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DEPARTMENT OF CHEMISTRY
ENGINEERING CHEMISTRY - I

UNIT III

SURFACE CHEMISTRY

PART-A

1. Define Adsorption

The phenomenon of concentration of molecules of a gas (or) liquid at a solid surface is called adsorption.

2. Define the term Adsorbent and Adsorbate with suitable example

Adsorbent: The solid that takes up a gas (or) a solute from the solution is called the adsorbent. Eg: charcoal, silica gel, starch, adsorption of H₂ on Ni.

Adsorbate: The substance which is held on the surface of the solid is called the adsorbate. Eg: adsorption of H₂ on Ni

Adsorbent: Ni (solid)

Adsorbate: H₂ (gas)

3. Distinguish between adsorption and absorption

ADSORPTION	ABSORPTION
Adsorption is a Surface phenomenon	Absorption is a Bulk phenomenon
It is a Rapid process	It is a Slow process
Equilibrium is attained easily	Equilibrium is attained slowly
The concentrations of molecules are more on the surface and less in the bulk.	But, distribution is uniform.
It depends on the surface area of the adsorbent	No such effects

4. What is chemisorptions? Give Eg.

The adsorbed molecules are held on the surface of the adsorbent by chemical bonds (covalent or ionic bond). Eg: adsorption of H₂ on Ni.

5. What is physical adsorption or physisorption? Give example

The adsorbed molecules are held on the surface of the adsorbent by weak physical (or) vander waal's forces of attraction. Eg: adsorption of H₂ on charcoal

6. What is an adsorption isotherm?

Adsorption isotherm is a relationship between magnitudes of adsorption with pressure.

$$X/m = KP^{1/n}$$

7. Mention some important characteristics of adsorption.

1. Adsorption on surface of a solid is always spontaneous.
2. Adsorption is always accompanied by evolution of heat.
3. Adsorption is accompanied both by decrease in enthalpy and entropy of the system.
4. Adsorption is a selective process.

8. Write any three difference between is physisorption and chemisorption?

PHYSISORPTION	CHEMISORPTION
By intermolecular vanderwaal's force	By chemical bond formation
Heat of adsorption is low (20-40 k.cal/mol)	Heat of adsorption is high (40-400 k.cal/mol)
Multi layer adsorption occurs	Only monolayer adsorption occurs
Adsorption is completely reversible	Adsorption is irreversible
Adsorption decreases with increase in temperature	Adsorption increases with temperature

9. Explain the effect of temperature on adsorption.

Physical Adsorption: it occurs rapidly at lower temperature and decreases with increase in temperature.

Chemical Adsorption: it increases with increase in temperature and then decreases.

10. What is Freundlich's adsorption isotherm?

The relationship between the magnitude of adsorption (x/m) and pressure (p) can be expressed mathematically by an equation known as Freundlich's adsorption isotherm.

$$X/m = KP^{1/n}$$

11. Write the limitations of Freundlich's adsorption isotherm?

1. Freundlich's equation is purely empirical and has no theoretical basis.
2. The equation is valid up to certain pressure and invalid at higher pressure.
3. The constants K and n are not temperature independent, they vary with temperature.
4. Freundlich's adsorption isotherm fails, when the concentration of adsorbate is very high.

12. What is Langmuir's adsorption isotherm?

The relationship between the amounts of the gas adsorbed to the pressure of the gas at a constant temperature is known as Langmuir's adsorption isotherm.

It is represented mathematically as

$$X = \frac{K'P}{1 + KP}$$

13. What is the demerit of Langmuir's adsorption isotherm?

Langmuir's adsorption isotherm holds good at lower pressure but fails at higher pressure.

14. What are promoters?

Promoters are defined as the substance which increase the activity of the catalyst.

15. What is catalytic poisoning?

A substance which destroys the activity of the catalyst accelerate a reaction is called catalytic poisoning

16. What is the effect of the temperature and pressure on the adsorption of hydrogen gas on charcoal?

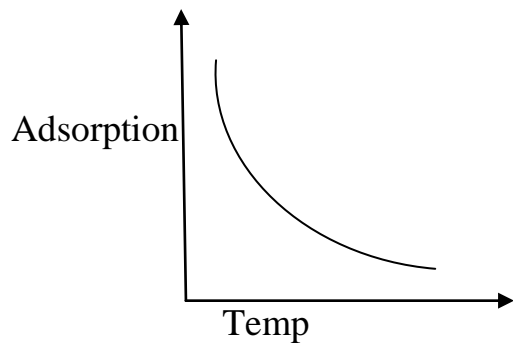
Adsorption of H₂ on charcoal is rapid at lower temperature and decrease with increase in temperature but the rate of adsorption increase with increase of pressure.

17. Define ion exchange adsorption?

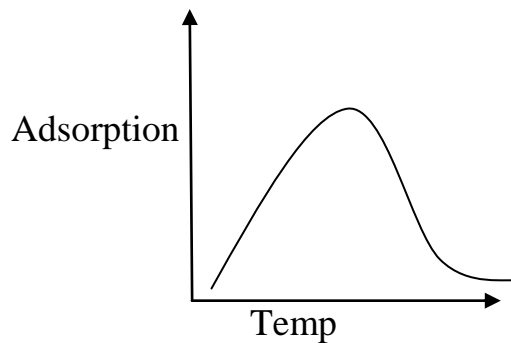
Ion exchange adsorption is the process of releasing the ion and adsorbing another like ion .Eg: water softening using zeolite.

18. What is the effect of increase in temperature and increase in pressure on the adsorption of a gas on a solid?

- 1. Effect of increase in pressure:** Adsorption generally increases with increase of pressure.
- 2. Effect of increase in temperature:**
 - (a) Physical adsorption:** It increases with decrease in temperature.
 - (b) Chemical adsorption:** It increases with increase in temperature and then decreases.



(a) Physical adsorption



(b) Chemical adsorption

19. How is evaporation of water in lake minimized?

Due to scarcity of water during summer layers of stearic acid is spread over water lakes and reservoirs. The adsorbed stearic acid on the surface of water minimizes evaporation of water.

20. What is role of adsorbent in catalysis?

1. The catalyst adsorbs the reactant molecule on its surface and brings them in close proximity for the reaction to occur

2. It helps in the formation of activated complex, where in bonds in the reactants are easily broken and the products are easily formed.

21. How is arsenic poisoning removed from the body?

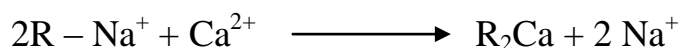
Colloidal ferric hydroxide is administered, which adsorbs arsenic poison and is removed from the body by vomiting.

22. Define ion-exchange adsorption. (Or) What do you understand by ion exchange adsorption? Give one example.

Ion-exchange adsorption is “the process of releasing the ion and adsorbing another like ion”.

Example: Water softening using zeolite.

When water containing Ca^{2+} and Mg^{2+} ions are allowed to pass over a zeolite bed, Ca^{2+} and Mg^{2+} ions are replaced by Na^+ ions.



23. List the factors that affect adsorption?

- (1) Nature of the gases
- (2) Nature and surface area of adsorbent
- (3) Heat (or) Enthalpy of adsorption
- (4) Reversible character of adsorbed gases.
- (5) Pressure of the gas
- (6) Temperature of the gas
- (7) Thickness of adsorbed layer of gas.

(8) Activation of adsorbent.

24. Mention the any four application of adsorption?

- (1) The adsorbents are used in gas mask
- (2) For the removal of moisture in the atmosphere silica and alumina gels are used
- (3) Arsenic poisoning removed from the body by vomiting
- (4) In water softening ion-exchange resin and zeolite are used.
- (5) Chromatographic analysis are carried out by adsorption.

25. What is the role of adsorbent in catalysis?

- I. The catalyst (adsorbent) adsorbs the reactant molecules on its surface and brings them in close proximity for the reaction to occur.
- II. It helps in the formation of activated complex, where in bonds in the reactants are easily broken and the products are easily formed.

26. Define the term interface.

Interface is the common surface of meeting of two media.

Adsorption is a surface phenomenon and during this process, the concentration of one medium (adsorbent) increases at the interface of adsorbent and adsorbate.

27. Write a suitable equation commonly applied to the adsorption of liquids on solids.

$$x/m = kC^{1/n} \quad (\text{or}) \quad \log x/m = \log k + 1/n \log C$$

Where k and n are constants.

x = mass of the adsorbate

m = mass of the adsorbent

C = concentration

28. What are sorption and desorption?

The term sorption should be used to describe a process in which both absorption and adsorption take place simultaneously.

The reverse of sorption, i.e., the release of the adsorbed or absorbed substances into the surrounding medium is termed desorption.

PART-B

1. Give the difference between physisorption and chemisorption.
2. Discuss the factors which influence adsorption of gas on solid.
3. Discuss the factors which influence adsorption of solutes from solution.
4. Discuss the adsorption of a solute from a solution.
5. Give any three factors on which adsorption depend.
6. Derive Freundlich's adsorption isotherm. Give the condition in which it fails.
7. Derive an expression for Langmuir's adsorption isotherm. Show that at normal pressure it becomes identical with Freundlich's adsorption isotherm. Or Derive an expression for Langmuir's unimolecular adsorption isotherm. What are its limitations?
8. Explain adsorption theory or contact theory with examples. Or Explain the role of adsorption in catalytic reactions.
9. Explain the classification and functions of ion –exchangers. Or Explain the role of adsorption in demineralization of water.
10. Explain the role of adsorbents in pollution abatement? Or Explain how treatment of polluted water and air is carried out using Granular and powdered activated carbons.
11. Give an account of various applications of activated carbons.
12. Explain the important characteristics of activated carbon.
13. Define the term adsorption and list its application.
14. Define adsorption isotherm. Explain the various types of adsorption isotherms.