

CHEMISTRY STUDY MATERIALS FOR CLASS 12 (NCERT BASED KEY POINTS OF CHAPTER – 05)

GANESH KUMAR

DATE:- 05/07/2021

Surface Chemistry (Key Points)

The branch of chemistry which deals with the study of surface phenomena.

Adsorption: The phenomenon of attracting and retaining the molecules of a substance at the surface of the solid or a liquid resulting into higher concentration of the molecules on the surface than in the bulk.

Adsorbent: The substance where adsorption occurs.

Adsorbate: The substance that gets adsorbed.

Absorption: The phenomenon in which the particles of gas and liquid get uniformly distributed throughout the body of the solid.

Desorption: The process of removal of an adsorbed substance from the surface on which it is adsorbed.

Sorption: When both absorption and adsorption occur together and are not distinguishable.

Mechanism of adsorption: arises due to unbalanced force of attraction on the surface of solid are responsible for attracting the adsorbate particles on the surface.

The extent of adsorption increases with increase in surface area.

Gibbs energy change during adsorption : During adsorption, there is always decrease in residual force i.e., there is decrease in surface energy, which appears as heat. Therefore adsorption is an exothermic process i.e. $\Delta H = -ve$.

Also movement of the particles is restricted in this process. Therefore $\Delta S = -ve$

According to Gibbs Helmholtz equation : $\Delta G = \Delta H - T\Delta S$, or $\Delta G = (-\Delta H) - T(-\Delta S)$

for adsorption to occur. ΔG must be negative which is possible only when $\Delta H > T\Delta S$

Types of Adsorption: physical and chemical adsorption

1. **Physical adsorption :** When the particles of adsorbate are held to the surface of adsorbent by weak Vander Waals forces,

Characteristics of physical adsorption: Lack of specificity, low enthalpy of adsorption, reversible in nature, no activation energy required, decrease with increase in temperature.

2. **Chemical adsorption:** When the molecules of adsorbate are held to the surface of adsorbent by strong chemical forces.

Characteristics of chemical adsorption: Highly specific in nature, high enthalpy of adsorption, Irreversible in nature, initially it increases with increase in temperature as it needs activation energy, very slow.

Adsorption Isotherm: The variation in the amount of gas adsorbed by the adsorbent with pressure at constant temperature can be expressed by means of a curve termed as adsorption isotherm.

(Its a plot/curve between extent of adsorption(x/m) and pressure P at constant T).

Freundlich adsorption Isotherm

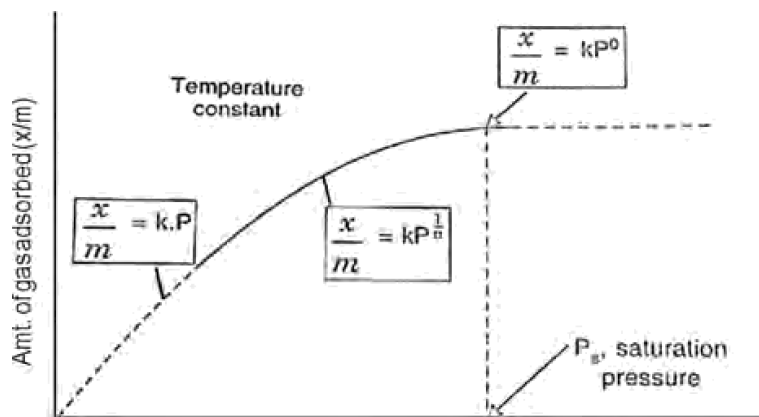
$$x/m = K.P^{1/n} \quad (n > 1) \quad \log x/m = \log k + 1/n \log P$$

The factor $1/n$ can have values between 0 & 1.

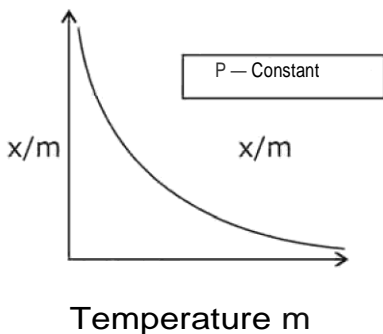
When $1/n=0$, $x/m = \text{constant}$ which shows that adsorption is independent of pressure.

When $1/n=1$, $x/m = kP$, the adsorption varies directly with pressure.

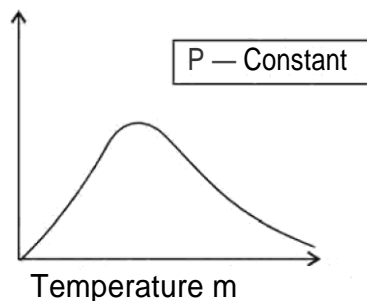
The variation in the amount of gas adsorbed by the adsorbent with temperature at a: Instant pressure can be expressed by means of a curve termed as adsorption isobar.



Adsorption isotherm in term of Freundlich.



Physical adsorption



Chemical adsorption

Factors Affecting adsorption

Nature of adsorbent: Transition metals act as good adsorbents for gases due to vacant or half filled d- orbitals and high charge-size ratio.

Surface area of adsorbent: surface area adsorption.

Nature of adsorbate: Easily liquefiable gases like ammonia, HCl, carbon dioxide etc. are adsorbed to a much greater extent than permanent gases like nitrogen, Hydrogen ,etc.

Adsorption from solutions: In case of adsorption from *solution* phase. Extent of adsorption (x/m) \propto 1/T.

Extent of adsorption (x/m) \propto surface area of the adsorption.

Extent of adsorption(x/m) \propto concentration of the solute.

The extent of adsorption depends on the nature of adsorbent and the adsorbate.

APPLICATIONS OF ADSORPTION:

- (i) Gas masks (ii) Production of high vacuum (iii) Humidity control
- (iv) Removal of colouring matter from solutions (v) Heterogeneous catalysis
- (vi) Separation of inert gases (vii) Softening of hard water (viii) De-ionization of water

CATALYSIS: Substances which alter the rate of reaction, themselves remaining chemically and quantitatively unchanged after the reaction and the phenomenon is called catalysis.

HOMOGENEOUS CATALYSIS When the reactants and the catalysts are in the same phase



HETEROGENEOUS CATALYSIS The catalytic process in which the reactants and the catalysts are in different phases. $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \xrightarrow{\text{Fe}(\text{s})} 2\text{NH}_3(\text{g})$

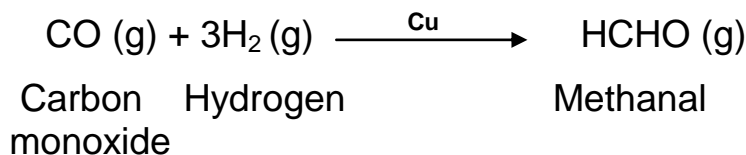
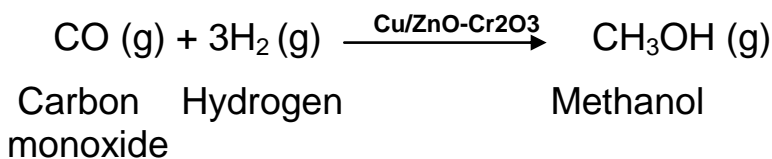
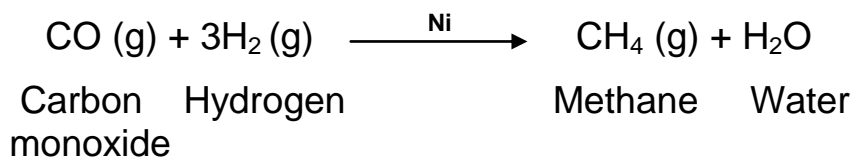
AUTO CATALYSIS— when one of the products increases the rate of reaction by acting as a catalysts.

FEATURES OF SOLID CATALYSTS-

1. **ACTIVITY** –The activity of a catalyst depends upon the strength of chemisorption to a large extent. The reactants must get adsorbed reasonably strongly on to the catalyst active.



2. **SELECTIVITY**- The selectivity of a catalyst is its ability to direct a reaction to yield a particular product.



ZEOLITES : are shape- selective catalysts because of their honey comb like structures. Chemically **micro porus aluminosilicates**.

The reaction taking place in zeolites depend upon :The size and shape of reactant and product molecules and pores and cavities of the zeolites.

Zeolites widely used as catalysts in petrochemical industries for cracking of zeolites catalysts used in petroleum industries. **ZSM-5**, converts alcohols directly lin to gasoline (petrol)

COLLOIDAL STATE

The substances whose solutions could pass through filter paper and animal membrane, having higher rate of diffusion are called **CRYSTALLOIDS**.

Substances whose solution can pass through filter paper and not animal membrane, having higherrate of diffusion are called **COLLOIDS**. Particle size 1nmto1000nm

Classification is based on following criteria

Physical state of dispersed phase and dispersion medium.

Nature of interaction between dispersed phase and dispersion medium.

Types of particles of the dispersed phase

Dispersion phase {DP} and Dispersion medium {DM}

The phase which is dispersed in the other (medium) is called DP or internal phase or discontinuous phase.

The phase or medium in which the dispersion is made is called dispersion medium (DM) or external phase or continuous phase.

Classification on the basis of affinity of DP for DM: lyophobic and lyophilic colloids

Lyophobic colloids (solvent hating colloids) : These colloids cannot be prepared by simply merge dispersed phase with dispersion medium, they need stabilizing agent to preserve them , irreversible. Ex: colloidal solutions of gold, silver, $\text{Fe}(\text{OH})_3$, As_2S_3 , etc.

Lyophilic colloids (solvent loving): Directly formed by mixing DP with a suitable dispersion medium), self-stabilizing, reversible sol, sol of starch, gum, gelatin, rubber.

Classification based on type of particles of the dispersed phase

Multimolecular colloids: Consists of aggregates of a large number of atoms or whose diameter is less than 1 nm. Ex Au sol

Macromolecular colloids: In these colloids the molecules have sizes and dimensions to colloidal particles. Ex: proteins, starch, cellulose.

Associated colloids: At low concentrations, behave as normal, strong electrolytes and at

higher concentrations exhibit colloidal state properties due to the formation of aggregated particles (micelles). e.g Soaps and detergents

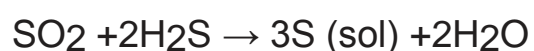
The temperature only above which the formation of micelles takes place is called Kraft temperature (**TK**) .

Critical Micelle Concentration: The concentration above which micelle formation takes place

Preparation of Lyophobic sols

Condensation methods: Particles of atomic or molecular size are induced to form aggregates

Oxidation method: Sulphur colloids are prepared by oxidation of H_2S by O_2 .



Reduction: Silver colloids are prepared by passing H₂ through a saturated aqueous solution of silveroxide at 65° C.

Hydrolysis: Dark brown Fe(OH)₃ colloidal solution is prepared by adding FeCl₃ into boiling water.
$$\text{FeCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{Fe(OH)}_3 + 3\text{HCl}$$

Double decomposition: Arsenious sulphide colloidal solution is prepared by passing of H₂S gas into a solution of As₂O₃.

Exchange of solvent: Colloidal solution of phosphorus is prepared by addition of alcohol into a solution phosphorous in excess water.

Dispersion methods & Mechanical disintegration

Peptization: Process of converting of a fresh precipitate into colloidal particles by adding

suitable electrolyte is known as peptization.

e.g. Fe(OH)₃ solution is formed from FeCl₃.

Electro-disintegration (Bredig's arc method) Purification of colloids:

Dialysis: Purification of colloidal solutions from the impurities(electrolytes) by diffusion through a porous membrane such as parchment, collodion, etc.

Electrodialysis: When dialysis process is accelerated by the application of a potential difference across the membrane, So ions migrate faster than the colloids.

Ultrafiltration: purification of colloidal solution using special filter paper called ultra filters

paper which is impregnated with gelatin or collodion followed by hardening in formaldehyde)

Colloidion: it is 4% nitrocellulose solution in alcohol and ether.
