H_2S in water, a colloidal sole of As_2S_3 will be obtained.

E.g - $$\underset{(hot\ water)}{As_2O_3} + \underset{(saturated\ sol^n\ in\ H_2O)}{3H_2S} \longrightarrow \underset{(sol)}{As_2S_3} + 3H_2O$$



$$\begin{array}{l} CH(OH)COOK \\ | \\ CH(OH)COO(SbO) \end{array} + 3H_2S \longrightarrow \begin{array}{l} CH(OH)COOK \\ | \\ CH(OH)COOH \end{array} + \underset{(orange\ sol)}{SbS_3} + 2H_2O$$

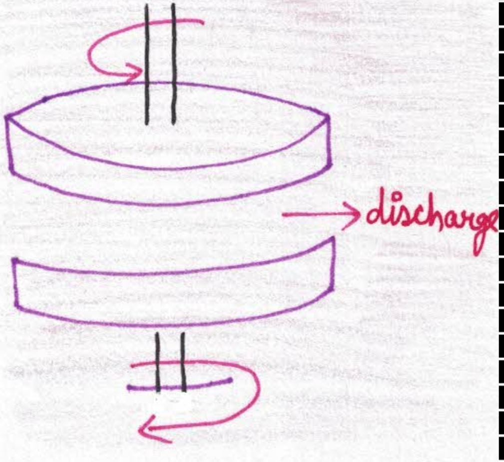
3. Dispersion Method:-

In this method, large particles of the substance are broken into particles of colloidal dimensions in presence of dispersion medium, these are stabilised by adding some suitable stabiliser.

(i) Mechanical Dispersion (By colloidal mill)

- Colloidal mill consists of two discs rotating in opposite direction and discharge will consist of particle size belonging to colloidal size.

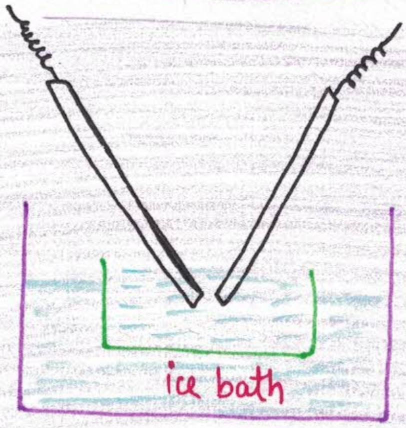
E.g. - This method is used to prepare printing ink.



(ii) Electrical Disintegration

A. Briding's Arc method

- This process involves dispersion as well as condension. colloidal sols of less reactive metals such as Au, Ag, Pt, Cu, Pb can be prepared by the method.



In this method, electric arc is generated b/w electrods of metal immersed in dispersion medium. The intense heat produced vapourises the metal which then condenses to form particle of colloidal size, by surrounding cooling mixtures (ice).

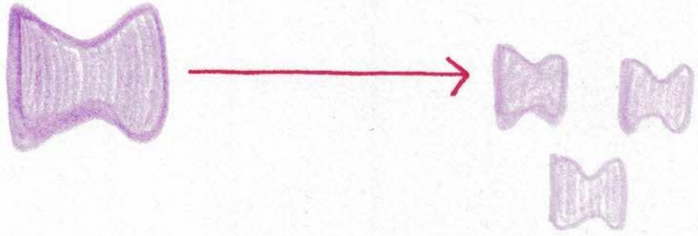
A slight trace of KOH is added in water to stabilise colloidal sol^n.

B. Ultrasonic Dispersion

- ultrasonic vibration (frequency larger than audible range) can bring about the transformation of suspension or liquids like mercury, oil etc into colloidal range. This is the latest method to produce metal oxides & metal sulphides sols from their suspension.

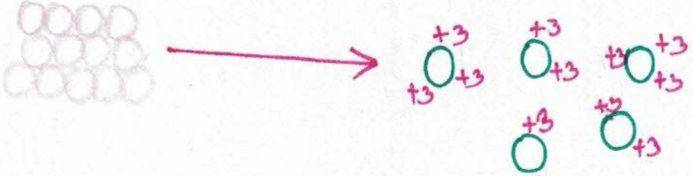
C. Peptization

- The term originates from digestion of proteins by the enzymes. Peptization may be defined as the process of converting a precipitate into colloidal sols by shaking it with dispersion medium in presence of small amt. of electrolyte. electrolyte used for this purpose is called "Peptizing agent." This method is applied generally to convert a freshly prepared precipitate into colloidal sols. During peptization, the precipitate adsorbs one of the ions of electrolyte on its surface. This ion may be anion or cation of the electrolyte.



Reverse of peptization ⟶ Coagulation

E.g. 1. When freshly prepared $Fe(OH)_3$ is shaken with aq. solⁿ of $FeCl_3$ (peptizing-agent), it adsorbs Fe^{+3} ions and breaks into small particles.



$FeCl_3 \longrightarrow Fe^{+3} + 3Cl^-$

2. Freshly prepared stannic oxide on treatment with a small amt. of dilute HCL solⁿ forms a stable colloidal sol. of stannic oxide.

$SnO_2 + 4HCL \longrightarrow Sn^{4+} + H_2O + 4Cl^-$

Sn^{+4} starts adsorbing on the surface of SnO_2. This sol is also positive.

3. Freshly prepared AgCl can be converted into a colloidal sol by adding a small amt. of HCL.

Cl^- will start adsorbing on surface of AgCl
This sol is negatively charged.

4. Cadmium sulphide can be peptized with the help of H_2S.

Purification of colloidal sols

The purification of colloidal sols is done by a semi permeable membrane & the process is called dialysis.

It is a process of removing a dissolved substance from a colloidal solution by means of diffusion through suitable membrance or parchment paper but colloidal particles do not. The apparatus used for this purpose is called Dialyser. A bag of suitable membrane containing colloidal solⁿ in suspended in a vessel through which fresh water continuously flows. The molecules and ions diffuse through membrane into the outer water and pure colloidal solⁿ is left behind. Movement of ions across the membrane can be

increased by applying some potential. This is called electro Dialysis.
The most important application of dialysis is in the purification of blood in artificial kidney machine.

Dialysis is not applicable for non electrolytes like Glucose sugar.

Vetra Filtration - In this method, colloidal sols are purified by carrying out filtration through special type of grated filters called ultra filters. These filter papers allow only the electrolytes to pass through. These filter papers are made of particular pore size by imprignation with colloidal solⁿ and hardened by soaking in formaldehyde.

Vetra centrifugation - The colloidal solⁿ is taken in a tube which is placed in an ultra centrifuge. on rotation of the tube at high speed, the colloidal particles settle down at the bottom of the tube and impurities remain in the solⁿ.

IMPORTANT PROPERTIES OF COLLOIDAL SOLUTION

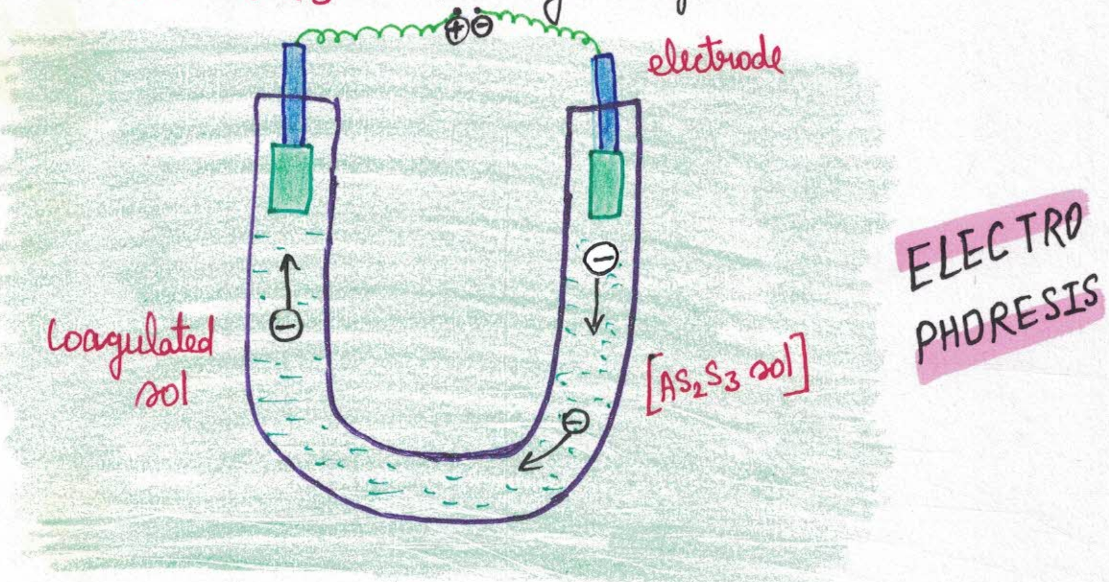
Brownian movement - colloidal particles move continuously and randomly in its solution. The particles were seen to be in constant zig zag motion seen under an ultra microscope. This motion is called Brownian motion factors affecting Brownian movement.

a. If particle is large, then brownian movement will be less.
b. It will increase on ↑ temperature.
c. It does not change with time, it remains same for month or even a year.

Brownian movement will confirm kinetic energy of colloidal particles and Brownian movement does not allow colloidal particles to settle down under gravity,
Thus it is responsible for stability of colloidal solⁿ.

Electricity Properties (Electrophoresis

- The particles of colloidal sol^n are electrically charged, carry either (+ve) or (-ve) charge. The dispersion medium has an equal and opposite charge making the system neutral. Due to similar nature of charge carried by particles they repel each other and do not combine to form bigger particles. That is why a sol is stable & particles do not settle down. Arsenic trisulfide (As_2S_3), gold, silver and Pt particles in their respective colloidal sols are negatively charged while particles of $Fe(OH)_3$, $Al(OH)_3$ are (+)ve by charged.



Charge on colloidal Particles

- colloidal particles are either positively charged or negatively charged. This charge is due to preferential adsorption of either (+)ve or (-)ve ions on their surface.

E.g. In $Fe(OH)_3$, Fe^{+3} is adsorbed ⟶ +ve charge

In $AgCl$, Cl^- is adsorbed ⟶ -ve charge

In AgI, both Ag^+ & I^- ⟶ +ve/-ve charge

Electric double Layer

- The surface of colloid particles acquire a (+)ve or (-)ve charge by preferential adsorption of common ion, either (+)ve or (-)ve charge respectively to form first layer. This Layer attract counter ions from dispersion of two layers of opposite charge around the colloidal particles is called Helmholtz electrical double Layer.

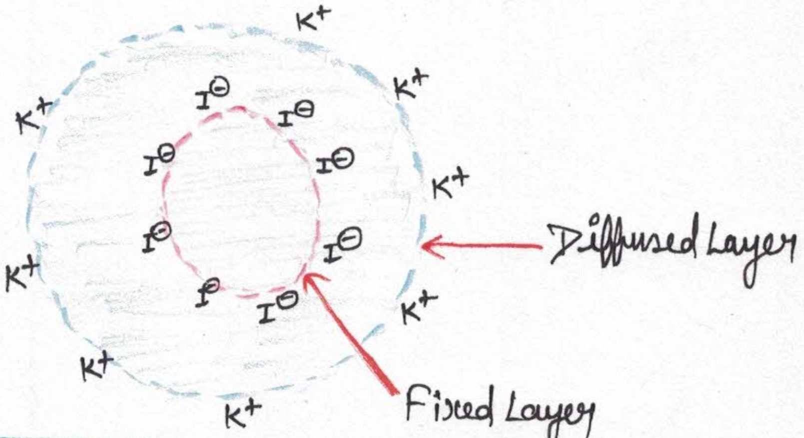
The first layer of ion is firmly held and is termed as fixed layer while the second layer is mobile which is termed as diffused layer. The charge of fixed and diffused layer results results in a difference of potential b/w two oppositely charged Layers is called electro Kinetic Potential or Zeta Potential.

$$Z = \frac{4\pi\eta u}{D}$$

η = coefficient of viscosity

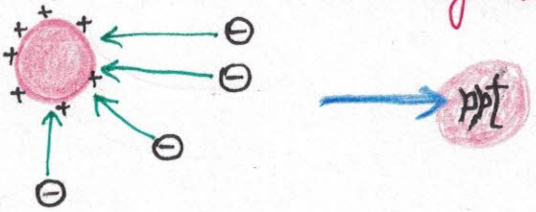
D = dielectric constant of medium

u = velocity of colloidal particles when an electric field is applied.



Coagulation / Floculation

- Process of aggregation of colloidal particles into an insoluble precipitate by addition of some suitable electrolyte is known as coagulation.



FLOCCULATION VALUE COAGULATION VALUE

The min. concⁿ of electrolyte in millimoles required to cause coagulation of 1L of colloidal solution is called coagulation value.

$$\text{Coagulation Value} = \frac{\text{millimoles of electrolyte}}{\text{Vol. of sols (in L)}}$$

$$\text{Coagulation Power} \propto \frac{1}{\text{Coagulation Value}}$$

Hardy Schulze rule

- According to this rule, greater the valency of coagulating ion, greater the power to cause precipitation.

$[Fe(CN)_6]^{-4} > PO_4^{-3} > SO_2^- > Cl^-$

$Al^{+3} > Mg^{+2} > Na^+$

$$\text{Flocculation value} \propto \frac{1}{Z^6}$$

Z is charge present on ion.

PROTECTIVE COLLOIDAL SOLS

Lyophilic colloidal sols are more stable than lyophobic colloidal sols. This is due to extensive solvation of lyophilic colloidal sols which forms a protective layer outside it and thus prevent it from forming associated colloids. Lyophobic sols can be easily precipitated by addition of small amt. of an electrolyte.

They can be prevented from coagulation by addition of some lyophilic colloid. This is due to formation of protective layer by lyophilic sols outside lyophobic sols.

Process of protecting the lyophobic colloids solution from precipitation by an electrolyte due to previous addition of some lyophilic colloids is called protection of colloid and lyophilic colloidal sols are called protective sols.

GOLD NUMBER

The min. amt. of protective colloid in "milligrams", which when added to 10 ml of a standard gold sol is just sufficient to prevent its coagulation with 1ml of 10% Nacl solution.

$$\text{Protecting Power} \propto \frac{1}{\text{gold No.}}$$

$$\text{Gold Number} = \frac{\text{wt. of Lyophilic sol (mg)} \times 10}{\text{Vol. of gold sol (ml)}}$$

COMPD.	GOLD NUMBER
Gelation	0.005 - 0.01
Haemoglobin	0.03 - 0.07
Egg albumin	0.1 - 0.2
Gum Arabic	0.15 - 0.25
Dextrin	6 - 6.2
Starch	20 - 25

EMULSION

Pair of immiscible liquids is called emulsion.
Emulsions are unstable. They are in separated into two layers. For the stabilizing of an emulsion a third component is added called emulsifying agent forms. An interfacial film b/w DP & DM.

E.g. milk is an emulsion in which liquid fat is DP and liquid water is DM. and casein is emulsifying agent.

DEMULSIFICATION

The separation of emulsion into its constituent liquids is called demulsification
Various technique imployed for this are –

- Freezing
- Boiling
- Centre fuge
- electrostatic precipitation
- chemical methods

Types of Emulsions

– Depending on the nature of DP, the emulsions are classified as –

1. Oil in water emulsion
2. Water in oil emulsion

In oil & water emulsion DP → oil, water → DM.

E.g. milk and vanishing cream are oil in water type emulsion.

In water & oil emulsion DP → water, DM → oil

E.g. cold cream and cod liver (liver oil) are water in oil emulsions.