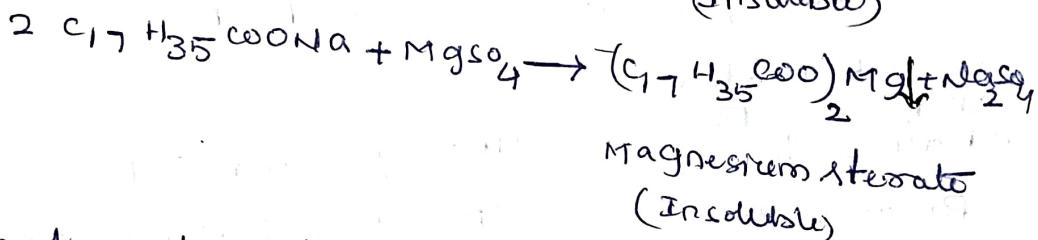
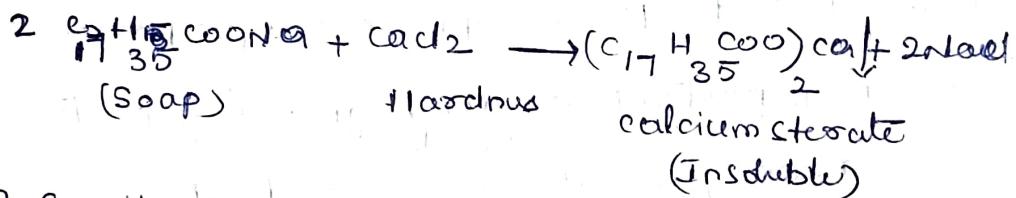


Hardness of water:

water which does not give good lather readily with soap is called Hard water.

This is due to presence of certain salts of water of calcium, Magnesium and other heavy metals dissolved in it. When a sample of Hard water treated with soap does not produce lathers but forms a white scum (or) precipitate.

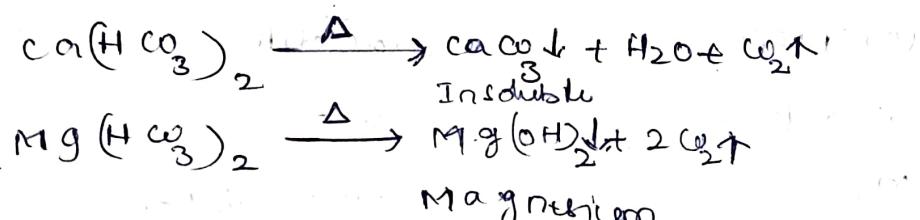


Hardness of water is divided into two types based on presence of chemicals (salts).

1. Temporary (or) carbonate Hardness:

It is caused by the presence of dissolved bicarbonates of calcium and magnesium and other heavy metals and the carbonate ion.

Temporary hardness is mostly removed by simply boiling of water.



Insoluble carbonates (or) hydroxides deposited as a crust at the bottom of vessel.

(2) Permanent (or) Non-carbonate Hardness
 It is also known as non-carbonate or non-alkaline Hardness.
 The presence of chlorides and sulphates of calcium and magnesium, Iron and other tracing metals in water. Unlike temporary Hardness, permanent hardness is not destroyed on boiling.
 $\text{CaCl}_2, \text{CaSO}_4, \text{MgSO}_4, \text{FeSO}_4, \text{Al}_2(\text{SO}_4)_3$ etc.

Degree of Hardness

Hardness of water conveniently expressed in terms of equivalent amount of CaCO_3 (Equivalents)

The reason for choosing CaCO_3 as the standard for reporting hardness of water is the ease in calculation as its m.w. is exactly 100. Moreover it is ~~more~~ the most insoluble salt that can be precipitated in water treatment.

$$\text{Equivalents of } \text{CaCO}_3 = \left[\frac{\text{Mass of hardness}}{\text{producing substance}} \right] \times \frac{\text{Chemical Equivalent of } \text{CaCO}_3}{\text{Chemical Equivalent of } \text{CaCO}_3}$$

Chemical Equivalent of Hardness producing substance.

$$= \frac{\text{Mass of hardness}}{\text{producing substance}} \times 50$$

Chemical Equivalent of Hardness producing substance

$$= \left[\frac{\text{Mass of hardness}}{\text{producing substance in mg/L}} \right] \times \frac{\text{Multiplication factor in mg/L}}{\text{PPM}}$$

Dissolved salt/ion	Molar Mass	Chemical Equivalent	Multiplication factor converting into equivalents of CaCO_3
$\text{Ca}(\text{HCO}_3)_2$	162	81	100/162
CaCl_2	111	55.5	100/111
$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	278	139	100/278

Units of Hardness

[parts per million (PPM)]

[milligrams per litre (mg/L)]

Units of Hardness

Degree French ($^{\circ}\text{F}$)

Degree Clarke ($^{\circ}\text{Cl}$)

1 parts per million (PPM)

1 part of CaCO_3 Eq. Hardness

It is defined as the number of parts by weight of calcium carbonate present per million (10^6) parts by weight of water.

i.e. 1 PPM = 1 part of CaCO_3 equivalents hardness in 10^6 parts of water.

2) milligrams per litre (mg/L): It is defined as the number of milligrams of CaCO_3 present in one litre of water.

1 mg/L = 1 mg of CaCO_3 equivalent Hardness per litre of water.

∴ 1 mg/L = 1 PPM for water

We know that $1\text{L} = 1\text{kg} = 10^6\text{mg}$ ($d = \frac{m}{V}$ $m = V \cdot d = r$)

$1\text{mg/L} = 1\text{mg of } \text{CaCO}_3 \text{ equivalent Hardness per lit of water}$

= 1 mg " " "

= 1 part " " "

" " 10^6 mg of water

" " 10^6 parts of water

$1\text{mg/L} = 1\text{PPM}$

(3) Degree Clarke ($^{\circ}\text{Cl}$)

It is defined as the parts of CaCO_3 equivalent hardness per 70,000 parts of water.

$\therefore 1^{\circ}\text{Cl} = 1 \text{ part of } \text{CaCO}_3 \text{ per 70,000 parts of water.}$

(4) Degree French ($^{\circ}\text{Fr}$)

It is defined as the parts of CaCO_3 equivalent hardness per 10^5 parts of water.

$1^{\circ}\text{Fr} = 1 \text{ part of } \text{CaCO}_3 \text{ equivalent Hardness per } 10^5 \text{ parts of water.}$

Relationship between various units of Hardness

$$10^6 \text{ PPM} = 10^5 \text{ }^{\circ}\text{Fr} = 70,000 \text{ }^{\circ}\text{Cl}$$

$$1 \text{ PPM} = 0.1 \text{ }^{\circ}\text{Fr} = 0.07 \text{ }^{\circ}\text{Cl}$$

$$1 \text{ PPM} = 1 \text{ mg/L} = 0.1 \text{ }^{\circ}\text{Fr} = 0.07 \text{ }^{\circ}\text{Cl}$$

Boiler Feed water (water for steam generation)

water is mainly used in boilers for the generation of steam. In this water all the impurities are not necessarily eliminated and only some of the impurities which lead to operational trouble.

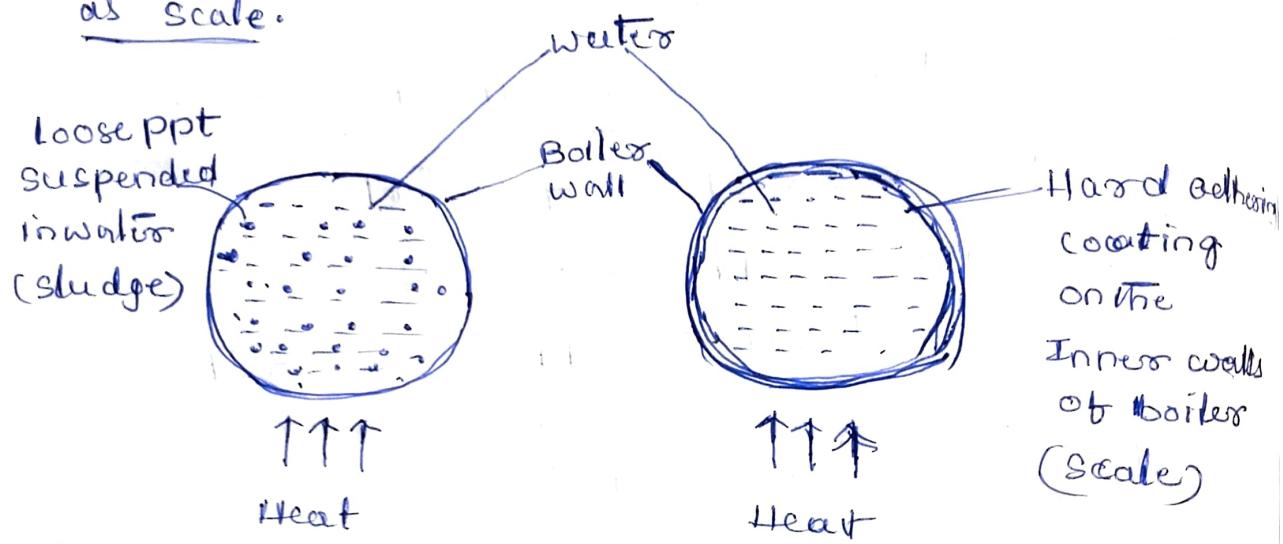
Generally A boiler-feed water should have the following composition

- (a) Its hardness should be below 0.2 ppm
- (b) Its caustic alkalinity (due to OH^-) should lie in between 0.15 ppm and 0.45 ppm
- (c) Its soda alkalinity (Na_2CO_3) should be 0.45-1 ppm
if Excess of impurities present them in Boiler feed water generally cause the following problems
 - 1) scale & sludge formation
 - 2) corrosion
 - 3) priming & foaming
 - (4) caustic embrittlement.

Scale and sludge formation in boilers

In a boiler, water is continuously evaporated to form steam. This increases the concentration of dissolved salts. Finally a stage is reached when the Ionic product of these salts exceeds their solubility product and hence they are thrown out as precipitates.

- If the precipitates formed are soft, loose and slimy, these are known as sludge, while if the precipitate is hard and adhering on the inner walls, it is called as scale.



Sludges can easily be scrapped off with a wire brush.
" are formed at cooler place in boiler.
" are formed by the substance which have greater solubility in hot water than cold water.
Eg: $MgCO_3$, $MgCl_2$, $CaCl_2$, $MgSO_4$ etc.

Disadvantages:

- ① Sludges are poor conductors of heat, so they tend to waste a portion of heat generated.
- ② If the sludges are formed along with scale, then former gets entrapped and both get deposited as scales.
- ③ Excessive sludge formation disturbs the working of boiler.

Prevention

- (1) By using well softened water
- (2) By frequently blowing down operation

scale

scales are hard deposits firmly sticking to the inner surface of the boiler. They are difficult to remove, even with the help of hammer and chisel, scales are the main source of boiler troubles.

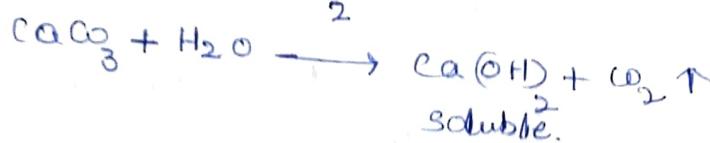
Formation of scales due to

(1) Decomposition of calcium bicarbonate

$\text{Ca}(\text{HCO}_3)_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$
 But scale composed chiefly of CaCO_3 is soft and is called Scale.
 The main cause of scale formation in low-pressure boilers.

But in high pressure boilers, CaCO_3 is soluble due to

The Formation of $\text{Ca}(\text{OH})_2$



(2) Deposition of CaSO_4

The solubility of CaSO_4 in water decreases with increase in temp. CaSO_4 soluble in cold water, but almost completely insoluble in super-heated water; consequently CaSO_4 gets ppt as hard scale on the hotter parts of the boiler. This type of scale causes troubles in high-pressure boiler.

(3) presence of silica (SiO_2)

Even if a small quantity of SiO_2 present, it may deposit as calcium silicate (Ca_2SiO_4) and/or magnesium silicate (MgSiO_4). These deposits adhere very firmly on the inner side of the boiler surface and very difficult to remove.

(4) Hydrolysis of Magnesium salts

Dissolved magnesium salts get hydrolysed forming $\text{Mg}(\text{OH})_2$ ppt, which forms a soft type of scale.



Disadvantages

(a) wastage of fuel

Scales have a poor thermal conductivity so the rate of heat transfer from boiler to inside water is greatly reduced. In order to provide a steady supply of heat to water, excessive (or) over heating is done and this causes increase a fuel consumption.

The wastage of fuel depending on the thickness of scale.

Thickness of scale (mm)	0.325	0.625	1.25	2.5	12
-------------------------	-------	-------	------	-----	----

wastage of fuel	10%	15%	50%	80%	150%
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(b) Decrease in efficiency

~~Deposition~~ Scales may sometimes deposit in the valves and condensers of the boiler and choke them partially. This results in decrease in efficiency of the boiler.

(c) Lowering of Boiler safety

(d) Danger of Explosion

Removal of scales.

- (1) With help of scraper (or) piece of wood (or) wire brush, if the scales are loosely adhering.
- (2) By frequent blow-down operation, if the scales are loosely adhering.
- (3) By giving Thermal shocks, if the scales are brittle
- (4) By dissolving them by adding them chemicals, if the scales are strongly adherent & hard.

Prevention of scales formation

- (1) External treatment (softening of hard water)
- (2) Internal Treatment : (Sequestration)

- In this method some chemicals reagents are added directly to the boiler water for removing dangerous scale forming salts.
- The chemicals convert the scale forming impurities into sludge (or) more dissolved compounds
- This method is generally followed by blow-down operation.

Important internal conditioning / treatment methods.

(1) carbonate conditioning.

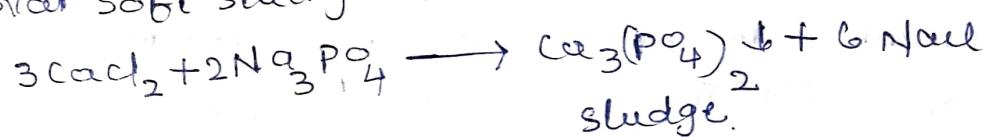
Reagent added to boiler water is sodium carbonate. In low pressure boiler scale formation can be avoided by adding sodium carbonate to boiler water.



Deposition of CaCO_3 as scale does not take place and calcium is ppt precipitated as loose sludge of CaCO_3 which can be removed by blowdown operation.

(2) phosphate conditioning.

Reagent added to the boiler water Sodium phosphate. In high-pressure boiler scale formation can be avoided by adding sodium phosphate. It reacts with hardness of water forms non-adherent, easily removal soft sludge of cal mg phosphate.



We can use different phosphates based on pH of water

Na_3PO_4 (alkaline nature) is used when alkalinity is low

Na_2HPO_4 (weakly alkaline) is used when alkalinity is sufficient

NaH_2PO_4 (acidic) is used when alkalinity is high.

Calgon conditioning

The reagent added to boiler water is calgon.

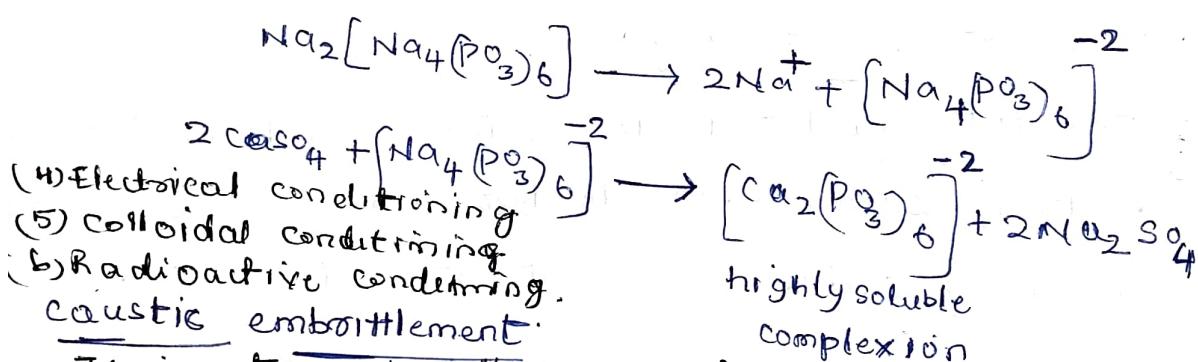
calgon is sodium hexametaphosphate $\text{Na}_2[\text{Na}_4(\text{PO}_3)_6]$

The process involves the addition of calgon to boiler water.

It prevents scale & sludge formation by forming highly

soluble hex metaphosphate complex compound with

CaSO_4



It is a type of boiler corrosion.

The formation of brittle and in crystalline cracks in the boiler is called caustic embrittlement.

- It is a type of boiler corrosion, caused by highly alkaline water in the boiler

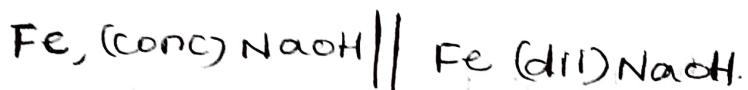
- During softening of water by lime-soda process, free Na_2CO_3 is usually present in small amount in softened water. In high pressure boilers, Na_2CO_3 decomposes to give NaOH & CO_2 , which makes boiler water caustic



This caustic water flows into the minute hair-cracks present in the inner side of boiler. On evaporation of water the dissolved caustic soda concentration

increases, which attacks the surrounding area
area by dissolving Iron of boiler as sodium ferrate.
This causes embrittlement of boiler walls more
particularly stressed parts (like bends, joints, rivets
etc.)

Mechanically embrittlement arises due to
the setting up of concentration cell.



Iron in the anode + cathode
anodic part gets dissolved (or) corroded.

Prevention

- (1) By using sodium phosphate as softening reagent instead of sodium carbonate in external treatment of boiler water.
- (2) By adding tanin (or) lignin to ~~not~~ boiler water which blocks the hair cracks in the boiler.
- (3) By adding sulphate to boiler water.

Priming & foaming

when a boiler is steaming rapidly, some particles of the liquid water are carried along with the steam. This process of 'wet steam' formation is called priming.

priming caused by

- (1) The presence of large amount of dissolved solids
- (2) High steam velocities
- (3) Sudden boiling
- (4) Improper boiler design.
- (5) Sudden increase in steam production rate.

Priming can be avoided by

- (1) efficient softening and filtration of boilers feed water.
- (2) Maintain low-water level in boiler.
- (3) Avoiding rapid change in steam rate.

Foaming

It is the production of persistent foam (or) bubbles in boilers, which do not break easily.

Foaming is due to presence of substance like oils.

Foaming can be avoided by-

- (1) adding anti-foaming chemicals like castor oil.
- (2) removing oil from boiler by adding ^{water} compounds like sodium aluminate.

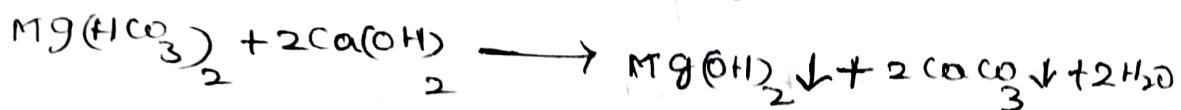
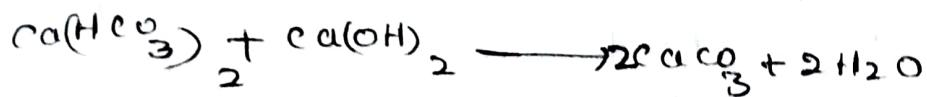
Softening methods

The process of removing hardness - producing salts from water is known as softening of water. In industry main three methods used for softening of water.

(1) lime-soda process

In this process hydrated lime & soda are to remove hardness from water.

In this Method, the soluble calcium and magnesium salts in water are chemically converted into insoluble compounds, by adding calculated amount of lime $[Ca(OH)_2]$ and soda $[Na_2CO_3]$, $CaCO_3 \& Mg(OH)_2$ so precipitated, finally filtered off.



The amount of lime-soda required for the softening of hardwater can be calculated by the following Formulae.

$$\text{lime requirement} = \frac{74}{100} \left[\begin{array}{l} \text{Temp hardness of } Ca^{+2} \\ + \text{Temp hardness of } Mg^{+2} \end{array} \right] + \text{Permanent Hardness of } Mg \text{ in terms of } CaCO_3 \text{ equivalent}$$

$$\text{soda requirement} = \frac{106}{100} \left[\begin{array}{l} \text{permanent Hardness of} \\ CaCO_3 + CaCl_2 + MgCl_2 + MgSO_4 \\ \text{in terms of } CaCO_3 \text{ Equivalent} \end{array} \right]$$

lime-soda process again divided into two types

(1) cold lime-soda process

(2) Hot lime-soda process

soda
It is better method than cold-lime process because purified water Hardness is 15 to 30 ppm.

Water with the process involves in treating softing chemicals at a temp of 80 to 150°C (lime + soda)

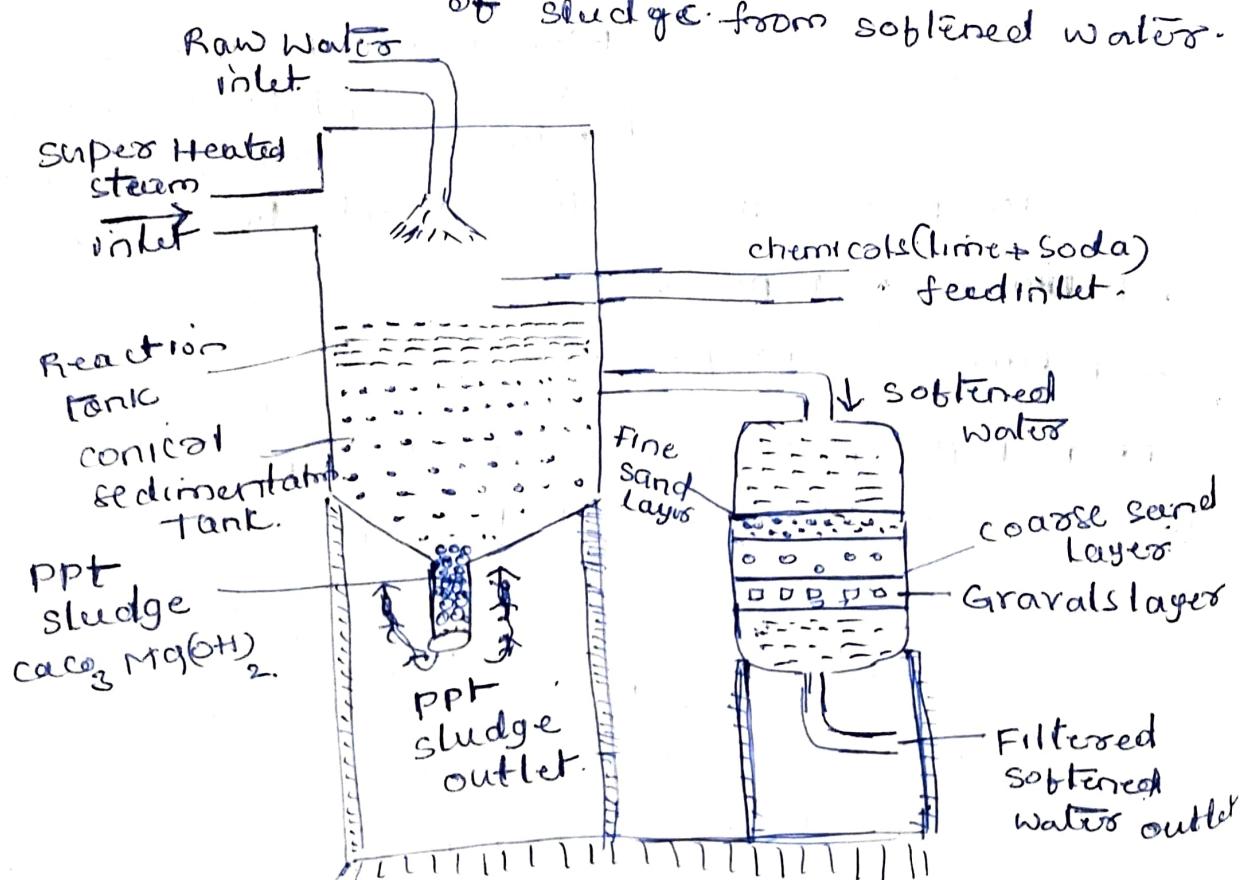
Since Hot process is operated at a temp close to the boiling point of the solution.

so the following advantages were observed

- (a) the reaction proceeds ~~more~~ faster
- (b) the softening capacity of hot process is increased many times
- (c) the PPT & sludge formed settle down rapidly so that no ~~any~~ coagulants are needed.
- (d) much of dissolved gases (CO_2 & air) driven out of the water
- (e) viscosity of softened water is lower
- (f) residual hardness of water is 15 to 30 ppm.

Hot lime soda plant consists of three parts

- (a) reaction tank (): In this part raw water, chemicals and steam are mixed.
- (b) conical sedimentation vessel : In this part formed sludges settle down.
- (c) sand filter : This ensures complete removal of sludge from softened water.



Note (1) In cold lime-soda process, chemicals (lime + soda) are added at room temp.

(2) PPT are not filtered easily, so that some coagulants (like alum, $\text{Al}_2(\text{SO}_4)_3$, NaAlO_2 , etc) are added in small amounts.

(3) Finally purified water has residual hardness of 50 to 60 ppm.

Due to the above problems in cold-lime-soda process, hot-lime-soda process commonly used for the purification of Hard water.

Ion exchange (or de-ionization (or) de-mineralization process)

Ion exchange resins are insoluble organic polymers with high molecular weight cross linked porous and the functional groups attached to the chains are responsible for the ion exchange properties.

Ion exchange resins are generally copolymers of styrene-divinyl benzene.

Ion exchange resins are of two types
cation exchange resins

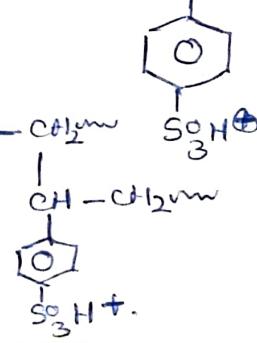
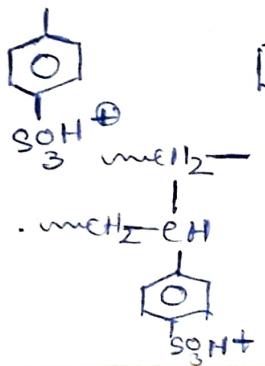
anion exchange resins.

cation exchange resins (RH^+)

These are capable of exchanging H^+ ions with cations.

It is mainly styrene divinyl benzene copolymer.

They have acidic functional groups like $-\text{SO}_3^-$, $-\text{COOH}$, etc.



Cation exchange resin (CROH)

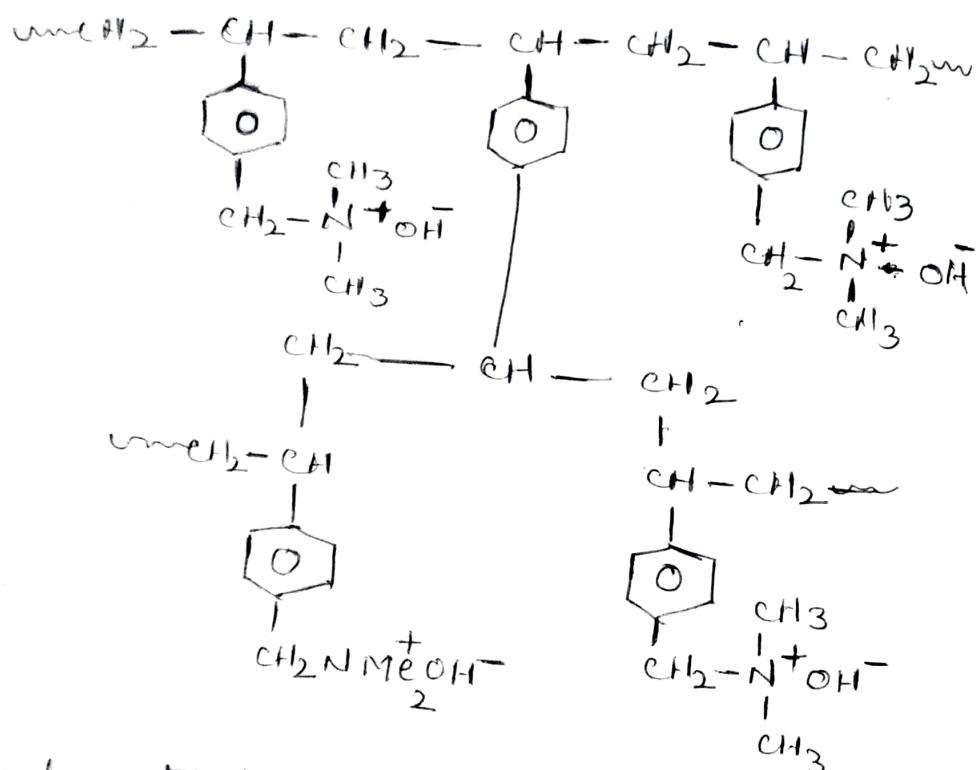
(i) They are capable of exchanging OH^-

ions with the anions.

(ii) It is nothing but a copolymer of styrene divinyl benzene.

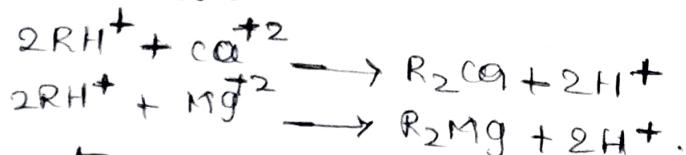
(iii) They contain basic functional group like quaternary ammonium.

(iv) On treatment with dil NaOH they have capability to exchange its OH^- ions with anions in the water.



The cation exchange removes all cations like Ca^{+2} , Mg^{+2} from it.

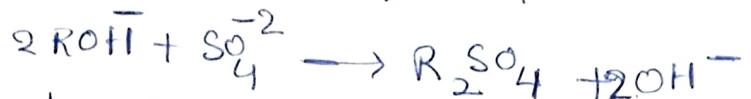
And equivalent amount of OH^- ions are released from the column to water.



The hard water now passes through anion exchange column.

which removes all the anions like SO_4^{-2} , Cl^- from it.

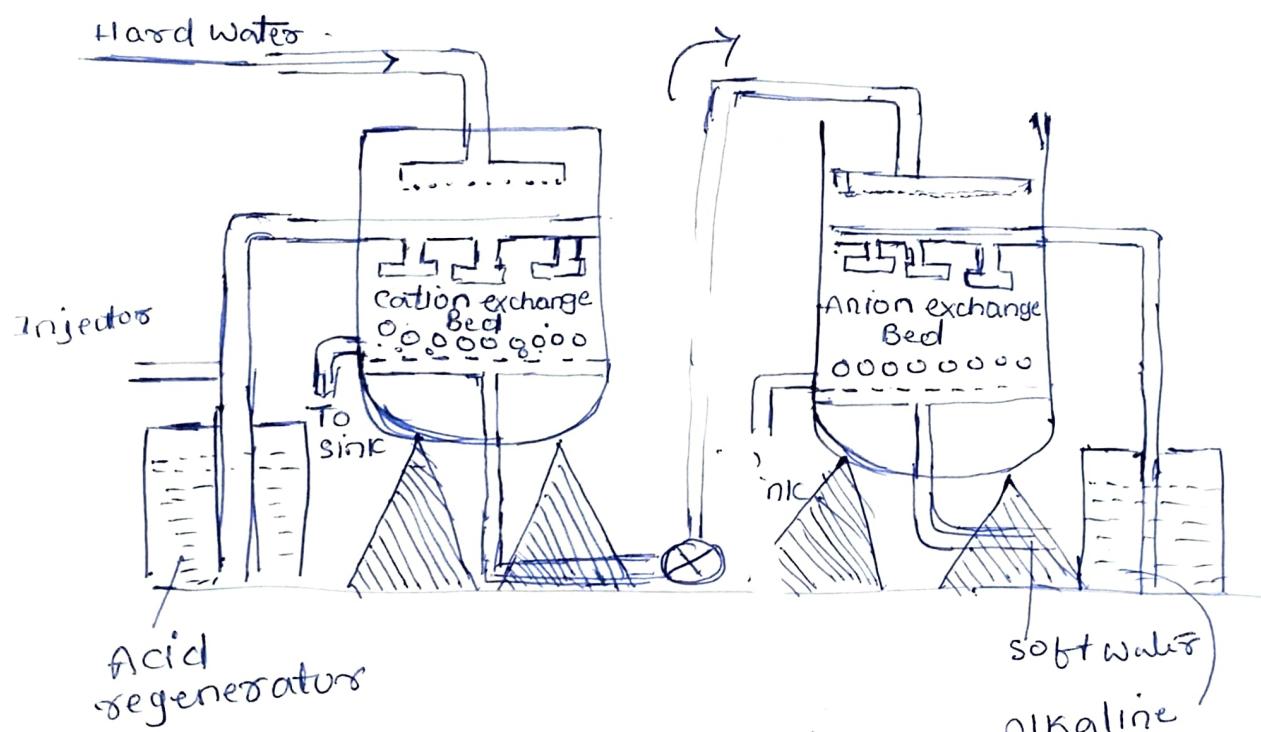
And equivalent amount of OH^- ions are released from the column to water.



H^+ and OH^- ions are released from cation exchange and anion exchange column respectively get combined to produce water molecule.



water coming out from exchangers is free from cations and anions and is known as deionized (or) demineralized water.

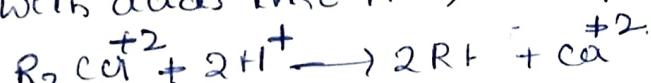


Regeneration of exhausted beds:

when the beds are getting exhausted (capacity to exchange H^+ & OH^- ions are lost)

then they are regenerated.

The exhausted cation exchanger is regenerated by washing with acids like HCl , H_2SO_4 etc.



The exhausted anion exchanger is regenerated by washing with bases like $NaOH$



The columns are washed with deionized water and washing are paused to sink (or) drain. Now they are ready for softening process.

Advantages

- (1) The process can be used to soften highly acidic & alkaline waters.
- (2) It produces water of very low hardness (say 2 ppm)

Disadvantages

- (1) The equipment is costly and more expensive chemicals are needed.
- (2) If water contains turbidity, then the output of the process is reduced.

Zeolite & permuntit process

zeolites are also known as permuntits.

zeolites are hydrated sodium aluminium silicate capable of exchanging reversibly its sodium ions for hardness-producing ions (Ca^{+2} , Mg^{+2}) in water producing ions (Ca^{+2} , Mg^{+2}) in water.

chemical structure is $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \times \text{SiO}_2 \cdot \text{Y H}_2\text{O}$

where $X = 2 - 10$

$Y = 2 - 6$

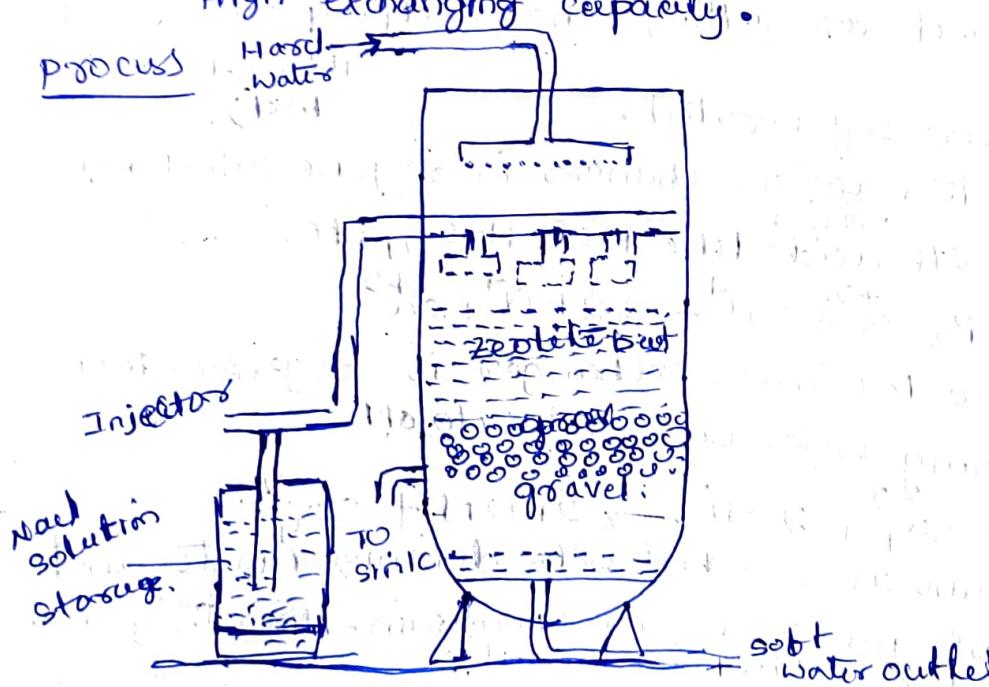
zeolites are two types.

1) Natural: These are non-porous

2) Synthetic: These are porous and they have

high exchanging capacity.

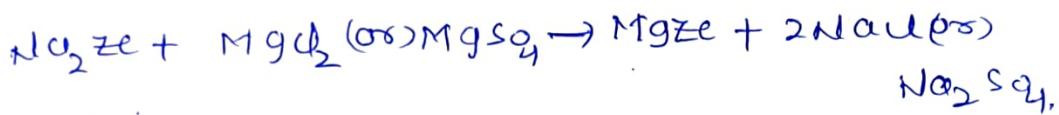
Process



~~QUESTION~~ For softening of water by zeolite process,

Hard water is passed at a specified rate through a bed of zeolite kept in a ~~cylinder~~ cylinder.

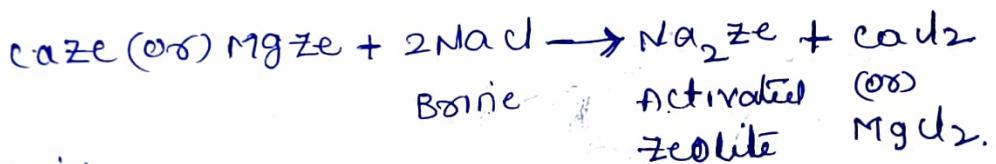
Hardness causing ions (Ca^{+2} , Mg^{+2}) are removed by zeolite as caze (or) mgze while outgoing water contains sodium salt. The following Reactions taking place during the softening process are



Regeneration:

After some time, the zeolite is completely converted into calcium and magnesium zeolite and it ceases to soften water. At this stage, the supply of hard water is stopped and exhausted.

• Zeolite is activated by treating with concentrated (10%) brine solution (NaCl)



Limitations

- (1) If the supply water is turbid, the suspended matter must be removed by filtration.
- (2) If the water contains large quantities of coloured ions such as Mn^{+2} and Fe^{+2} , this method is not suitable.
- (3) If the Hard water has mineral acids, this method is not suitable because mineral acids will destroy the zeolite.

Advantages

- (1) It removes the Hardness almost completely and water about 10 ppm Hardness is produced.
- (2) The Equipment used is compact, occupying small space.
- (3) It requires less time.
- (4) NO impurities are precipitated so that we are not observe the sludge formation.

Drinking water (municipal water)

Drinking water (or) Potable water

The water which is safe to drink is called drinking water (or) potable water.

Essential requirements : The water should be

- (1) clear
- (2) colourless and odourless.
- (3) pleasant in taste
- (4) It should not have turbidity (not exceed 10 ppm)
- (5) pH should be in the range of $7-8$ ppm
- (6) Free from gases like H_2S & minerals like $\text{Pb}, \text{As}, \text{etc}$ & Mn salts.
- (7) Total hardness should be less than 500 ppm
- (8) Free from disease producing bacteria (micro-organisms)

These are two steps involved in producing municipal water

- (1) Removal of suspended matter.
- (2) Removal of microorganism + disinfection

(1) Removal of suspended matter :

(1) Screening

- The raw water is passed through screens which contain large number of holes where floating matter is ~~settled~~ removed.

(2) Sedimentation :

- suspended impurities are removed by allowing the water to stand undisturbed for few hours (about 2-3 hr)

in big tank (5m deep)
due to force of gravity most of the particles settles down at the bottom of tank.
about 70-75% of the suspended matter can be removed.

Sedimentation with coagulation:

plain sedimentation can't remove finely divided silica, clay and organic matter.

Sedimentation with coagulation is a process of removing fine particles by addition of chemicals (coagulants) before sedimentation.

commonly used coagulants are

alum ($K_2SO_4 Al_2(SO_4)_3 \cdot 24H_2O$)

sodium aluminate ($NaAlO_2$)

Ferrous sulphate ($FeSO_4 \cdot 7H_2O$)

(3) Filtration: (2) Removal of microorganism - disinfection:

Filtration

By using this technique, removing colloidal matter and most of the bacteria, micro-organism. Filtration is carried out by using sand filter.

Removal of pathogenic (Disease causing bacteria) is known as disinfection.

a) Boiling

When water is boiled the harmful bacteria & viruses cannot survive at this temp. But this process can be applicable only on house hold, municipalities cannot apply.

b) Bleaching powder

By adding bleaching powder, disinfection of water is done.



When bleaching powder is added to water first

Cl_2 is liberated along with $Ca(OH)_2$

Cl_2 reacts with water & forms $HCl + HOCl$

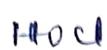
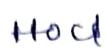
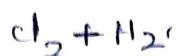
Hypochlorous Acid

$HOCl$ is a germicide which kills bacteria (or) germs present in water.

Limitations

- (1) It is unstable,
- (2) It introduces hardness of water
- (3) Addition of chlorine

Disinfection is done with gaseous chlorine, then gaseous chlorine reacts with water to form hypochlorous acid ($HOCl$) which kill



Initially

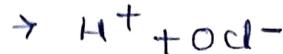
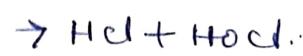
from $HOCl$ is killing microorganisms. Scientists found that $HOCl$ is causing death of microorganisms at pH of 6.5 (below).

ult to store

in water which increases in used in excess.

-chlorination)

The addition of liquid chlorine to chlorine is most efficient because produces hypochlorous acid ($HOCl$) which kills germs.



→ kills germs.

was found that normal oxygen (or) microorganisms, but later on two microorganisms chlorine is good disinfectant at pH of 6.5 (below).

chlorination depends upon

Time of contact

Number of micro-organisms destroyed by chlorine per unit time is proportional to number of microorganism remaining alive. so death rate is maximum at starting.

Temperature of water:

Higher the temp, the rate of reaction is faster & killing of microorganism increase.

pH value of water:

At lower the pH value, the reaction is faster & a small contact period is required.

Advantages

Effective & economical.

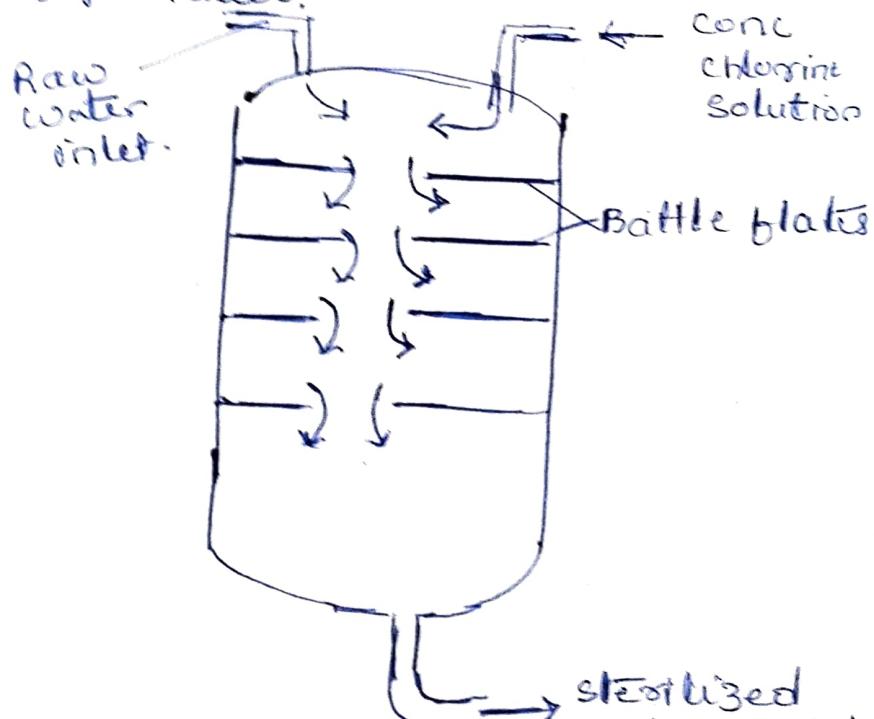
It require very little space.

Disadvantages

Excess of chlorine produces unpleasant odour & taste.

Free chlorine should exceed 0.1 - 0.2 ppm.

It is more effective below 6.5 & less effective at higher pH value.



chlorinator.

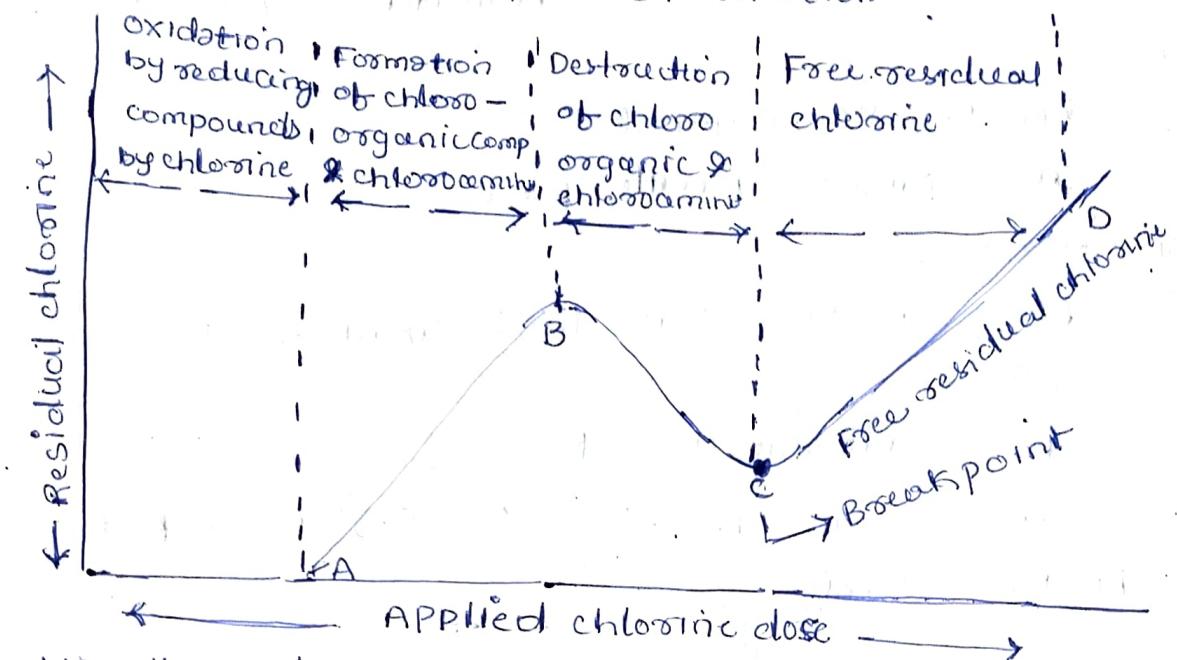
Break point chlorination (or) Dip point (free residual chlorine)

The addition of sufficient amount of chlorine to satisfy chlorine demand is called break point chlorination.

The addition of chlorine at the dip (or) break point is called as Breakpoint chlorination.

Free residual chlorine is present

When a graph is drawn between the added chlorine to residual chlorine a dip (or) break is formed in the graph is called breakpoint chlorination.



Usually all taste odour disappears at break-point chlorine time

Advantages

- (1) It completely oxidises organic compounds, ammonia, and other reducing compounds
- (2) It removes colour in water
- (3) It completely destroying (100%) all the disease producing bacteria.
- (4) It removes both odour & taste from water

(4) By using chloramines

When chloramines produced HCl when it is dissolved in water. HCl acts as germicide

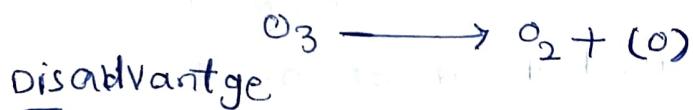
chloramines are prepared by passing Cl_2 gas into ammonia chamber.



Nowadays municipalities are using this product.

5) Disinfection by ozone.

By sending raw water through ozonizer, we get oxygen produced from O_3 (ozone). The nascent oxygen has germicide property so that it kills the microorganisms.



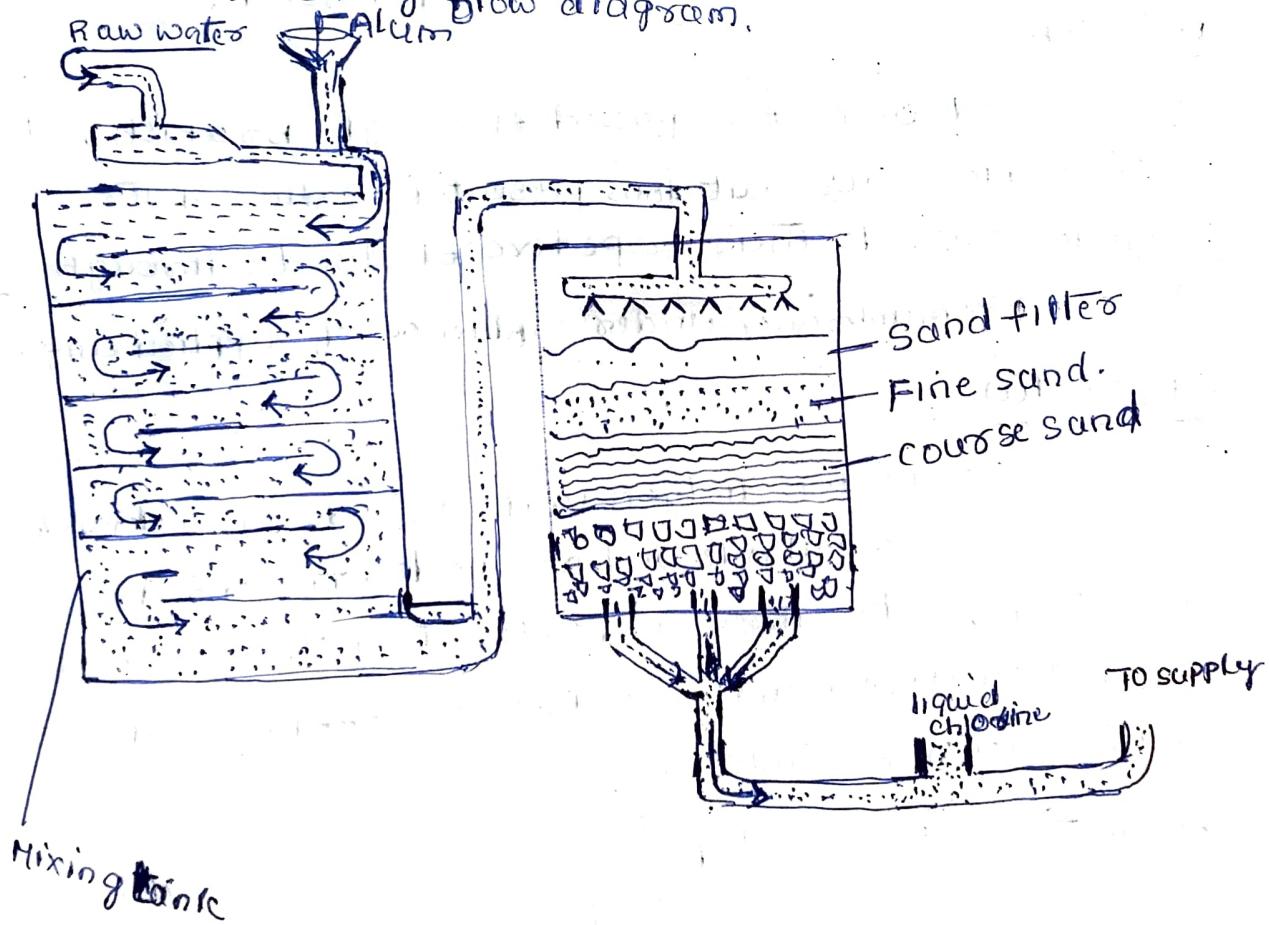
disadvantage

Equipment is expensive.

Advantage

- if excess of O_3 present in water, it is not harmful because O_3 decomposes into O_2 .

- The municipal water treatment in short may be illustrated by flow diagram.



Desalination of Brackish water

water containing dissolved salts with a peculiar salty (Brackish) taste is called brackish water.

Seawater is an example for brackish water as it contains about 3.5% salts.

The process of removing common salt (NaCl) from the brackish water is called desalination.

Commonly used methods for the desalination of brackish water are

(1) Electrodialysis,

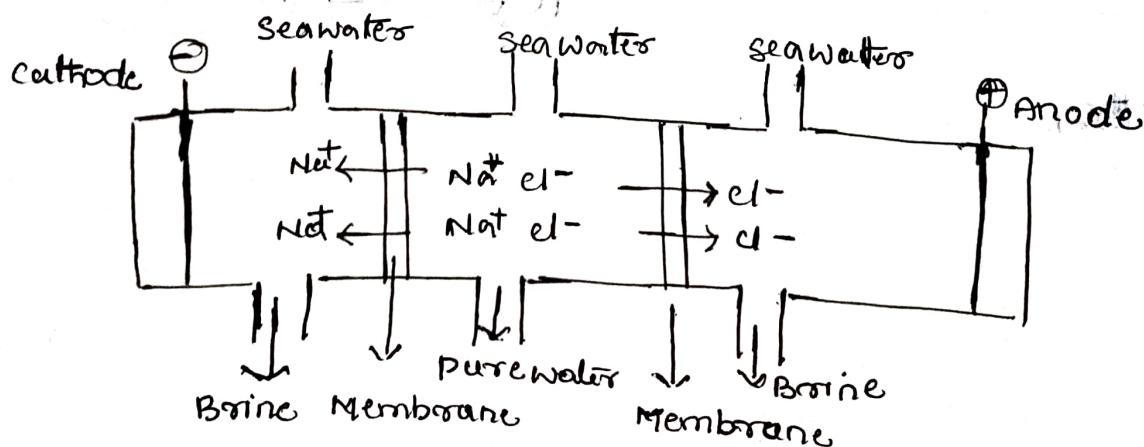
It is a membrane process, during which ions are transported through semipermeable membrane, under the influence of an electric potential.

Principle

When direct current is passed through brackish water using electrodes, salt ions present in saline water migrates towards their respective electrodes through ion selective membrane, under influence of applied emf.

Apparatus

The Electro dialysis unit consists of a chamber, two electrodes a cathode and an anode. The chamber is divided into three compartments with the help of ion selective membrane, these are ~~permeable to~~ permeable to either cations or anions.



process

→ When direct electric current is passed through saline water, the sodium ions move towards cathode (-ve pole) and the chloride ions move towards anode (+ve pole) through membrane.

- The conc of brine decreases in the central compartment whereas conc in outer compartment decreases.
- Desalinated water (pure water) is removed from time to time.
- Ion Selective membrane are used for more efficient separation which has permeability for one kind of ions.

Advantages

It is a compact unit, economical

Best suited if Electricity is available

Reverse osmosis

Reverse osmosis is one of the membrane filtration process. The process is used to remove salts and organic micro pollutants from water.

Osmosis:

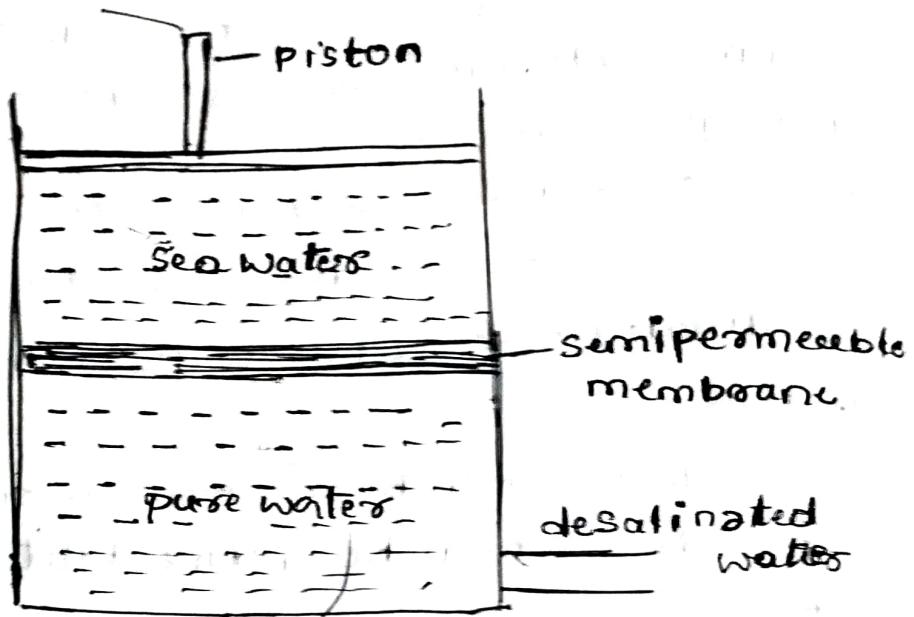
When two solutions of different concentrations are separated by a semi permeable membrane, solvent flows from region of low concentration to region of high concentration. This is called osmosis.

The pressure developed on the membrane is called osmotic pressure (Π).

If the pressure higher than osmotic pressure (Π) is applied on the concentration side, then the solvent

flows in reverse direction i.e. from higher conc region to lower concentration region. This is called reverse osmosis.

Procedure



Method

- Reverse osmosis cell consists of a chamber filled with semipermeable membrane.
- Pressure (order 15-40 kg/cm²) is applied to the sea water.
- The membrane consists of very thin films of cellulose acetate/polyamide polymers affixed to either side of the perforated tube.

Advantages

- (1) Membrane can be replaced within few minutes.
- (2) It removes colloidal silica.
- (3) Removes ionic and nonionic colloidal particles, and high molecular weight organic matter.

