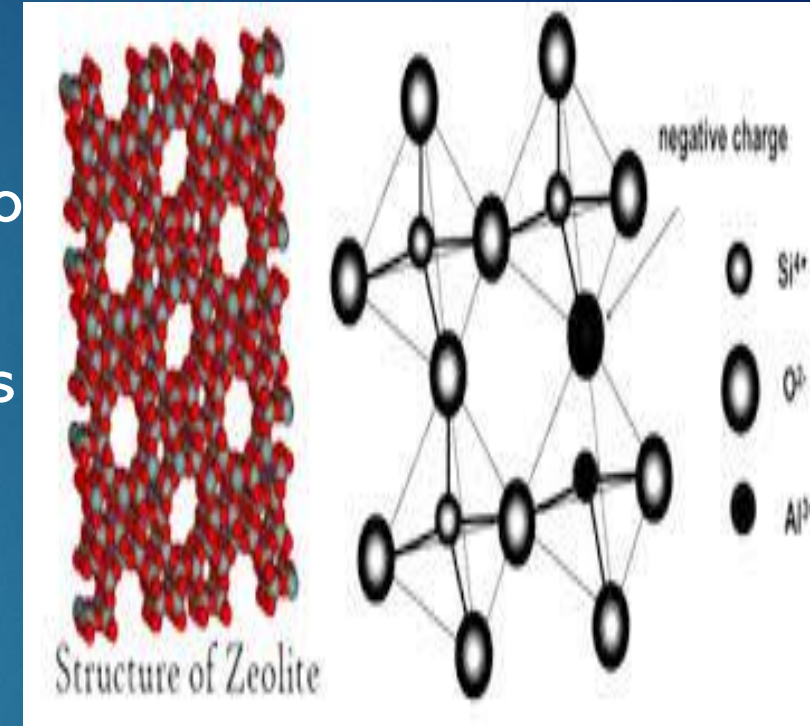





# ENGINEERING CHEMISTRY

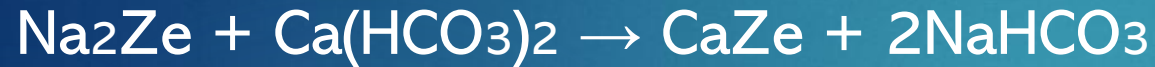
## ZEOLITE PROCESS

- ▶ Zeolites are hydrated sodium aluminosilicate minerals with general formula  $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot x \text{SiO}_2 \cdot y \text{H}_2\text{O}$  where  $x = 2 - 10$  and  $y = 2 - 6$ . commonly used as commercial adsorbents and catalysts.
- ▶ Zeolites occur naturally but are also produced industrially on a large scale.
- ▶ Zeolites are also known as Permutits which in Greek means boiling stone
- ▶ Zeolites have a porous structure that can accommodate a wide variety of cations, such as  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$  and others. These positive ions are rather loosely held and can readily be exchanged for others in a contact solution. Some of the more common mineral zeolites are natrolite, Phillip site, and stilbite. An example of the mineral formula of a zeolite is:  $\text{Na}_2 \text{Al}_2 \text{Si}_3 \text{O}_{10} \cdot 2\text{H}_2\text{O}$ , the formula for natrolite

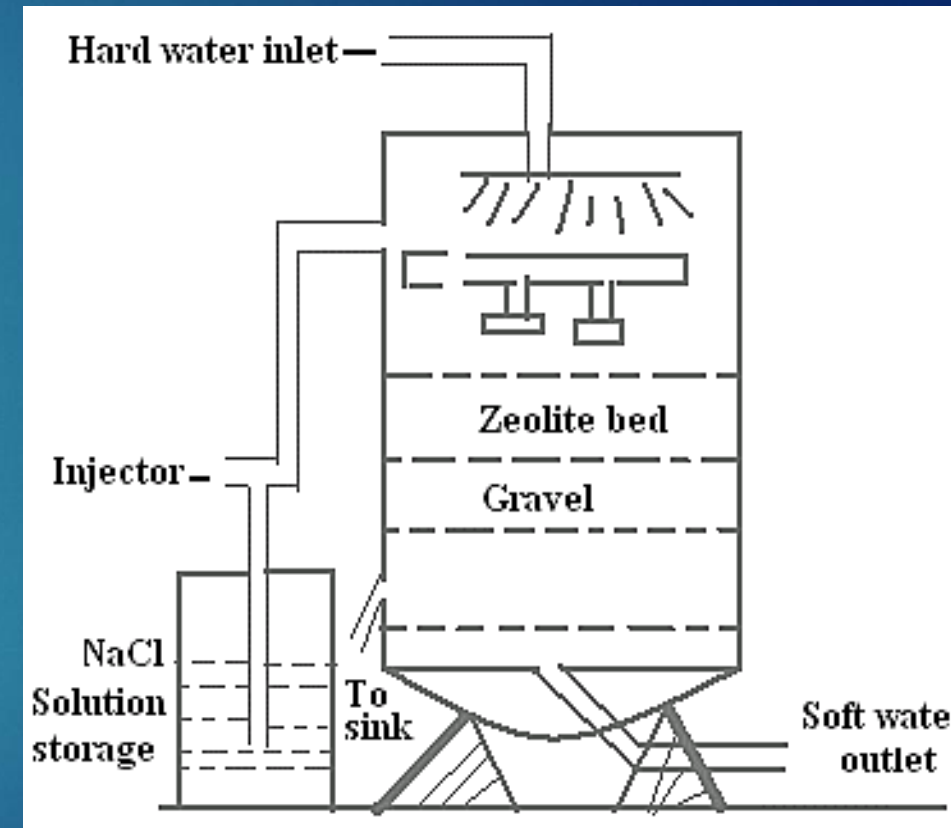
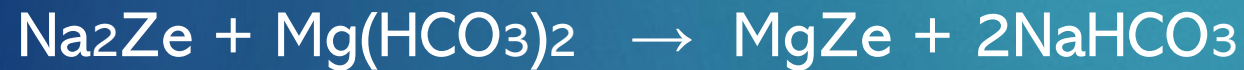


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- ▶ Sodium zeolite softening is the most widely applied use of ion exchange.
  - ▶ In zeolite softening, water containing scale-forming ions, such as calcium and magnesium, passes through a resin bed containing Zeolite resin in the sodium form.
  - ▶ In the resin, the hardness ions are exchanged with the sodium, and the sodium diffuses into the bulk water solution.
  - ▶ The hardness-free water, termed soft water, can then be used for low to medium pressure boiler feedwater, some chemical processes, and commercial applications, such as laundries.

- ▶ For softening of water by zeolite process, hard water is percolated at a specified rate through a bed of zeolite, kept in a cylinder. □ The hardness causing ions ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ , etc.) are retained by the zeolite as  $\text{CaZe}$  and  $\text{MgZe}$ ; while the outgoing water contains sodium salts.



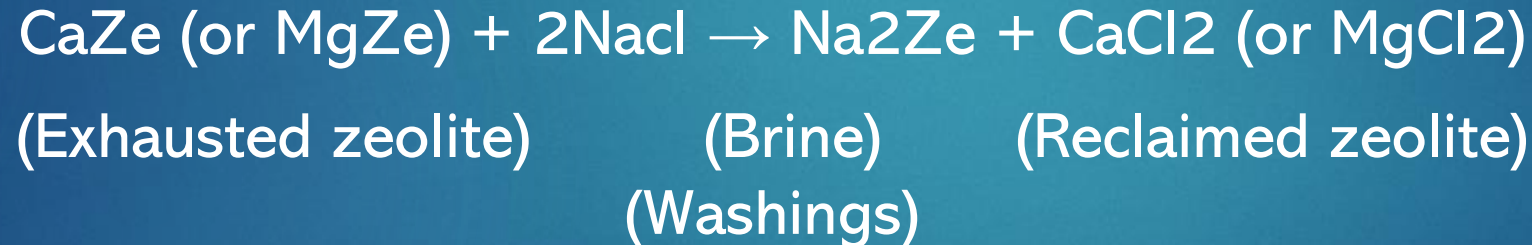
(Zeolite) (Hardness)





## Regeneration

- ▶ After some time, the zeolite is completely converted into calcium and magnesium zeolite and it ceases to soften water, i.e., it gets exhausted.
- ▶ At this stage, the supply of hard water is stopped and the exhausted zeolite is reclaimed by treating the bed with a concentrated (10%) brine (NaCl) solution.



- ▶ The washing (containing  $\text{CaCl}_2$  and  $\text{MgCl}_2$ ) are led to drain and the regenerated zeolite bed thus-obtained is used again for softening purpose.



► Limitations of process:

1. If the supply of water is turbid, the suspended matter must be removed (by coagulation, filtration, etc.), before the water is admitted to the zeolite bed ; otherwise the turbidity will clog the pores of zeolite bed, thereby making it inactive.

2. If water contains large quantities of coloured ions such as  $Mn^{2+}$  and  $Fe^{2+}$  they must be removed first, because these ions produce manganese and iron zeolite, which cannot be easily regenerated.

3. Mineral acids, if present in water, destroy the zeolite bed and, therefore, they must be neutralised with soda, before admitting the water to the zeolite softening plant.

## Advantages of process:

1. It removes the hardness almost completely and water of about 10 ppm hardness is produced.
2. The equipment used is compact, occupying a small space.
3. No impurities are precipitated, so there is no danger of sludge formation in the treated water at a later stage.
4. The process automatically adjust itself for variation in hardness of incoming water.
5. It is quite clean.
6. It requires less time for softening.
7. It requires less skill for maintenance as well as operation.



## Disadvantages of process :

- ▶ The treated-water contains more sodium more sodium salts than in lime-soda process.
- ▶ The method only replaces  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions, but leaves all the acidic ions ( like  $\text{HCO}_3^-$  and  $\text{CO}_3^{2-}$ ) as such in the softened water. When such softened water (containing  $\text{NaHCO}_3$  ,  $\text{Na}_2\text{CO}_3$  ,etc.) is used in boilers for steam generation, sodium bicarbonate decomposes producing  $\text{CO}_2$  , which causes corrosion ;and sodium carbonate hydrolysis to sodium hydroxide, which causes caustic embrittlement.
- ▶ High turbidity water cannot be treated efficiently by this method, because fine impurities get deposited on the zeolite bed, there by creating problem for its working.