Types of ion exchanger resins in analytical chemistry:

1. Cation exchange resins (positive ion exchanger)

These resins contain **acid groups** linked to the aromatic ring, the positive ions exchangers (strong acid) **are sulfonic** acid groups (SO_3H^+) and it's a very **strong acid** similar to sulfuric acid

while The positive ion exchangers (**weak acid**) are carboxylic groups (**$COOH^+$),** They partially ionize so that protons of these groups can be exchanged with other cations.

$$Resin\text{-}H^+ + M^+ \longrightarrow Resin\text{-}M^+ + H^+$$

(in solution) (in eluting solution)

Using a cation exchange resin

$$n\ R\text{-}SO_3H^+ + M^+ \rightleftharpoons (R\_SO_3^-)_n M^{+n} + nH^+ \quad \text{(strong acid)}$$

$$n\ R\text{-}COOH^+ + M^+ \rightleftharpoons (R\_COO^-)_n M^{+n} + nH^+ \quad \text{(weak acid)}$$

- Note

R ⟶ the resin

n ⟶ the number of moles

M^+ ⟶ the positive ions in solution (salt ions)

strong $SO_3^-H^+$

R

weak COO^-H^+

يحصل تاين تام بين ايونات (H^+ في الراتنج مع الايونات الموجبة الموجودة في المحلول والمضافه الى العمود) وهو ملح

يحصل تاين جزئي بين ايونات (H^+ في الراتنج مع الايونات الموجبة الموجودة في المحلول والمضافه الى العمود) وهو ملح

هنا يحصل تبادل في الايونات الموجبة فقط والايونات السالبة تبقى في العمود مرتبطة مع السلسله بوليمرية للراتنج

2. Anion Exchange Resins (Negative ion exchanger)

These resins contain **basic groups** (hydroxyl ions OH^-) can be exchanged with the other anions. The (Quaternary ammonium groups) are very **strong base** while the amine groups are **weak base** groups.

$$n\ R\_NR_3\ OH^- + A^{-n} \rightleftharpoons (R\text{-}NR_3)_n\ A^{-n} + n\ OH^-$$ (Strong base)

$$n\ R\_\ NH_3\ OH^- + A^{-n} \rightleftharpoons (R\text{-}\ NH_3)_n\ A^{-n} + n\ OH^-$$ (Weak base)

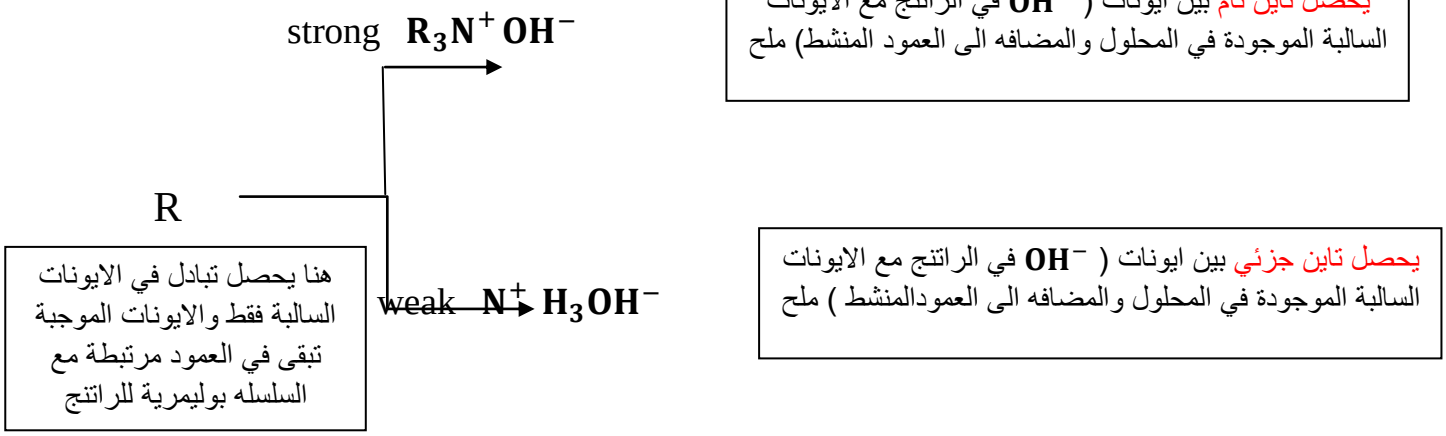
Note

R ⟶ the resin

n ⟶ the number of moles

A^{-n} ⟶ the negative ions in solution (or in salt ions)


Ion Exchange Resin



يحصل تاين تام بين ايونات (OH^- في الراتنج مع الايونات السالبة الموجودة في المحلول والمضافه الى العمود المنشط) ملح

يحصل تاين جزئي بين ايونات (OH^- في الراتنج مع الايونات السالبة الموجودة في المحلول والمضافه الى العمودالمنشط) ملح

هنا يحصل تبادل في الايونات السالبة فقط والايونات الموجبة تبقى في العمود مرتبطة مع السلسله بوليمرية للراتنج

Properties of Exchangers

Ion exchangers must have certain properties in order to be use several times. Some of these properties that must be known and controlled are :

1- **The size of the exchanger granules must be large.**
2- **Degree of branching.**
3- **Degree of inflation.**
4- **Capacity.**

Capacity Resin (T.C)

The number of opposite ions that a certain amount in the exchanger can link to and is usually estimated at the number of milliliters of the ions taken by 1g of resin

- It is the number of the (m.eq) of (H^+ or OH^-) per gram of **solid resin**.
- It is the number of the (m.eq) of (H^+ or OH^-) in the one milliliters of volume of **the wet resin** .

$$1.\ \textbf{capacity T.C} = \frac{\textbf{m.eq}(\ \textbf{H}^+ \textbf{ or } \textbf{OH}^-)}{\textbf{g (Solid R.)}}$$

$$2.\ \textbf{capacity T.C} = \frac{\textbf{m.eq}(\ \textbf{H}^+ \textbf{ or } \textbf{OH}^-)}{\textbf{ml (Liquid R.)}}$$

preparation of ion exchanger column

The column is prepared by filling the solid material (resin) inside the column by adding it to a column filled with solvent and left until it precipitates. The column can be mechanically shaken or the solvent is crushed by a long piston during filling. The **air bubbles formed in the column should be expelled and made less efficient.**

A glass wool or perforated glass disc is placed in the bottom of the column **to support the stationary phase** and we can be use the burette as a column.

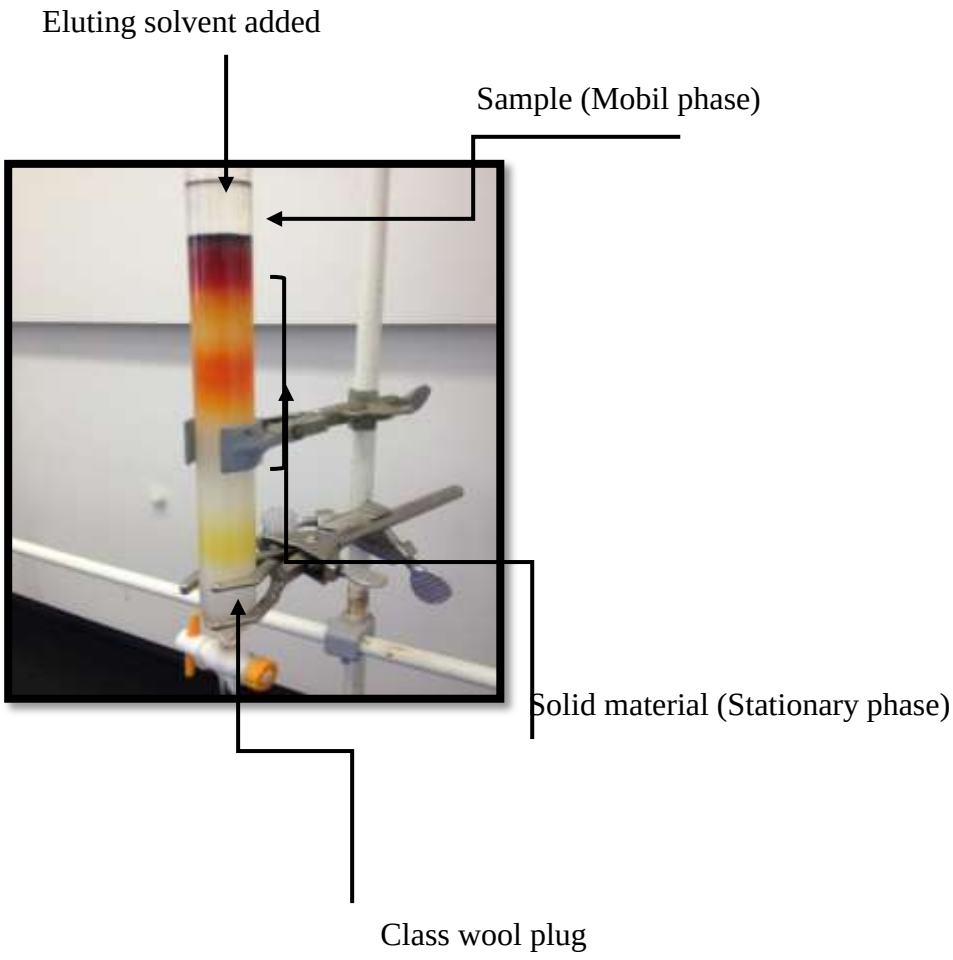
The dimensions of column depend on:

1- Separation efficiency required.

2- The size of the sample

3- The type of the chromatography separation method.

The dimensions of the ion exchanger column are range from a few millimeters in diameter and a few centimeters in length to a few centimeters in diameter and several tens of centimeters in length.



Activate the ion- exchanger

To converting the resin (exchanger) to the desired shape **(H^+-Form)** or **(OH^--Form)** depends on the type of exchanger (cationic or anionic) and it depends on the purpose of the experiment. In the process of water desalination (**Deionized water**, removing the ions from the water).

It is for activate the column of (H^+- form) cationic exchanger by adding a (3 drop) dilute acid such as (3M) HCl to the column containing the cation resin while **the anionic exchanger (OH^-- Form)** by adding (3 drop) dilute base such as (3M) NaOH to the column containing the anionic resin and then wash the column with the distilled water to the column becomes neutral then check it by using silver nitrate (**$AgNO_3$**) .

If the **eluent** collected solution is **turbid** , that is mean (**column is acidic**) and the eluent collected solution is contain salts that is formed by the ion-exchange between the added acid (H^+- ions) with the positive ions in the resin, then continuous washing the resin by **distilled water** (D.W).

If the **eluent** collected solution **is not turbidity** this refers of (**neutral column**) and check by adding a drop of the methyl orange (**M.O**) indicator. When the color of the solution is **pink** that is mean the presence of the **acid** in the column while if the solution is **yellow** color that is mean **neutral** column.

❖ The washing process is done by adding distilled water to the column with the opening of the column faucet and **maintaining the flowing speed.**

❖ The cation exchanger activates by added an acid like (3M) HCl, and then added of distilled water **as a few batches**.

❖ The separation by the ion exchanger is one of the types of chromatography (**liquid - solid**) which are separated **all similar ions in the charge.**

The diagram shows the column activation process

$$\text{R-Na} + \text{HCl} \rightarrow \text{R-H} + \text{NaCl} \xrightarrow{H2O} \text{R-H} + H_2O$$

Inactive cation exchanger	3 drops	column is acidic	Euent solution it is check by AgNO3 turbidity appears? why.	neutral column	Euent solution it is check by AgNO3 not turbidity appears? why