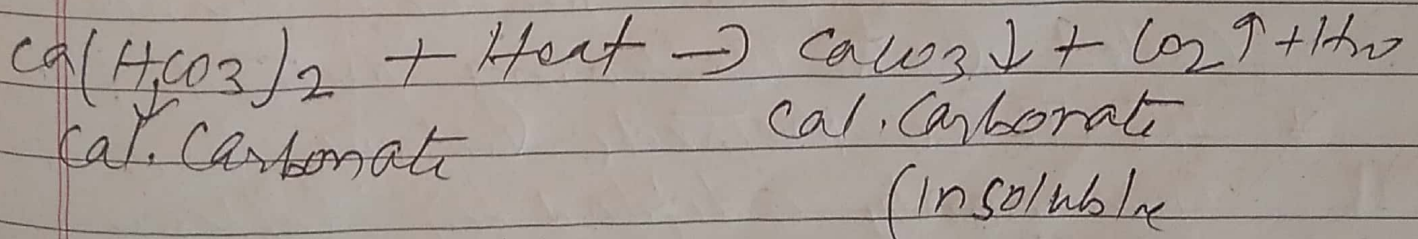


- The Treatment for removing the hardness or dissolved impurities from water is known as softening of water.
- The water containing chlorides, sulphates and bicarbonates of calcium and magnesium is referred as hard water.
- The hardness may be temporary and permanent.
- The hardness due to the presence of calcium and magnesium carbonates or bicarbonates is known as temporary hardness.
- The hardness due to presence of sulphates, chloride and nitrates of calcium and magnesium is known as permanent hardness.
- The temporary hardness may be removed by boiling the water or by adding lime water in the water which is called lime process.
- The permanent hardness of water may be removed by lime soda process, zeolite (silicate of sodium) or base exchange process (also known as cation exchange method).

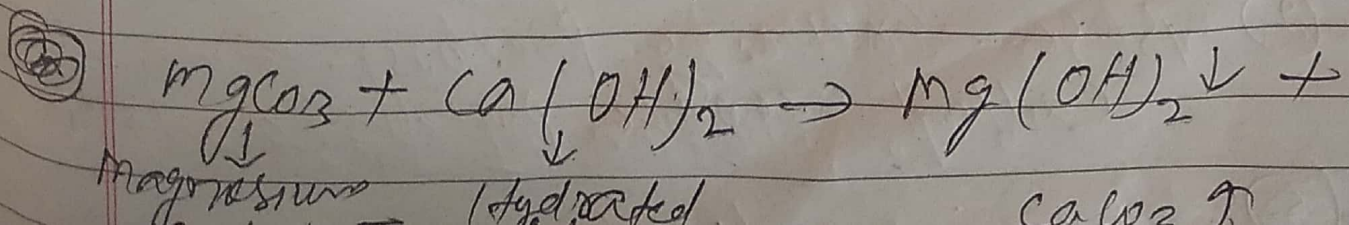
* Method of Removing Temporary Hardness

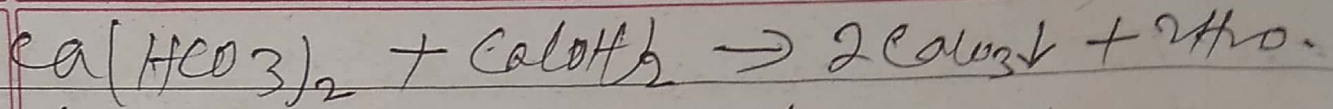
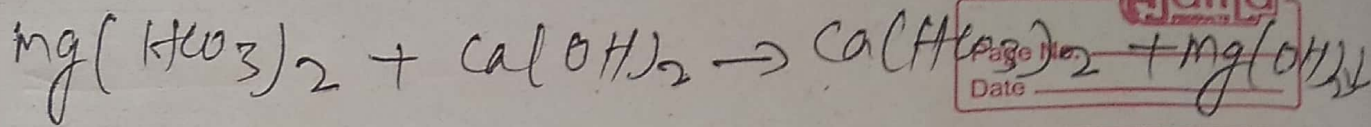
→ The temporary hardness can be removed either by ~~soft~~ boiling or by adding lime to the water as given below.

① Boiling → Calcium carbonate, being only slightly soluble, will usually exist in water as calcium bicarbonates because it easily dissolves in natural water containing carbon dioxide. When such a water is boiled, the carbon dioxide gas will get out leading to the precipitation of CaCO_3 which can be sedimented out by setting aside. The reaction can be represented as



② Addition of lime → Lime (CaO), generally hydrated lime (Ca(OH)_2) is added to the water. The following reaction takes place,





- The calcium carbonate and magnesium hydroxide are precipitated and can be removed in the sedimentation tank.
- This method is generally adopted for softening water which contains only temporary hardness.

* Method of Removing Permanent Hardness

→ The permanent hardness is more permanent and difficult to remove.

→ It can however be removed by certain special method generally called water softening methods.

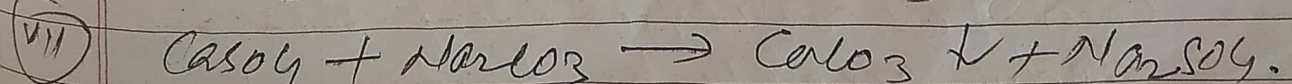
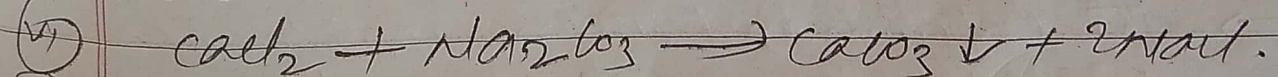
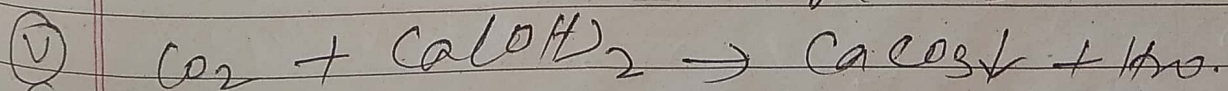
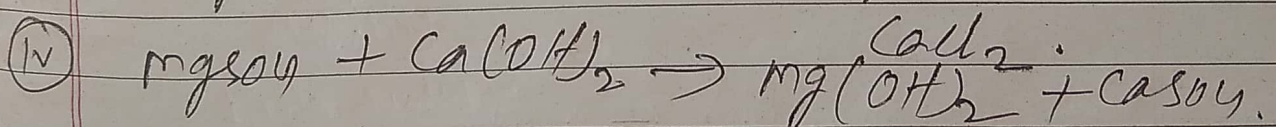
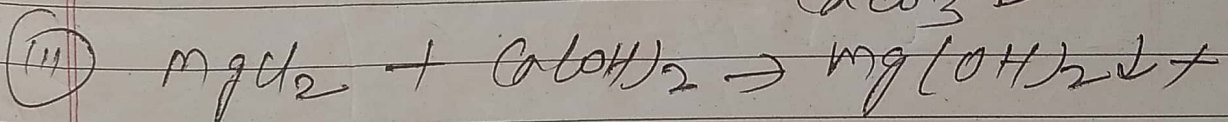
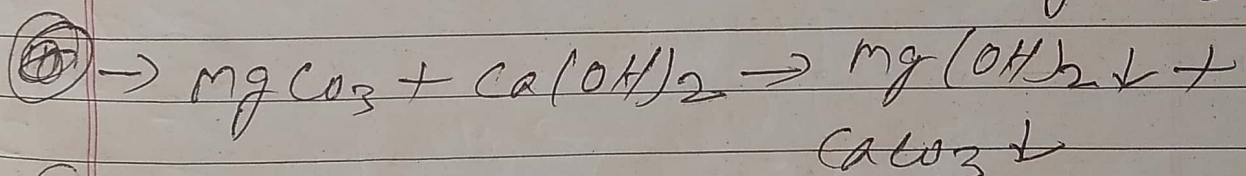
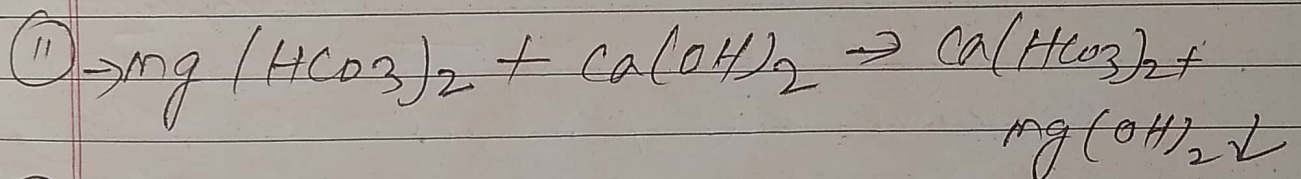
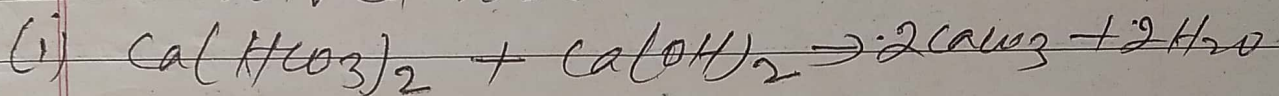
* The three methods which are commonly adopted for softening waters containing either permanent hardness or temporary hardness are:

- ① Lime-soda process
- ② Base-exchange process - generally called zeolite process and
- ③ Demineralisation process.

① Lime soda process for removing hardness

→ In this process lime (Ca(OH)_2) and soda ash (Na_2CO_3) are added to the hard water which react with the calcium and magnesium salt, so as to form insoluble precipitates of calcium carbonate and magnesium hydroxide.

→ The chemical reaction which may be involved are.

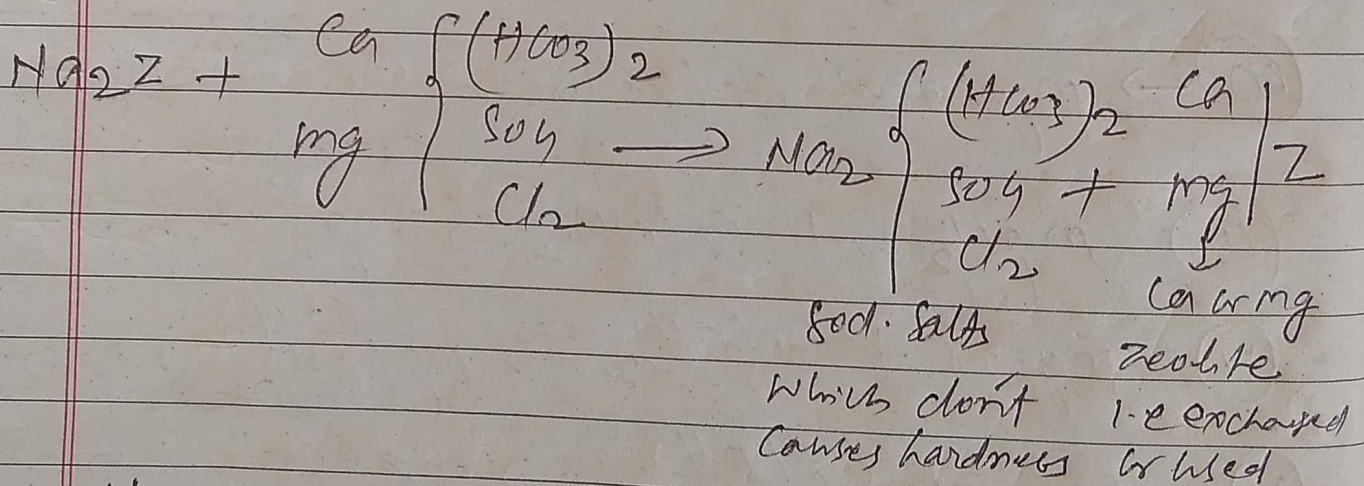


→ From the above reaction, it can be easily seen that lime helps in removing the entire carbonate hardness.

②

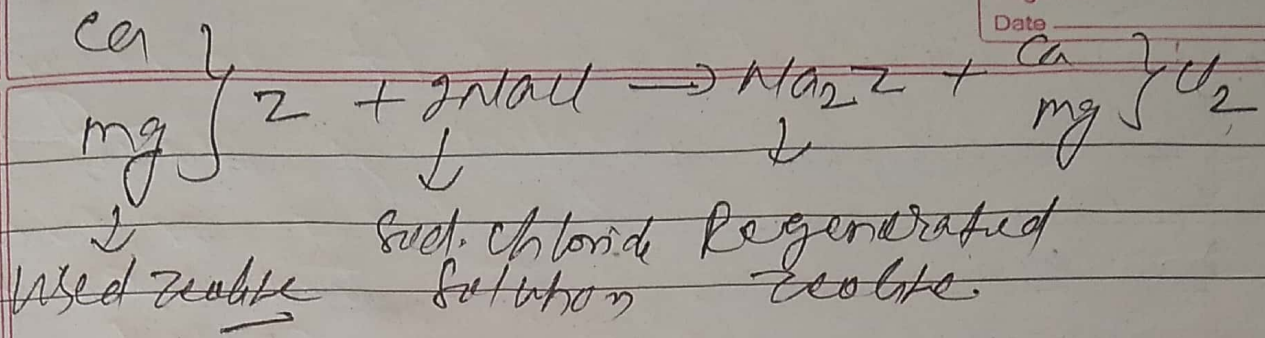
Zeolite or Base-Exchange Cation Exchange processes

removing Hardness $\rightarrow$ Zeolite are natural salt or clays, which are hydrated silicates of sodium and aluminium having the general formula as ~~$\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot x\text{SiO}_2 \cdot y\text{H}_2\text{O}$~~ $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot x\text{SiO}_2 \cdot y\text{H}_2\text{O}$. The usual value of x is 2 or more and that of y of ranging amounts. Naturally occurring zeolite like substances can also be manufacturing synthetically and they are known as Resins.



- $\rightarrow$ The calcium and magnesium Zeolite can be regenerated into active sodium zeolite by treating it with 5-10% solution of sodium chloride.
- $\rightarrow$ The exchange reaction that take place during regeneration

can be represented as.



* A zeolite softener (or a cation exchange unit) resembles a sand filter in which the filtering medium is a zeolite rather than sand.

→ The hard water enters through the top, and is evenly distributed on the entire zeolite bed. The softened water is collected through the strainers at the base. When a significant portion of the sodium in the zeolite has been replaced by calcium and magnesium, it is regenerated by first washing it with water by ~~top~~ reversing the flow and then treating it with 10% solution by brine.

③ demineralisation process for Removing Hardness → As its very name implies ~~det~~ demineralisation means removing the minerals from the water. Since this process helps us in completely removing or reducing the minerals content

by any desired extent it is very suitable for producing water of any desired hardness or even mineral free water. This demineralised water, sometimes called de-ionised water is as pure as distilled water and is very suitable for industrial purposes, especially for steam raising in high pressure boilers.

→ This complete removal of minerals present in water can be carried out by first passing the water through a bed of cation exchanging resins, and then through a bed of anion exchange resins.

