



## **WATER SOFTENING OR CONDITIONING METHOD**

Water used for industrial purposes should be free from hardness producing substances, suspended impurities and dissolved gases etc. The process of removing hardness producing substances, from water is known as softening or conditioning of water.

Softening of water can be done by two methods

- External treatment
- Internal treatment

### **External treatment**

It involves the removal of hardness producing salts from the water before feeding into the boiler. The external treatment can be done by the following methods

- Lime soda process
- Zeolite or permutit process
- Demineralisation or ion exchange process

### **Demineralization or ion exchange process**

In this process almost all the ions (Both hardness producing anions and cations) present in the hard water gets removed

The soft water produced by zeolite process does not contain hardness producing  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions. But it will contain other ions like  $\text{SO}_4^{2-}$  and  $\text{Cl}^-$  ion. On the other hand D.M (Demineralised water) does not contain both hardness producing cations and anion

In this process ion exchange resins are used which are long chain, cross linked, insoluble organic polymers with a microporous structure. The functional groups attached to the chains are responsible for the ion exchanging properties.

### **Cation exchanger**



Resins containing acidic functional groups ( $-\text{COOH}$ ,  $-\text{SO}_3\text{H}$ ) which are capable of exchanging their  $\text{H}^+$  ions with other cations of hard water are called cation exchangers. The back bone is represented as  $\text{RH}_2$

Examples

- Sulphonated coals
- Sulphonated polystyrene

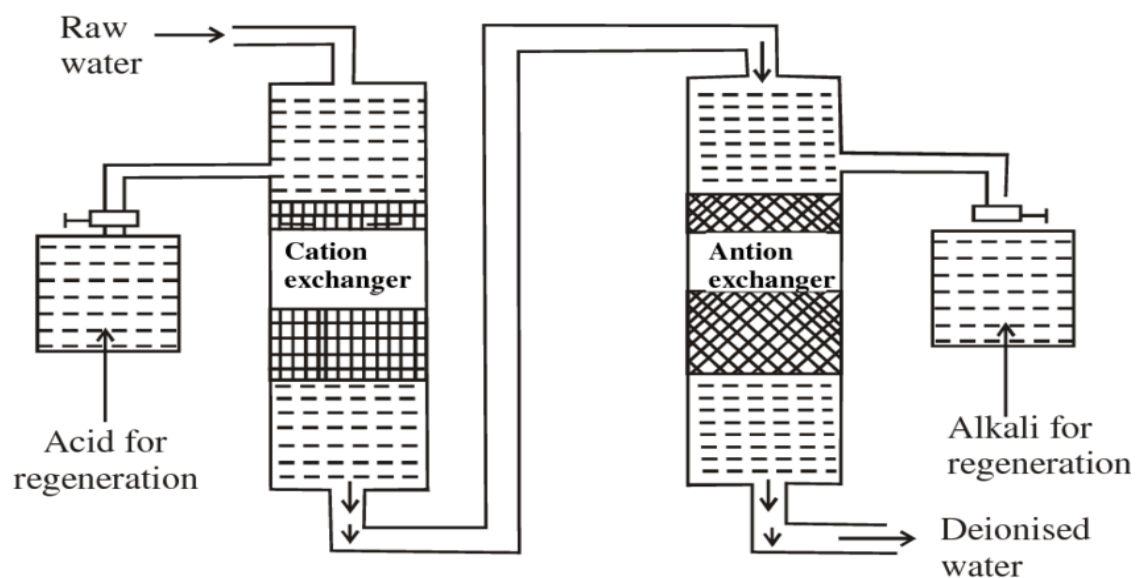
### Anion exchanger

Resins containing basic functional groups ( $-\text{NH}_2$ ,  $-\text{OH}$ ) which are capable of exchanging their  $\text{OH}^-$  ions with other anions of hard water are called anion exchange resins. The back bone is represented as  $\text{R}(\text{OH})_2$

Examples

- Cross linked quaternary ammonium salts
- Urea-Formaldehyde resin

### Process:



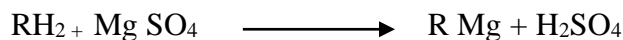


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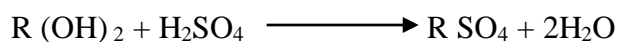
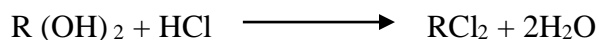
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The hard water is passed first through cation exchange column. It removes all the cations ( $\text{Ca}^{2+}$  &  $\text{Mg}^{2+}$ ) and equivalent amount of  $\text{H}^+$  ions are released from this column.



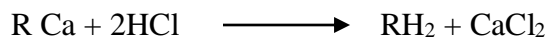
After this the hard water is passed through anion exchange column, which removes all the anions like  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$ ,  $\text{CO}_3^{3-}$  etc and release equal amount of  $\text{OH}^-$  from this column.



## Regeneration

The output water is also called as de ionised water or demineralized water after this the ion exchanges get exhausted.

The cation exchangers are regenerated by mineral acid (HCl)



Anion exchanges are regenerated by dil NaOH solution.



## Advantages of ion exchange method

- It can treat highly acidic or alkaline water.
- We can get pure water as hardness as low of 2 ppm.

## Drawbacks of Ionexchange method



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- Expensive
- Fe, Mn cannot be removed as they form complexes with resins
- Cannot be used for turbid water as they clog the resins.