7. Surface Chemistry

Colloids:

- Heterogeneous system
- Intermediate between true solutions and suspensions
- Consist of two phases – Dispersed phase and dispersion medium
- Classification of colloids: Colloids are classified depending upon the following three criteria.

Physical state of the dispersed phase and the dispersion medium

Dispersed phase	Dispersion medium	Type of colloid	Examples
Solid	Solid	Solid sol	Gem stones, some coloured glasses
Solid	Liquid	Sol	Paints, cell fluids
Solid	Gas	Aerosol	Smoke, dust
Liquid	Solid	Gel	Cheese, butter, jellies
Liquid	Liquid	Emulsion	Milk, hair cream
Liquid	Gas	Aerosol	Fog, mist, cloud
Gas	Solid	Solid sol	Stone, foam rubber
Gas	Liquid	Foam	Froth, soap lather

Nature of interaction between the dispersed phase and the dispersion medium

- **Lyophilic colloids (solvent attracting):**
  - Also called reversible sols
  - Quite stable and cannot be easily coagulated
- **Lyophobic colloids (solvent repelling):**
  - Also called irreversible sols
  - Can be easily coagulated
- **Type of particles of the dispersed phase**
  - Multi-molecular colloids
  - Macromolecular colloids
  - Associated colloids (Micelles)
  - The temperature above which the formation of micelles takes place is called Kraft temperature (T_k).
  - The concentration above which the formation of micelles takes place is called critical micelle concentration (CMC).
- **Preparation of colloids:**
  - Chemical method
  - Electrical disintegration or Bredig's Arc method
  - Peptisation – Process of converting a precipitate into colloidal sol by shaking it with the dispersion medium in the presence of a small amount of electrolyte

Adsorption: Phenomenon of accumulation of molecules at the surface of a solid, which results in a higher concentration on the surface than in the bulk

- **Adsorbate:** The substance which gets adsorbed onto a surface
- **Adsorbent:** The substance on which adsorption takes place
- **Desorption:** The phenomenon of removing an adsorbate from an adsorbent
- **Types of adsorption –**

1. **Physical adsorption or physisorption**
2. Chemical adsorption or chemisorption

•	Physisorption	•	Chemisorption
1.	Arises because of van der Waals forces	1.	Arises because of chemical forces
2.	Not specific in nature	2.	Highly specific in nature
3.	Reversible	3.	Irreversible
4.	Enthalpy of adsorption is low	4.	Enthalpy of adsorption is high
5.	No appreciable activation energy is required	5.	Sometimes, high activation energy is required
6.	Results in multi-molecular layers	6.	Results in uni-molecular layer

- Gas is adsorbed in almost all solids.
- **Factors on which the extent of adsorption of a gas on a solid depends upon**:
  - Nature of the gas
  - Nature of the solid
  - Surface area of the solid
  - Pressure of the gas
  - Temperature of the gas

- **Adsorption isotherm:**

The relation between the extent of adsorption (x/m) and the pressure of a gas at constant temperature

1. Freundlich adsorption isotherm –

$$\frac{x}{m} \propto P^{\frac{1}{n}}$$

$$\frac{x}{m} = kP^{\frac{1}{n}} \qquad n > 1$$

Now, taking log,

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

- **Applications of Adsorption**
  - Production of high vacuum.
  - Gas mask.
  - Silica and aluminium gels are used as adsorbents for controlling humidity.
  - A number of drugs are used for killing germs; the drugs get adsorbed on the germs.

- Used in heterogeneous catalysis
- Used in chromatographic analysis.

- The substance which alters the rate of a reaction, but itself remains chemically and quantitatively unaltered after the reaction is called a catalyst.
- The phenomenon of using a catalyst is called catalysis.
- The substances which enhance the activity of a catalyst are called promoters.
- The substances which decrease the activity of a catalyst are called poisons.
- Broadly divided into two groups:
  - Homogeneous catalysis – The reactants and the catalyst are in the same phase
  - Heterogeneous catalysis – The reactants and the catalyst are in different phases
- **Shape selective catalysis:**
  Catalysis that depends upon the pore structure of the catalyst, and the size of the reactant and the product
- **Enzyme catalysis or biochemical catalysis:** An enzyme acts as the catalyst
  - Highly specific in nature
  - Highly active under optimum temperature and pH
  - Influenced by inhibitors and poisons
- **Industrial catalytic processes:**
  - Haber's process
  - Ostwald's process
  - Contact process

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- **Purification of colloidal solutions:**
  Reduction of the amount of impurities to a requisite minimum
  - Dialysis – Process of removing a dissolved substance by diffusion through a suitable membrane
  - Electro dialysis
  - Ultra-filtration
- **Properties of colloidal solutions:**
  - Colligative properties
  - Tyndall effect
  - Colour
  - Brownian movement
  - Charge on colloidal particles
  - **Electrophoresis**– Movement of colloidal particles under applied electric potential.
  - **Electro osmosis** – Movement of dispersion medium through membrane in an applied electric field.
  - **Coagulation or precipitation** – Process of settling of colloidal particles.
  - Ways to carry out coagulation of sol are:
    1. By electrophoresis
    2. By mixing two oppositely charged sols
    3. By boiling
    4. By persistent dialysis
    5. By addition of electrolytes
    6. Hardy-Schulze rule: The greater the valence of the flocculating ion added, the greater is its power to cause precipitation.

Emulsions

- A colloidal system.
  - both the dispersed phase and the dispersion medium are liquids

- There are two types −
- Oil dispersed in water (O/W type)
- Water dispersed in oil (W/O type)
- Emulsifying agent: The third component used for stabilising an emulsion
- Emulsification: Process of making an emulsion

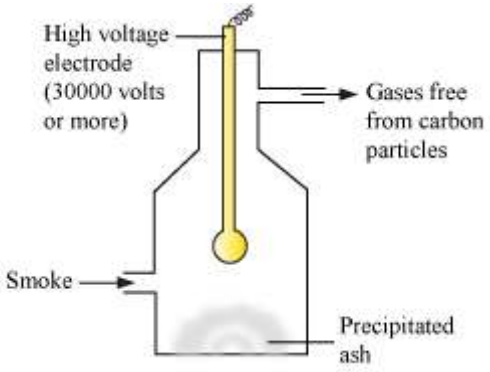
Colloids around Us

- Dust particles in sky, milk, butter, fruit juices, fog,smoke, mist, rain, blood, river water etc..

Applications of Colloids

- Purification of drinking water.
- Colloidal Medicines
    - Example: Milk of magnesia (an emulsion)
- Cleansing action of soaps and detergents
- Photographic plates or films
- Paints, inks, rubber, graphite lubricants, etc.,.
- Rubber industry.

Electrical precipitation of smoke:



1. The science which deals with the study of atoms, molecules and objects whose size is on nanometer scale is called nanoscience. One nanometer generally defined as 1 to 100 nm.

2. Materials behave differently when they are used at nanoscale. The same metal can become semiconductor or insulator at the nanoscale.

3. Nanoscience involves the making of ultra small devices which are about a nanometer. It is roughly the size of 3.5 gold atom placed end to end.

4. When the size of the matter is reduced to few nanometers then its surface area gets increased. Then this increased surface area takes up the critical role such as chemical catalysis.

Application of nanotechnology:

- It is used in making mini pumps which are used in hospitals.

- Efficiency of batteries can be improved by using nanomaterials as catalysts.
- Degradation of food and vegetables is also reduced by using nanotechnology.
- Very small computers are produced which are many times faster and efficient.
- It finds applications in various fields ranging from semiconductors to textile industries.