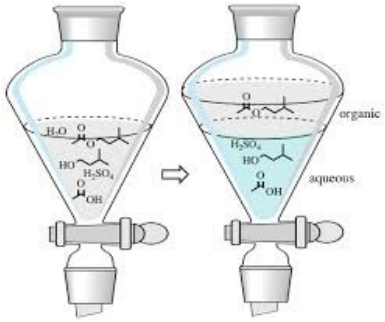
Chapter III:
Chemical Extraction



Introduction

Chemical extraction is an essential method used in many scientific fields, including chemistry, pharmacy, metallurgy, and the environment. It consists of isolating or purifying specific compounds from a mixture through chemical reactions or the use of suitable solvents. This course details the principles, steps, types, and applications of this technique.

III.1 Definition:

Chemical extraction is a method based on the physicochemical properties of substances to isolate them from a complex mixture. Unlike mechanical extraction, this method relies on chemical interactions (covalent bonds, ionic interactions, complexation, etc.) to extract compounds of interest.

III. 2 Fundamental principles :

(a) **Partition coefficient (K):** Describes the partitioning of a solute between two immiscible phases (e.g., an aqueous phase and an organic phase).

(b) **Chemical reactions:** Some extractions require chemical reactions to transform a compound into a more extractable form. For example:

- ✓ **Complexation:** Formation of soluble complexes with specific ligands.
- ✓ **Neutralization:** Transformation of an acid or base into a salt to improve its solubility.

(c) **Selectivity:** The ability of a solvent or reaction to target a specific component among several present in a mixture.

III. 3 Steps of chemical extraction :

(a) **Sample preparation:** Dilution, filtration or pH adjustment to facilitate extraction.

(b) **Choice of solvent:** The solvent must have a good affinity for the compound to be extracted and be immiscible with the initial phase.

(c) **Phase mixing:** The two phases (e.g. aqueous and organic) are mixed to maximize contact between them, thereby allowing transfer of the compound.

(d) **Phase separation:** After stirring, the phases are separated by gravity or centrifugation.

(e) **Recovery of the compound:** By evaporation of the solvent, precipitation, or filtration.

III.4. Types of chemical extraction:

(a) **Liquid-liquid extraction:** Used to separate soluble compounds between two immiscible liquids.

- Example: Extraction of organic compounds with an organic solvent (ether, chloroform).

(b) **Liquid-solid extraction:** Involves the dissolution of a solid solute in a solvent.

- Example: Extraction of alkaloids from plants.

(c) **Acid-base extraction:** Uses acid-base reactions to extract ionizable compounds.

- Example: Extraction of a carboxylic acid by adding a base to convert it into a water-soluble salt.

(d) **Complexation extraction:** Formation of complexes between a metal ion and a ligand to extract the metal.

- Example: Using EDTA to extract metal ions.

(e) **Precipitation extraction:** The solute is transformed into an insoluble form which precipitates out of solution.

- Example: Precipitation of metal salts with specific reagents.

III.5 Parameters influencing extraction:

(a) **Temperature:** High temperature can improve solubility but can also promote side reactions.

(b) **pH:** A crucial parameter for ionizable compounds. Adjusting the pH helps maximize extraction efficiency.

(c) **Nature of the solvent:** The polarity of the solvent must correspond to that of the compound to be extracted.

(d) **Solvent to sample ratio:** An optimal ratio ensures efficient extraction while minimizing excessive solvent use.

(e) **Contact time:** Must be long enough to allow equilibrium between the phases.

❖ ***Practical example: Acid-base extraction :***

✓ ***Sample:*** *Mixture of benzoic (acid), amine (base) and naphthalene (neutral).*

✓ ***Steps:***

a) *Add an aqueous base to ionize the benzoic acid and extract it into water.*

b) *Add aqueous acid to protonate the amine and extract it into water.*

c) *Recover the naphthalene in the remaining organic phase.*

Conclusion

Chemical extraction is a powerful method for isolating compounds from complex mixtures. It offers great flexibility through the adjustment of many parameters (pH, temperature, solvents) and finds varied applications in industry and research.