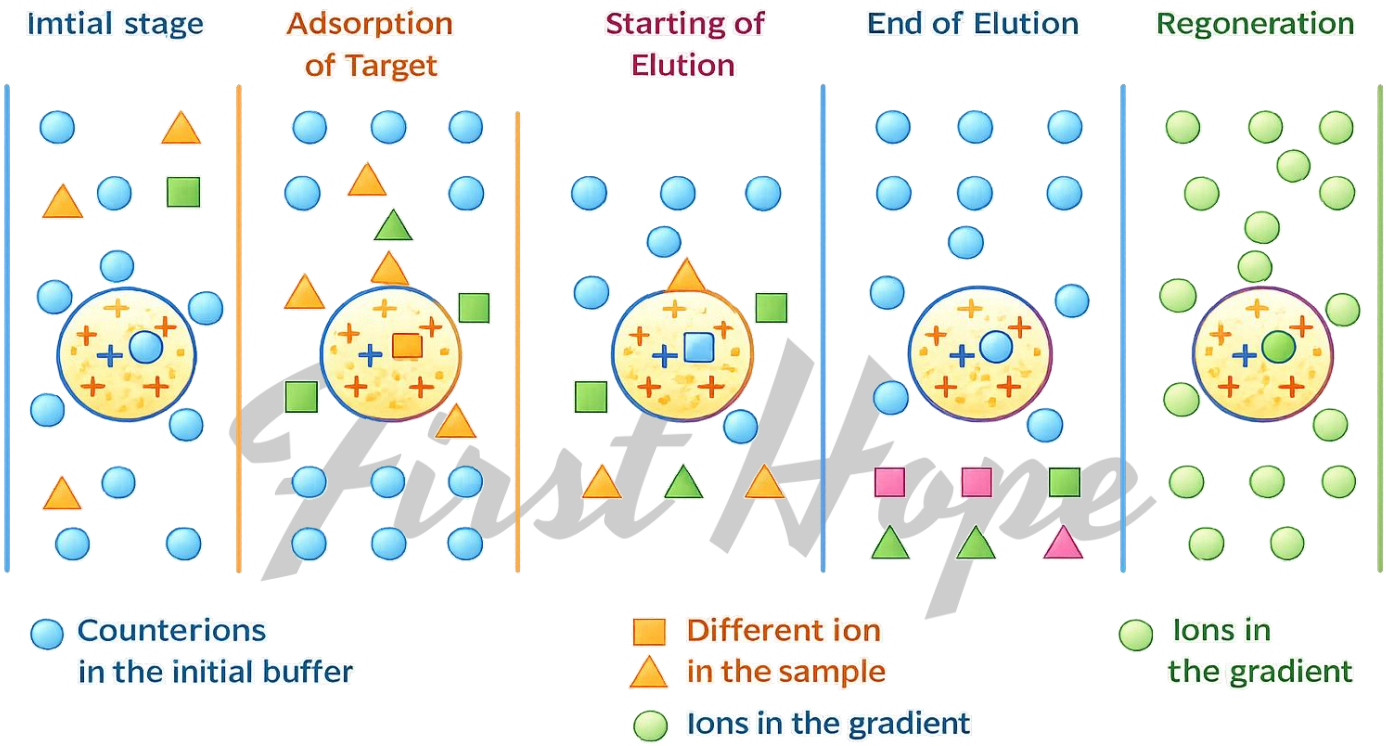
Ion Exchange Chromatography

Introduction to Ion Exchange Chromatography

- **Ion Exchange Chromatography (IEC)** is a type of chromatography that separates ions and polar molecules based on their charge.
- It is widely employed in various fields, including protein purification, water analysis, and diverse ion analyses.
- Chromatography, as a technique, separates components of a mixture by passing them through a medium where they migrate at different rates due to differences in their interactions with the medium.



Principle

- The fundamental principle of IEC involves the use of a **charged stationary phase** to separate ions present in the **mobile phase**.
- Depending on the charge of the stationary phase:
    1. **Cation Exchange Chromatography**: Utilizes a negatively charged stationary phase to attract and retain positively charged ions (cations).
    2. **Anion Exchange Chromatography**: Utilizes a positively charged stationary phase to attract and retain negatively charged ions (anions).

Components of Ion Exchange Chromatography

1. Stationary Phase

- **Composition**: Typically consists of a resin made from organic polymers with ionic functional groups.

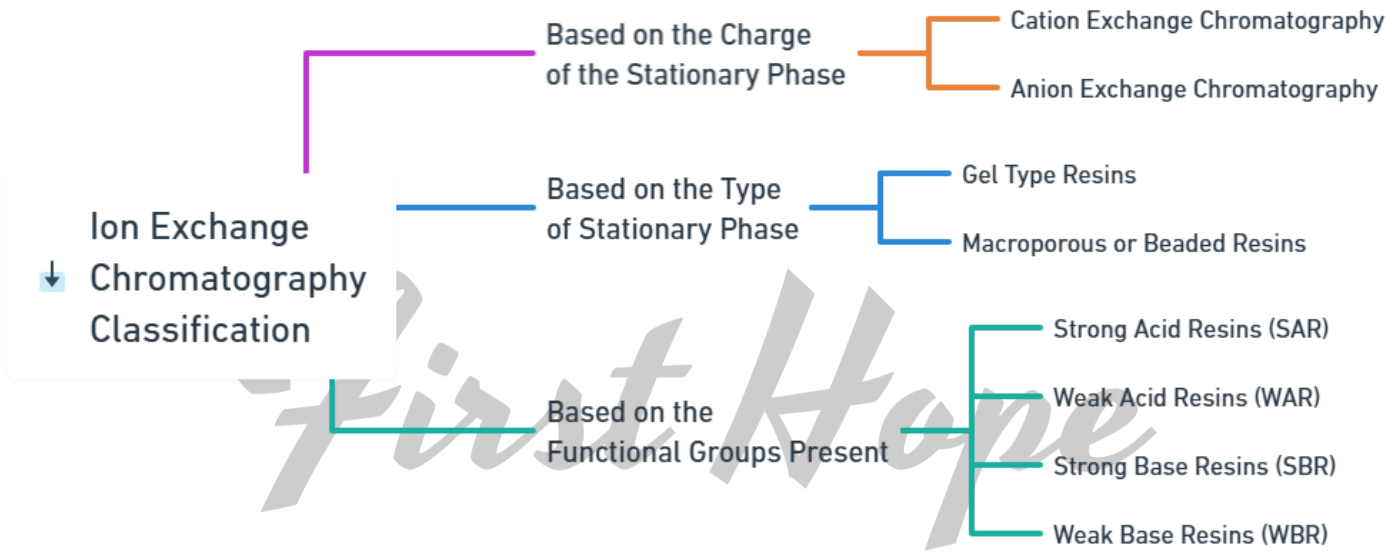
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- **Types**:
  - **Cation Exchangers**: Contain negatively charged groups.
  - **Anion Exchangers**: Contain positively charged groups.
- **Function**: Provides the charged sites for ion exchange.

2. Mobile Phase

- **Composition**: Usually a water-based solution that transports the sample through the stationary phase.
- **Adjustability**: The composition and pH can be modified to influence the separation process.

Classification of Ion Exchange Chromatography



A. Based on the Charge of the Stationary Phase

1. Cation Exchange Chromatography

- **Stationary Phase:** Negatively charged groups
- **Function:** Attracts and exchanges positively charged cations from the solution

2. Anion Exchange Chromatography

- **Stationary Phase:** Positively charged groups
- **Function:** Attracts and exchanges negatively charged anions from the solution

B. Based on the Type of Stationary Phase

1. Gel Type Resins

- **Structure:** Cross-linked polymers with a three-dimensional network
- **Examples:** Dextrans, agarose
- **Features:** Porous structure allowing ion exchange

2. Macroporous or Beaded Resins

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- **Structure:** Resins with larger pores and higher surface areas
- **Advantages:** Increased capacity and faster exchange rates

C. Based on the Functional Groups Present

1. **Strong Acid Resins (SAR)**
   - **Functional Groups:** Sulfonic acid groups (-SO_3H)
   - **Characteristics:** Can exchange all types of cations across a wide pH range
2. **Weak Acid Resins (WAR)**
   - **Functional Groups:** Carboxylic acid groups (-COOH)
   - **Characteristics:** Exchange capacity is pH-dependent
3. **Strong Base Resins (SBR)**
   - **Functional Groups:** Quaternary ammonium groups
   - **Characteristics:** Can exchange all types of anions
4. **Weak Base Resins (WBR)**
   - **Functional Groups:** Primary, secondary, or tertiary amine groups
   - **Characteristics:** Exchange capacity for anions is pH-dependent

Ion Exchange Resins

- Ion exchange resins are the core materials facilitating the separation of ions based on their charge.
- They are typically insoluble matrices in the form of small beads containing charged sites that attract and hold ions of opposite charge from a passing solution.

Structure of Ion Exchange Resins

- **Polymer Base**: Can be natural or synthetic, often cross-linked for mechanical stability and insolubility.
- **Ionizable Groups**: Covalently attached to the polymer, determining the resin's charge properties.

Composition

- **Base Polymers**: Commonly synthesized from styrene-divinylbenzene or acrylic/methacrylic acid esters.
- **Functional Groups**:
  - **Cation Exchangers**: Sulfonic (-SO_3^-) or carboxyl (-COO^-) groups.
  - **Anion Exchangers**: -NR_3^+ or Ammonium (-NR_3^+) groups.

Classification of Ion Exchange Resins

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