WATER AND ITS TREATMENT

Introduction to hardness of water – Estimation of hardness of water by complexometric method and related numerical problems. Portable water and its specifications – steps involved in the treatment of portable water – Disinfection of portable water by Chlorination and break – point chlorination. Defluoridation – Determination of F^+ ion by ion-selective electrode method.

Boiler troubles: sludges, scales and caustic embrittlement, Internal treatment of Boiler feed water – calgon conditioning – phosphate conditioning – colloidal conditioning, External treatment methods – Softening of water by ion-exchange processes. Desalination of water – Reverse osmosis.
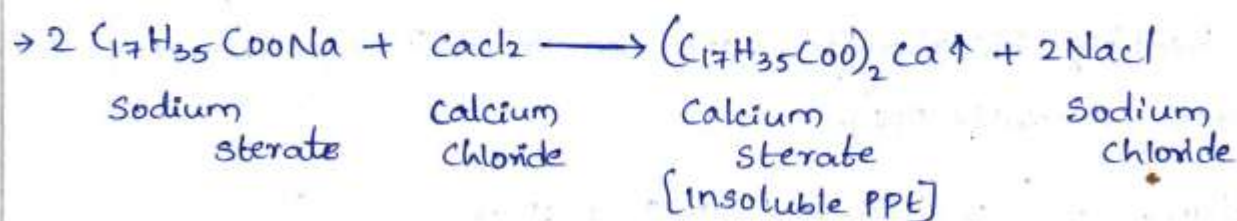
Types of Water:-

There are two types of water

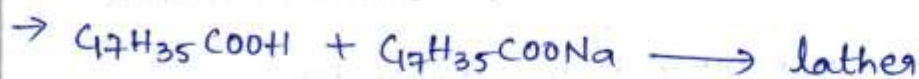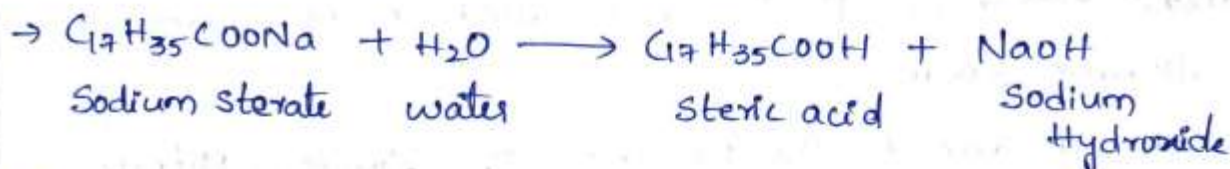1. Hard water
2. Soft water

1. Hard Water:

→ It doesn't produce leathering soap solution.

→ It forms insoluble ppt.

→ $2 C_{17}H_{35}COONa + CaCl_2 \longrightarrow (C_{17}H_{35}COO)_2 Ca\uparrow + 2NaCl$

| Sodium sterate | Calcium Chloride | Calcium sterate [Insoluble PPt] | Sodium chloride |

→ $2 C_{17}H_{35}COONa + MgCl_2 \longrightarrow (C_{17}H_{35}COO)_2 Mg + 2NaCl$

2. Soft water:

→ Water which produces leathering soap solution

→ $C_{17}H_{35}COONa + H_2O \longrightarrow C_{17}H_{35}COOH + NaOH$

Sodium sterate   water   Steric acid   Sodium Hydroxide

→ $C_{17}H_{35}COOH + C_{17}H_{35}COONa \longrightarrow$ lather
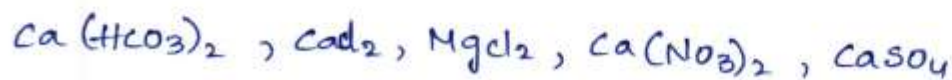
Hardness of water:-

→ It is a characteristic property of water

→ The water which prevents the lathering with soap solution (or) lather prevention capacity is called Hardness of water.

→ This is caused due to the presence of Bicarbonates, chlorides, Sulphates, Nitrates of Ca^{+2}, Mg^{+2} and other heavy metal ions.

$Ca(HCO_3)_2$, $CaCl_2$, $MgCl_2$, $Ca(NO_3)_2$, $CaSO_4$
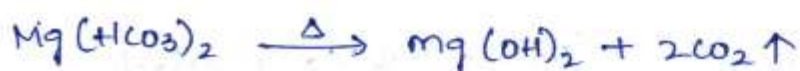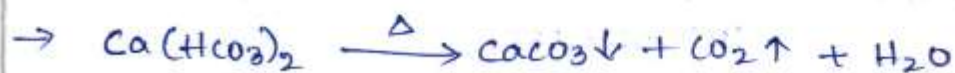
Types of Hardness :

1. Temporary Hardness:- It is also called carbonate hardness and alkaline hardness.

→ It is caused due to the presence of bicarbonates of Ca^{+2}, Mg^{+2} and other heavy metal ions.

i.e. $Ca(HCO_3)_2$, $Mg(HCO_3)_2$.

→ Temporary hardness is removed by simple boiling of water.

→ While heating bicarbonates are converted into carbonates and hydroxides [Insoluble PPt].

→ $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3\downarrow + CO_2\uparrow + H_2O$

$Mg(HCO_3)_2 \xrightarrow{\Delta} Mg(OH)_2 + 2CO_2\uparrow$

→ this insoluble ppt deposited as a clust at the bottom of the vessel.

2. Permanent Hardness:- It is also called as non-carbonate or non-alkaline hardness.

→ It is caused due to the presence of chlorides, Nitrates, Sulphades of Ca^{+2}, Mg^{+2} and other heavy metal ions.

i.e $CaCl_2$, $Ca(NO_3)_2$, $CaSO_4$

$MgCl_2$, $Mg(NO_3)_2$, $MgSO_4$

→ Like temporary hardness, Permanent hardness cannot be removed by simple boiling.

Types of H_2O	Hardness
Soft H_2O	0–70 PPM
Hard H_2O	70–150 PPM
Moderate Hard H_2O	150–300 PPM
Very hard H_2O	above –300 PPM

Degree of Hardness or (experience)ᵉˣᵖʳᵉˢⁱᵒⁿ of Hardness of Water:-

→ The Hardness of water calculated interms of $CaCO_3$ equivalence.

→ It is express in $CaCO_3$ equivalence because of two reasons.

1. Its molecular weight is 100 easy for calculations.

2. It is most insoluble ppt in water treatment.

Hardness in terms of $CaCO_3$ equivalence = $\dfrac{\text{Amount of hardness}}{\text{Molecular weight of hardness of salt.}} \times 100$

Units of Hardness:-

1. PPm

2. mg/l

3. % clark

4. % french

1. Parts per million:- No. of parts of hardness causing salts in $CaCO_3$ equivalent present in 10^6 parts [1 million parts] of water.

One PPm = One parts of hardness causing salts in $CaCO_3$ equivalent present in 10^6 parts of water.

2. Milli gram per litre:- It is the no. of parts or milligrams of $CaCO_3$ equivalent hardness present per one litre of water.

1 mg/lit = 1 mg of CaCO₃ equivalent hardness present per one litre of water.

3. Degree clark :- It is the no. of parts of CaCO₃ equivalent hardness present per Gallon [70,000] of water.

$1°/clark$ = 1 grain of CaCO₃ equivalent hardness per gallon of water or 70,000 parts of water.

4. Degree french :- It is no. of parts of CaCO₃ equivalent hardness present per 10^5 parts of water.

$1°/french$ = 1 part of CaCO₃ equivalent hardness per 10^5 parts of water.

$$\boxed{1\, PPm = 1\, mg/lit = 0.07°cl = 0.1°Fr}$$

ESTIMATION OF HARDNESS OF WATER
BY COMPLEXOMETRIC METHOD

→ It is a complexometric method in this method EDTA is the reagent.
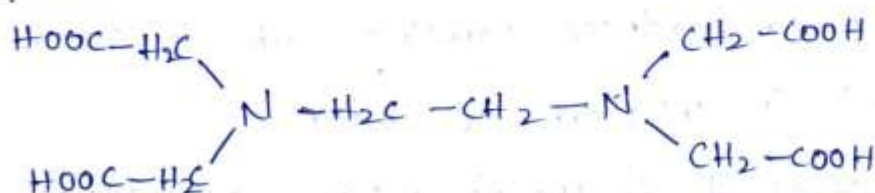
→ EDTA forms the complexes at different PH.

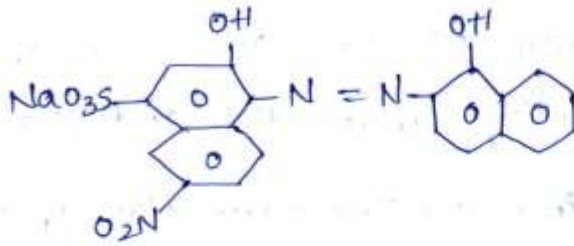For eg: Ca^{+2}, Mg^{+2} ions form the complexes with EDTA at PH 9-10

→ To maintain the pH 9-10 buffer solution added [$NH_4OH + NH_4Cl$]

→ In this method Eriochrome Black-T is used as an indicator.

EDTA :

HOOC-H₂C   CH₂-COOH
          \   /
           N-H₂C-CH₂-N
          /   \
HOOC-H₂C   CH₂-COOH

EBT:

Metal EDTA :-

$$[M = Ca^{+2}/Mg^{+2}]$$
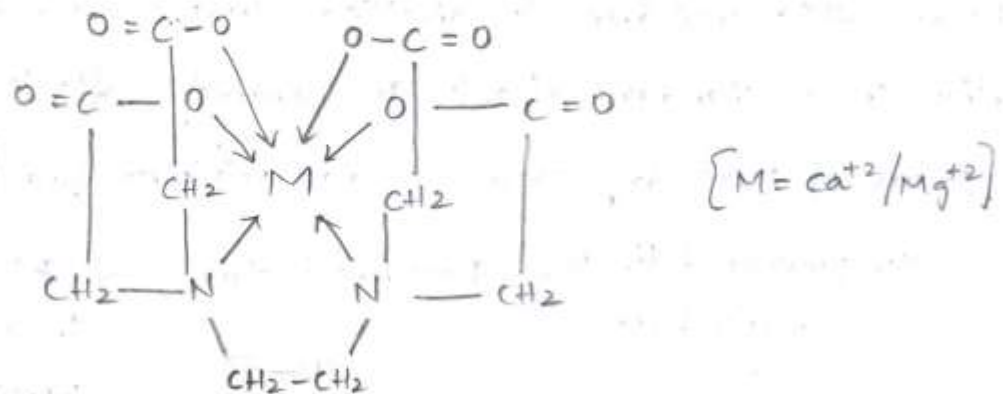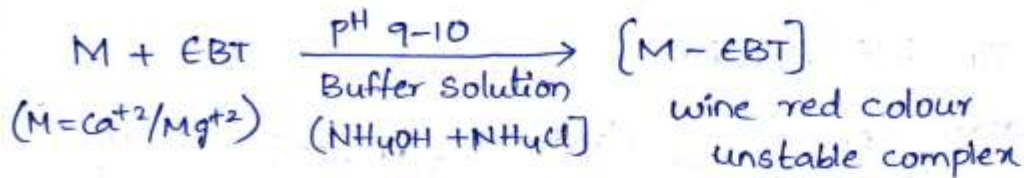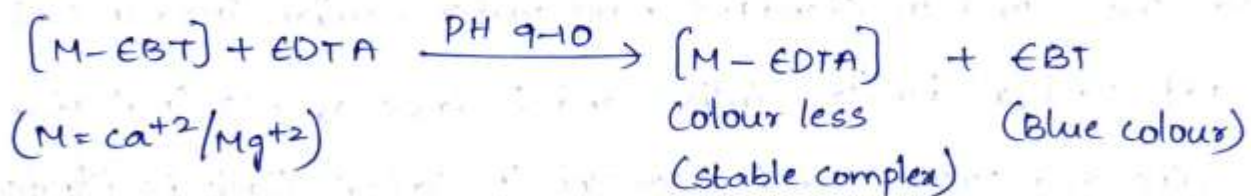
Principle :-

→ When hardwater treated with EBT indicator it forms M-EBT complex which is in wine red colour and forms unstable complex

→ To maintain the pH 9-10 the buffer solution is added.

$$M + EBT \xrightarrow[\text{Buffer Solution} \atop (NH_4OH + NH_4Cl)]{pH\ 9-10} [M-EBT]$$

$(M = Ca^{+2}/Mg^{+2})$ wine red colour   unstable complex

→ This wine red colour solution is titrated against with EDTA and it forms (M-EDTA) complex which is colourless and stable complex and it releases the free EBT indicator which is in blue colour.

$$[M-EBT] + EDTA \xrightarrow{PH\ 9-10} [M-EDTA] + EBT$$

$(M = Ca^{+2}/Mg^{+2})$ Colour less   (Blue colour)

                                    (stable complex)

Procedure:-

Preparation of standard hardwater:- Dissolve one gram of pure and dry $CaCO_3$ in minimum quantity dilute HCl and evaporate the solution to dryness (or) water bath. The formation of residue will takes place.

→ Dissolve this residue in distilled water to make one litre solution in a standard flask or volumetric flask.

→ 1 gram of pure dry $CaCO_3$ → add minimum quantity of HCl →

　　　　evapourated it in → Residue is form → This residue dissolved
　　　　water bath 　　　　　　　　　　　　　in 1 lit of distilled
　　　　　　　　　　　　　　　　　　　　　　water by standard flask

　　Molarity of standard hard water (M) = $\dfrac{wt}{M.wt} \times \dfrac{1}{V(lit)}$

　　　　　　　$M_1 = \dfrac{1}{100} \times \dfrac{1}{1}$

　　　　　　　$\boxed{M_1 = 0.01}$

Standardisation of EDTA solution:-

Take 20ml of standard. 　　2ml of 　　　2/3 drops 　　[M-EBT] 　Titrate
Hard water in a conical + buffer 　+ of EBT 　→ wine red 　→ with
flask 　　　　　　　Solution 　　　　　　　colour 　　　EDTA

　　　　　　　　　　　　　　$\left[M-EDTA\right] + EBT$
　　　　　　　　　　　　　　Colour less 　　Blue colour

→ Pipette out 20ml of standard hard water solution into a conical flask add 2ml of buffer solution and 3 drops of EBT indicator.

→ The wine red colour solution present in conical flask is titrated against with EDTA solution [which is taken in a burette] till the wine red colour changes to blue colour.

→ Let the volume of EDTA is 'x' ml

$$M_1 V_1 = M_2 V_2$$
(SHW)   (EDTA)

M_1 = Molarity of standard hard water = 0.01 m

V_1 = volume of standard hard water = 20 ml

M_2 = Molarity of EDTA = ?

U_2 = Volume of EDTA = x ml

$$M_2 = \frac{M_1 V_1}{V_2}$$

$$M_2 = \frac{0.01 \times 20}{x}$$

Standardisation of total Hardness :-

→ Pipette out 20 ml of the water sample in to a clean conical flask, and and 2 ml of buffer solution, add 3 drops of EBT indicator and titrate this against with EDTA solution (which is taken in a burette). Till the wine red colour changes to blue colour.

→ Let the volume of EDTA is 4 ml

$$M_2 V_2 = M_3 V_3$$
(EDTA)   (Hard water)

M_2 = Molarity of EDTA

V_2 = volume of EDTA = 1 ml

M_3 = Molarity of hard water solution = ?

V_3 = volume of Hard water solution = 20 ml

$$M_2 = \frac{M_3 V_3}{V_2}$$

Total Hardness of water = $M_3 \times 10^5$ PPM.

Standardisation of permanent Hardness :

→ Pipette out 100ml of hard water sample (Tap water) in a beaker and boil it till the volume reduced to 20ml. Cool the solution and filtered the water into a conical flask and add 2ml of buffer solution and add 3 drops of EBT indicator and titrate with EDTA till a blue colour end point is obtained.

→ Take the reading as 'z' ml

$$M_2 V_2 = M_4 V_4$$
$$(EDTA) \quad (HWS \text{ after heating})$$

M_2 = Molarity of EDTA

V_2 = volume of EDTA

M_4 = molarity of hard water solution after heating

V_4 = volume of hard water solution after heating.

Permanent hardness of water = $M_4 \times 10^5$ PPm

Calculation of temporary hardness :-

Total hardness = Temporary hardness + permanent hardness

Temporary hardness = Total hardness − Permanent hardness

PORTABLE WATER

→ The water which is used for drinking purpose (or) safe to drink is called as portable water
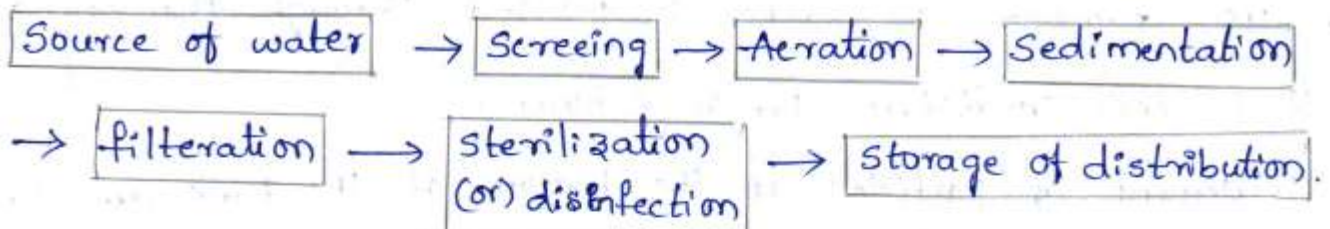
Specifications :-

→ It is colourless, odourless.

→ It should be good in taste

→ The optimum hardness of water must be 125 PPm.

→ Turbidity of water must not exceed 25 PPm

→ Water must be free from Pathogenic bacteria and dissolved gases like H_2S.

→ The total dissolved salts in water must not exceed 500ppm.

→ Water must be free from heavy metals like dead, chromium and manganese.

→ The p^H of water should be 7-8.5

Steps involved in the treatment of portable water:-

→ It involves in the removal of collidal impurities, suspended impurites and pathogenic bacteria in water.

→ Treatment of water for domestic supply involves following steps.

| Source of water | → | Screeing | → | Aeration | → | Sedimentation |

→ | filteration | → | sterilization (or) disinfection | → | Storage of distribution |.

Screening :-

→ The water is passed through the screen which is having large no. of holes

→ While passing it involves removal of floating materials like leaves, wooden pieces.

→ large no. of holes
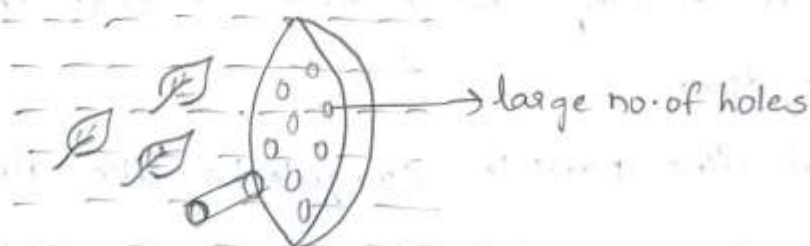
Aeration:-

The water is then subjected to aeration

→ which helps in exchange of gases between water and air.

→ Increases the oxygen (contan)' content, taste.

→ It removes impurities like iron, manganese in the form of their hydroxides.

Sedimentation:-
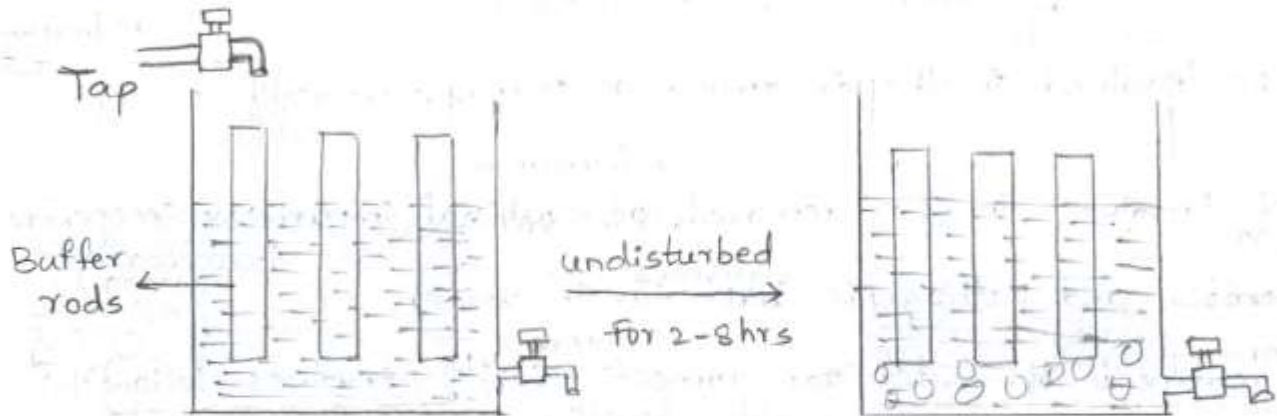
In this process the water is passed through the cans.

→ It is left undisturb for 2-8 hours.

→ settlement of particles at the bottom of the tank due to gravitational force.

Sedimentation with coagulation:-

The suspendend and collidial impurities are allowed to settle under gravitation.

→ The basic principle of this treatment is to allow water to flow at a very slow velocity so that the heavier particles are settle down.

→ (For off fine particle coagulants like alum, sodium aluminate are added which produces gelatinous ppt called

'floc'.

→ It absorbs the collidal and suspended impurities in water. $Al_2(SO_4)_3 + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2SO_4$

→ The following sedimentation tank used for the removal collidal impurities.

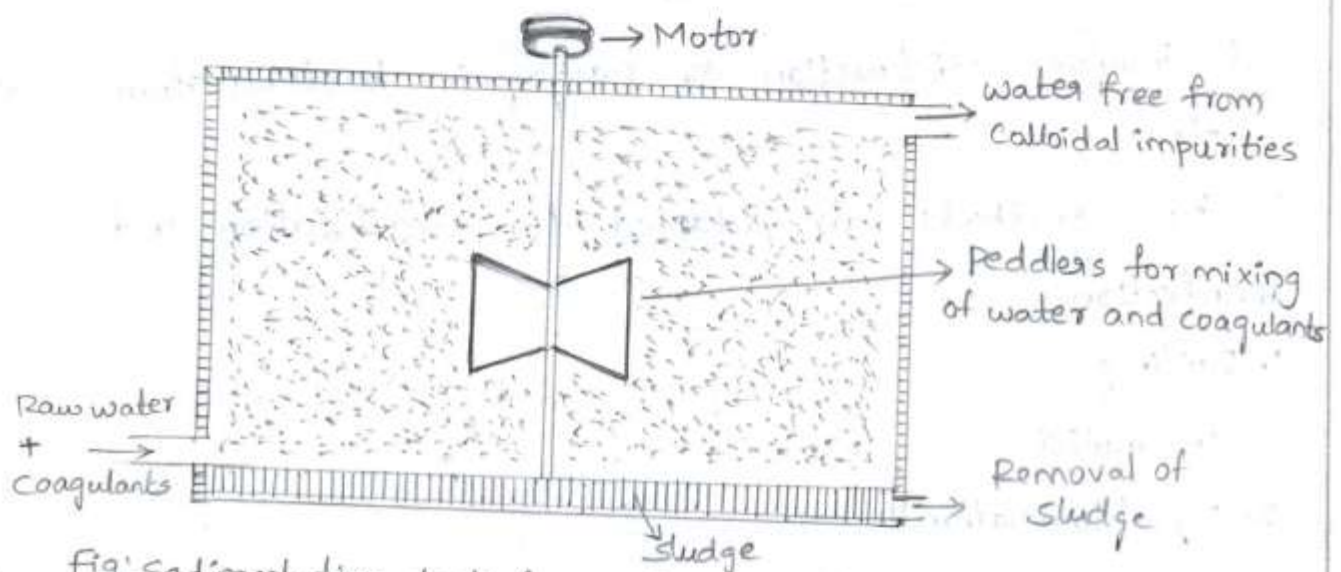Potash alum — $K_2(SO_4) \cdot Al_2(SO_4)_3 \cdot 24H_2O$

Sodium aluminate — $NaAlO_2$

Fig: Sedimentation tank for purification of colloidal impurities.

Filteration:-

It involves removal of collidal particles which are not removed in sedimentation process. In these two types of Sand filters are used.

1. Slow sand filter

2. Rapid sand filter

→ In case of rapid sand filter, filteration becomes fast. When compared to slow sand filter due to application of pressure.

(a) Slow Sand Filter   (b) Rapid Sand Filter
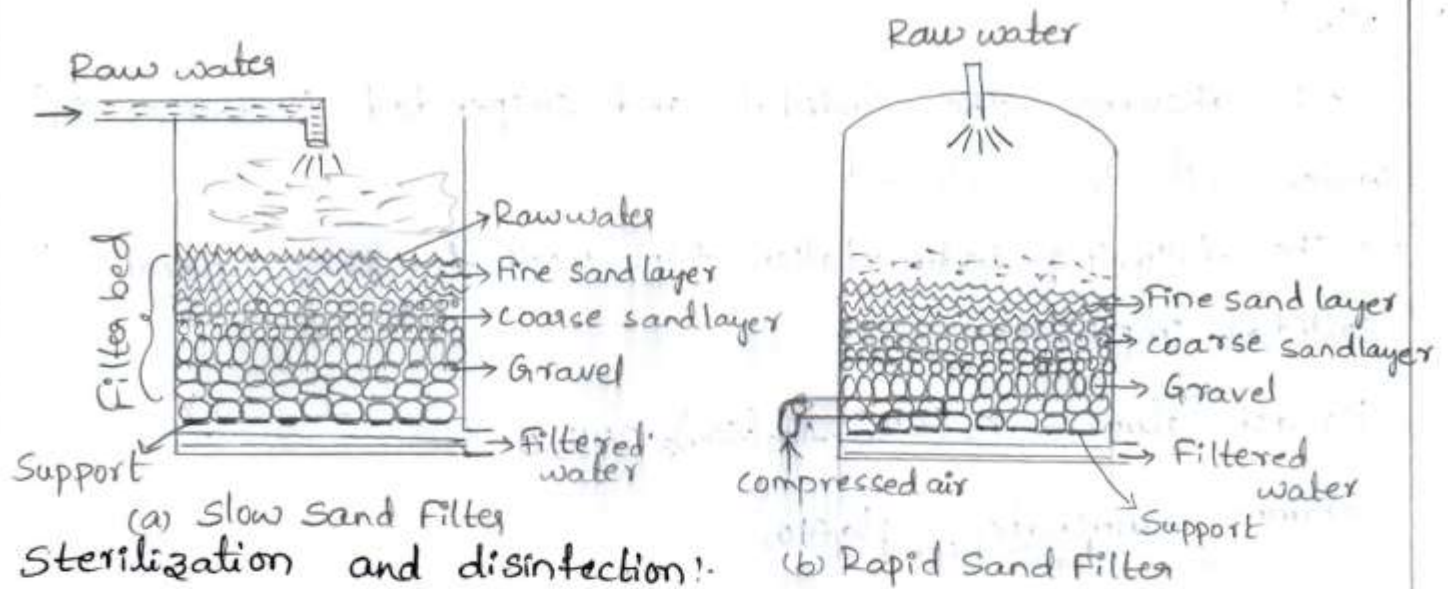
Sterilization and disinfection:-

→ It involves distruction of pathogenic bacteria from water Sample.

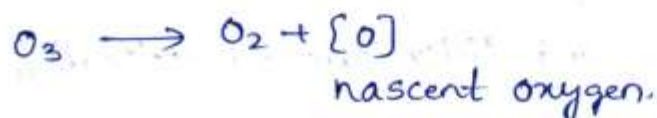→ Three methods are adapted for sterilization and disinfection.

1. Boiling

2. Ozonolisis

3. By chlorination.

1. By boiling :-

By boiling water about 20-30 mins bacteria are killed this process is adapted for domestic purpose but not for industrial purpose.

2. By adding ozone:-

When ozone is passed into water in decomposes into O_2 and nascent oxygen (O).

$$O_3 \longrightarrow O_2 + [O]$$
$$\text{nascent oxygen.}$$

→ Nascent oxygen acts as disinfectant [which kills bacteria]

→ O_3 is an unstable isotope of oxygen.

Disadvantage:-

This treatment is costly and ozone is unstable and cannot be stored for a long time.

3. Chlorination:

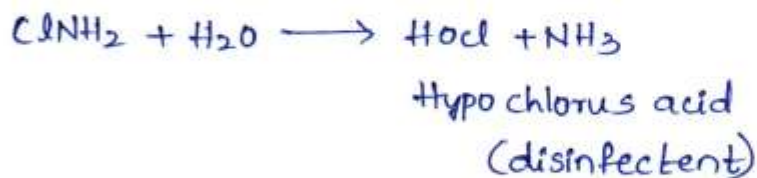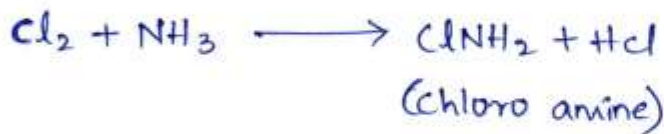The process of adding chlorine to water to kill bacteria is called chlorination.

→ There are 3 types of chlorinating reagents are used.

1. By (passing)ᵃᵈᵈⁱⁿᵍ chloramine

2. By adding bleaching powder

3. By adding chlorine.

1. By Passing chloramine :-

$$Cl_2 + NH_3 \longrightarrow ClNH_2 + HCl$$
(Chloro amine)

$$ClNH_2 + H_2O \longrightarrow HOCl + NH_3$$
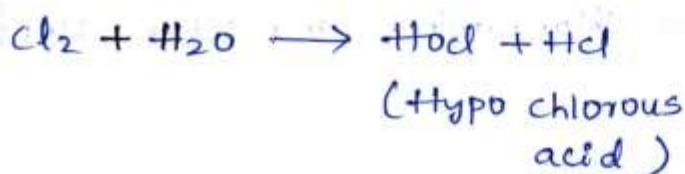Hypo chlorus acid
(disinfectent)

→ chlorine is mixed with Ammonia in the ratio 2:1 to form a stable chloro amine further it reacts with water to form Hypo chlourous (HOcl) acid and Ammonia (NH_3).

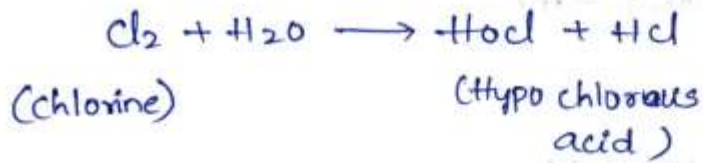→ HOcl is acts as disinfectent.

2. By adding bleaching powder:-

$$CaOCl_2 + H_2O \longrightarrow Ca(OH)_2 + Cl_2$$
(Bleaching powder)

$$Cl_2 + H_2O \longrightarrow HOCl + HCl$$
(Hypo chlorous acid)

→ Here HOCl acts as disinfectant [which kills bacteria]

3. By adding chlorine :-

$$Cl_2 + H_2O \longrightarrow HOCl + HCl$$

(chlorine)   (Hypo chlorous acid)
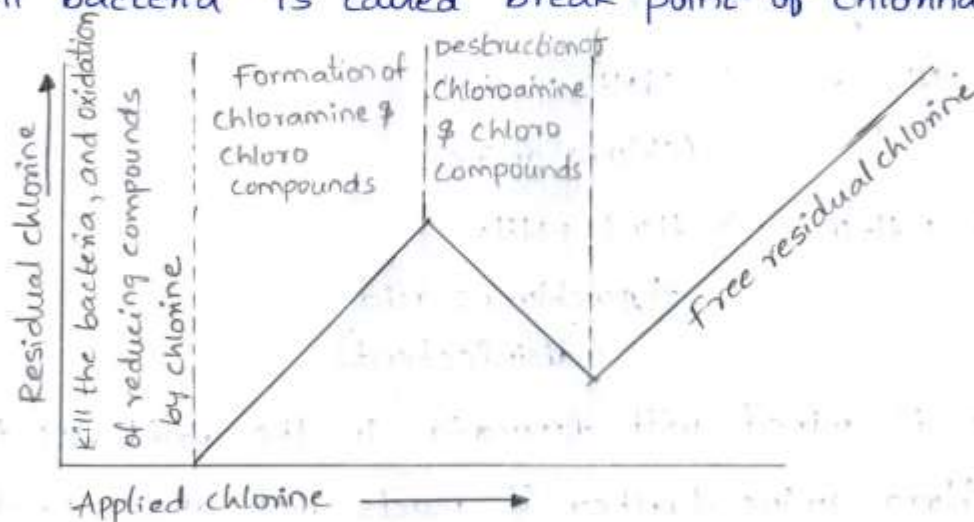
→ chlorine after reacting with bacteria excess amount of chlorine remains in water as residual chlorine which cause bad taste, odour and toxic to human beings.

BREAK – POINT OF CHLORINATION

→ The process of adding required amount of chlorine to H_2O to kill bacteria is called break point of chlorination.

→ The water sample is treated with chlorine and estimated for the residual chlorine in water and plotted a graph as showned above which gives the "Break point of chlorination",
From graph it is clear that

* 'a' gms of chlorine added oxidises reducing impurities of H_2O.

* 'b' gms of 'cl' added forms chloroamines and other chloro compounds.

* 'c' gms of 'cl' added causes distruction of bacteria.

* 'd' gms of chlorine is residual chlorine.

* 'c' gms is the break point for the addition of chlorine to water. This is called "Break point of chlorination".

Advantages !-

→ It removes colour taste and organic impurities.

→ It destroys all disease causing bacteria in water.

→ It prevents growth of weeds in water.

DEFLUORIDATION

→ Flourine is most active element found in naturally occuring rocks.

→ The limited flourine water is 1 ppm.

→ Above one ppm is causing a disease called flurosis.

→ Due to this weekening and bending of bones decay of teeth etc.

→ The following are the list of ways to obtained drinking water without flourine.

1. Reverse osmosis filteration

2. Activated Aluminium defloridation

3. Distilled water.

DETERMINATION OF F⁻ ION BY ION – SELECTIVE METHOD

F^- (fluoride ions) in water can be determined by using solid-state membrane electrode.

Construction

Solid-state membrane electrode consists of an internal reference electrode (Pt) in reference solution containing $NaF + NaCl$ (for sensing fluoride ions). The body of the electrode is made up of teflon and the pellet, lanthanum trifluxode (LaF_3) crystal doped with europium di fluoride (EuF_2), is held is position with epoxy resin. These electrode will sense only F^- ions ignoring others.

Teflon body
Reference electrode
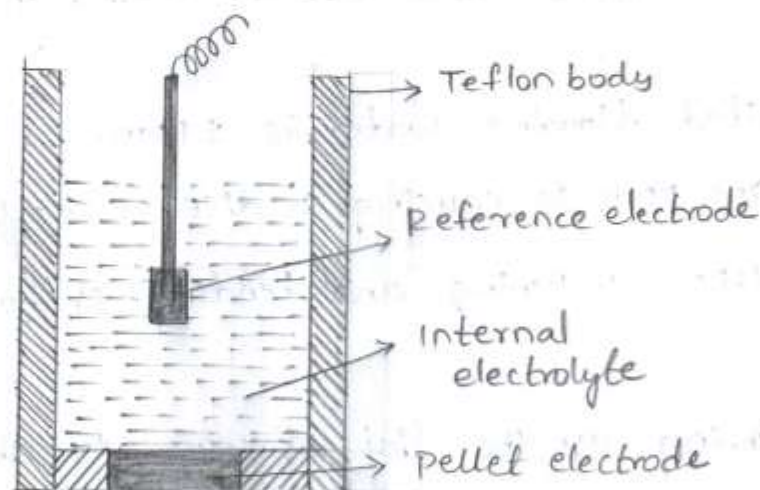Internal electrolyte
Pellet electrode

fig: Solid State membrane electrode

Uses

Fluoride ions selective electrode is used in the estimation of fluoride ions in water and in tooth pastes.

BOILER TROUBLES

→ It is caused by using hard water.

→ Boiler troubles are

i. Sludge

ii. Scale

iii. Caustic embrittlement.

(i) Sludge :-

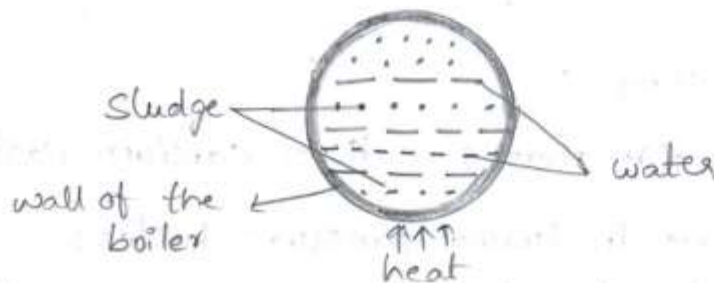→ It is a soft, loose, slimmy and non-sticky precipitate form with in the boiler.

Fig: sludge formation in boilers.

Reasons:-

→ Salts which have high solubility in hot water compare to cold water cause formation of sludge.

Disadvantages:-

→ It is a poor conductor of heat and results wastage of fuel like kerosine, L.G.P etc.

→ The efficiency of boiler decreases.

→ Safety of boilers also lowers

→ Explotion of boilers takes place.

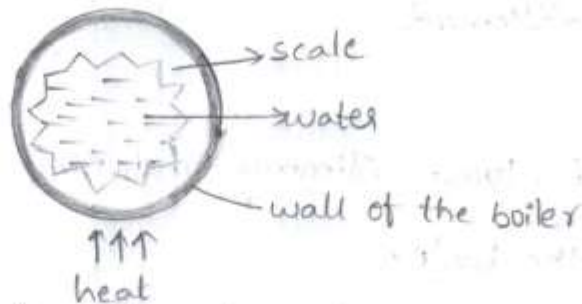**Prevention:-**

→ Using soft water in boiliers

→ By using Blow down operation (removal of high concentrated salts at the bottom of the tank through a tap).

Removal of sludge :

→ It is formed at colder places of boiler and get collected by using wire brushes.

(ii) Scale :-

→ It is a hard and sticky ppt formed are inner walls of boilers.

→ scale
→ water
— wall of the boiler

↑↑↑
heat

Reasons:-   Fig! Scale formation in boilers

1. Decomposition of Ca(HCO₃)₂ :-

→ Ca(HCO₃)₂ on decomposition forms ~~calcium~~ calcium carbonate (CaCO₃) which forms scale in lower pressure boilers

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + CO_2 + H_2O$$
$$(scale\ in\ L.P.B)$$
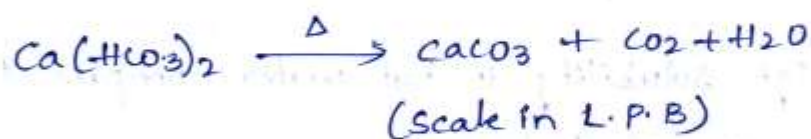
→ Because CaCO₃ dissolve in H·P·B

2. Decomposition of CaSO₄ :-

The solubility of calcium sulphate increases on decreasing temperature. So, in H·P·B and increasing temperature. the solubility of CaSO₄ will decrease and forms a hard scale on the inner walls of the boilers.

3. Hydrolysis of Mg salts :-

$$MgCl_2 + 2H_2O \longrightarrow Mg(OH)_2 + 2HCl$$
$$scale$$

4. Presence of silica :

If silica is present in H₂O then it precipitates out as calcium silicate and magnesium silicate which form scale in boilers.

Disadvantages :-

→ It is poor conductor of heat and results' wastage of fuel like kerogene, L.P.G etc

→ The efficency of boiler decreases.

→ Safety of boilers are lower.

→ Explotion of boilers takes place.

Prevention :-

→ By using soft water in boilers

Removal of scale :

→ calcium carbonate scale can be removed by treating with 10% HCl.

→ $CaSO_4$ scale can be removed by treated with EDTA method.

Caustic embrittlement :-

The phenomenon in which boiler material becomes brittle due to acumulation of caustic substances like NaOH.

Reason :-

The H_2O purified by lime soda process contains little amount of sodium carbonate which are decomposition form NaOH.

$$Na_2CO_3 + H_2O \longrightarrow 2NaOH + CO_2$$

→ The formed NaOH flows into cracks are the inner walls of the boiler bends, rivets and joints then water is evapoura-ted. Con. NaOH increases at above areas and forms con. electrolytic cells as follows.

→ At anode NaOH attacks on iron so, iron undergoes corrosion. So, iron at anode becomes brittle.

→ In this process NaOH cause brittleness of boiler so, this phenomenon is called 'caustic embrittlement'.

Prevention:

→ By using Na_3PO_4 instead of sodium carbonate (Na_2CO_3) in lime soda process.

Treatment of boiler feed H_2O:-

Internal treatment
1. Colloidal conditioning
2. Phosphate conditioning
3. Calgon conditioning.

External treatment
1. Ion exchange process.

INTERNAL TREATMENT OF BOILER FEED WATER

→ Removal of hardness causing salts with in the boiler

1. Colloidal conditioning:-

→ In low pressure boilers scale formation can be prevented by adding substances. like Kerosene and Agaragar.

→ These substances get absorbed over scale forming salts and results formation of soft, loose, non-sticky ppt (sludge)

→ Which can be easily removed by using wire brushes and Blow down operations.

2. Phosphate conditioning:-

→ In high pressure boilers, scale formation can be avoided by adding Na_3PO_4 which reacts with hardness causing

Salts $(Ca^{+2}|mg^{+2})$ salts · forming sludge. Soft, loose and Non-sticky ppt of calcium phosphate, Magnesum phosphate which can be easily removed by wire brushes and Blow down operation.
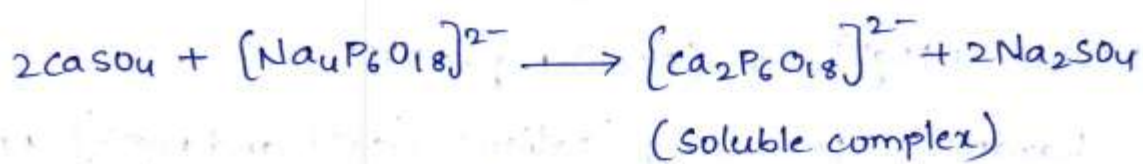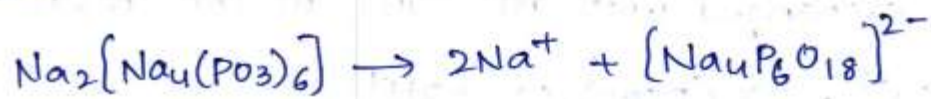
$$3MCl_2 + 2Na_3PO_4 \longrightarrow M_3(PO_4)_2 + 6NaCl$$
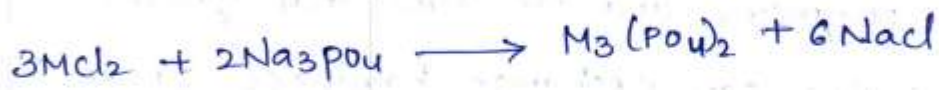
3. Calgon conditioning :-

→ It is sodium hexa meta phosphate $[Na_2[Na_4(PO_3)_6]$ in this process scale formation can be prevented by adding calgon.

→ 0·5 – 5ppm calgon prevents scale formation.

→ This forms soluble complex compounds with $CaSO_4$ which causes no boiler troubles.

$$Na_2[Na_4(PO_3)_6] \longrightarrow 2Na^+ + [Na_4P_6O_{18}]^{2-}$$

$$2CaSO_4 + [Na_4P_6O_{18}]^{2-} \longrightarrow [Ca_2P_6O_{18}]^{2-} + 2Na_2SO_4$$

(Soluble complex)

→ The treatment of boiler water with calgon is called calgon conditioning.

EXTERNAL TREATMENT METHODS

→ Removal of hardness causing salts from the water outside of boiler.

Ion exchange process (or) Deionisation (or) Demineralisation Process :-

It involves exchange in cation of Hardness causing salts with H^+ ions and anions of Hardness causing salts with OH^- ions, for this two types of ion exchange resins are used.

(i) cation exchange resin

(ii) Anion exchange resin

Principle :-

Ion exchange resins are insoluble, cross-linked, longchain organic polymers and the functional groups attached to the chains can exchange hardness producing cations and anions present in water.

Process :-

This process involves the following steps :-

Step-1 :- The Hard water is passed through a bed of cation exchange resin [$RCOOH$ (or) SO_3H] of tank 'A'. The Ca^{+2} and Mg^{+2} ions are exchanged with H^+ ions of the resin.

$$2RCOOH + Ca^{+2} \longrightarrow (RCOO)_2Ca + 2H^+$$

$$2RCOOH + Mg^{+2} \longrightarrow (RCOO)_2Mg + 2H^+$$

→ Thus hardness producing cations [Ca^{+2} and Mg^{+2}] are removed.

→ The water coming out contains Cl^-, SO_4^{-2}, HCO_3^-.

→ Styrene divinyl benzene copolymer is used as cation exchanged resin.

Step 2 :-

→ The hard water is then passed through a bed of anion exchange resin [$R-OH$ (or) $R-NH_2$] of tank 'B'.

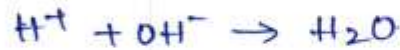→ The Cl^-, SO_4^{2-}, HCO_3^- ions are exchanged with OH^- ions of the resin.

$$R-OH + Cl^- \longrightarrow R-Cl + OH^-$$

$$2ROH + SO_4^{-2} \longrightarrow R_2SO_4 + 2OH^-$$

$$ROH + HCO_3^- \longrightarrow RHCO_3 + OH^-$$

→ Thus hardness producing anions $[Cl^-, SO_4^{-2} \& HCO_3^-]$ are removed.

Step 3:-

→ The H^+ ions produced in tank 'A' combined with OH^- produced in tank 'B' to form water.

$$H^+ + OH^- \rightarrow H_2O$$

→ Thus this process removes all types of hardness producing cations and anions present in water.

→ The resulting water is known as "De-mineralised" (or)

"De-ionised water".

→ When water sample is completely de-ionised, it has the tendency to absorb gases like CO_2, O_2 etc... from atmosphere which cause boiler corrosion.

→ Hence De-ionisation must be followed by de-gasification.

→ Phenol formaldehyde (or) Amine formaldehyde is used as anion exchange resin.

Regeneration of resins:-

→ With constant use, the resins get exhausted.

→ This can be regenerated as follows.

1. The exhausted cation exchange resin can be regenerated by passing dil. HCl

$$(RCOO)_2Ca + 2HCl \longrightarrow 2RCOOH + CaCl_2$$

$$(RCOO)_2Mg + 2HCl \longrightarrow 2RCOOH + MgCl_2$$

→ $CaCl_2$ and $MgCl_2$ are removed as wash.

2. The exhausted anion exchange resin can be regenerated by passing dil. NaOH.

$$RCl + NaOH \longrightarrow R\text{-}OH + NaCl$$

$$R_2SO_4 + 2NaOH \longrightarrow 2ROH + Na_2SO_4$$

$$RHCO_3 + NaOH \longrightarrow ROH + NaHCO_3$$

$\longrightarrow$ NaCl, Na_2SO_4 and $NaHCO_3$ are removed as wash.

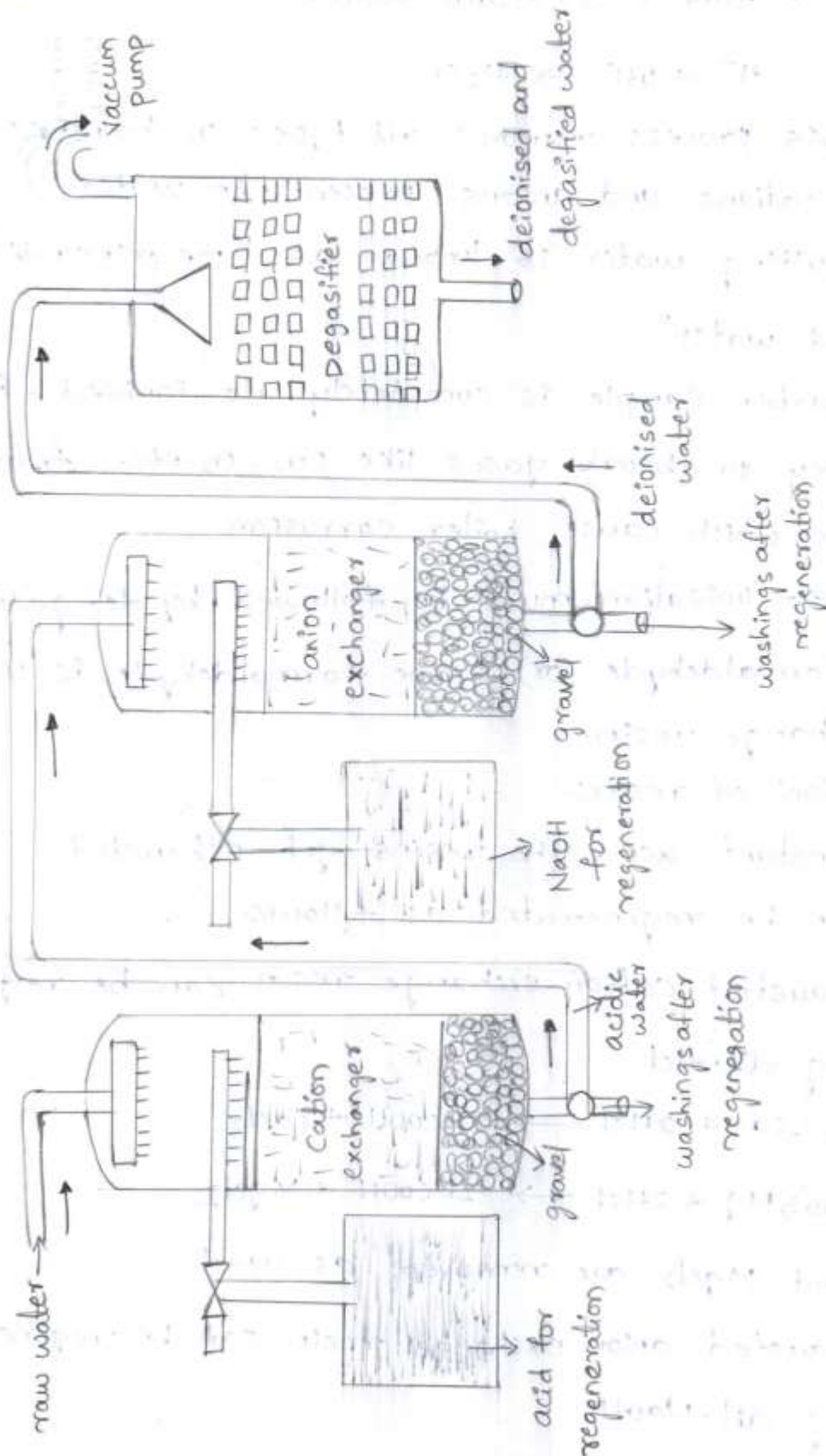Fig : Deionisation of water.

Advantanges!.

→ Highly acidic or Alkaline water samples can be purified by this process.

→ The hardness possessed by de-ionized water is 2ppm.

→ The de-ionised water is most suitable for high pressure boilers.

Disadvantages:-

→ The ion exchanging resins are expensive, Hence the cost of purification is high.

→ Raw water should contain turbidity below 10 ppm other wise pores in the resin will be blocked and output of the process is reduced.

DESALINATION OF WATER

→ Water containing high concentrations of dissolved solids with a brakish taste is called brakish water.

→ Sea water is an example of brakish water containing about 3.5 % dissolved salts.

→ This water cannot be used for domestic and industrial applications unless the dissolved salts are removed by

REVERSE OSMOSIS

→ When 2 solutions of unequal concentration are sp. Separated by semi permeable membrane.

→ Which doesn't permit the passage of dissolved solid particles (molecules and ions)

→ Flow of solvent takes place from the dilute solution to concentrated solution this is called osmosis.

→ If a hydrostatic pressure it excess of osmotic pressure is applied on the concentrated side of the solvent, the solvent is forced to move from higher concentration to lower concentrated side across.

→ Thus, the solvent flow is reversed hence this method is called reverse osmosis.

→ Thus, reverse osmosis pure water is separated from the contaminated water.

→ This membrane filtration is called super filteration (or) Hyper filteration.

Reverse osmosis cell:-
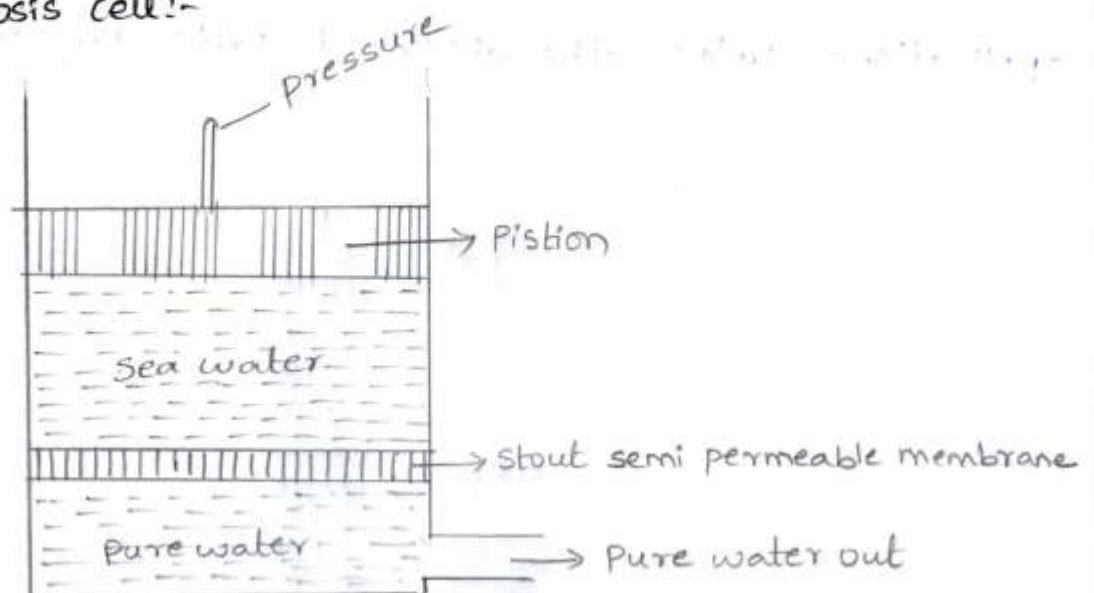
Advantages:-

→ cost of purification of water is less and maintance cost is less.

→ This water can be used for high pressure boilers.

→ Both ionic and non-ionic, colloidal, high molecule weight, Organic matter is removed from the water sample.