UNIT - 3 (Marks 14)

water


H2O

Classification of soft and hard water based on soap test

- Water, along with soap, is used for washing purposes. On the basis of effective washing with soap, water has been classified as soft water and hard water.

- **Soft water:** Water which produces good lather with soap is called soft water. When water falls as rain, it is naturally soft. Washing with soap is easy in soft water.

- **Hard water:** Water which does not produce good lather with soap is called hard water. It is difficult to wash with soap in hard water. Water seeping through the ground becomes hard water. It is not useful for laundry and laboratory purposes.

- Cleaning Capacity of Soap with Hard and Soft Water
- Although soap is a good cleaning agent, its cleaning capacity is reduced when used in hard water. Hardness of water is due to the presence of sulphates, chlorides or bicarbonate salts of Ca^{2+} or Mg^{2+} ions. Soaps are sodium or potassium salts of long chain fatty acids. When soap is added to hard water, the Ca^{2+} and Mg^{2+} ions present in hard water react with soap. The sodium salts present in soaps are converted to their corresponding calcium and magnesium salts which are precipitated as scum. The insoluble scum sticks on the clothes and so the cleaning capacity of soap is reduced.

$$Ca^{2+} + RCOONa \rightarrow RCOOCa + 2Na^{+}$$

$$Mg^{2+} + RCOONa \rightarrow RCOOMg + 2Na^{+}$$

- The cleaning action of soap is very effective in soft water because it contains negligible calcium and magnesium ions.
- Synthetic detergents are used in the case of hard water also because the calcium and magnesium salts of detergents are soluble in water. Detergents are more soluble than soaps and hence form more lather than soaps.

Causes of Hardness

- Hardness of water is due to the presence of Bicarbonates, Chlorides, Sulphates and Nitrates of Calcium and Magnesium. These soluble salts get mixed with natural water due to the following reasons:
- 1. When natural water containing CO_2 flows over the rocks of the limestone ($CaCO_3$) and Dolamite ($CaCO_3$ & $MgCO_3$), they get converted into soluble bicarbonates. Thus, water gets hardness.
- $CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$ Insoluble Soluble
- 2. When natural water flows over the rocks containing chlorides and sulphates and Nitrates of Calcium and magnesium, these salts dissolve in water. Thus water gets hardness.

Types of Hardness of Water

- The hardness of water can be classified into two types:
- **Temporary Hardness**
- **Permanent Hardness**

- Temporary Hardness of Water:
- The presence of magnesium and calcium carbonates in water makes it temporarily hard. In this case, the hardness in water can be removed by boiling the water.
- When we boil water the soluble salts of $Mg(HCO_3)_2$ is converted to $Mg(OH)_2$ which is insoluble and hence gets precipitated and is removed. After filtration, the water we get is soft water.

- Permanent Hardness of Water:
- When the soluble salts of magnesium and calcium are present in the form of chlorides and sulphides in water, we call it permanent hardness because this hardness cannot be removed by boiling.
- We can remove this hardness by treating the water with washing soda. Insoluble carbonates are formed when washing soda reacts with the sulphide and chloride salts of magnesium and calcium and thus, hard water is converted to soft water.

Units of hardness

- **(1)** Parts Per million (ppm): It is defined as the number of parts by weight of $CaCO_3$ equivalent present in per million (10^6) parts by weight of water.
- 1 ppm = 1 part of $CaCO_3$ equivalent hardness in (10^6) parts of water.
- **(2)** Milligrams per litre (mg/l): It is defined as the number of milligrams of $CaCO_3$ equivalent hardness present in one litre of water.
- 1 mg/L = 1 mg of $CaCO_3$ equivalent hardness present per litre of water.
- It can be easily proved that 1mg/L = 1 ppm, for water
- Weight of 1 litre of water = 1kg = 10^3g = 10^6mg
- = 1000*1000g= 10^6mg
- 1mg/L = 1mg of $CaCO_3$ equivalent hardness per 10^6 parts of water.
- 1mg/L = 1 part of $CaCO_3$ equivalent hardness per 10^6 parts of water.
- **1mg/L = 1ppm**

- (3) Degree Clark (^0Cl): It is defined as the parts of $CaCO_3$ equivalent hardness per 70,000 parts of water or it is number of grains (1/7000lb) of $CaCo_3$ equivalent hardness per gallon (10lb or 70,000 grains) of water. 1^0 Clark= 1 part of $CaCo_3$ per 70,000 part of water.
- (4) Degree of French (^0Fr): It is defined as the parts of $CaCO_3$ equivalent hardness per Lac (100000) parts of water.
- 1^0Fr = 1 part of $CaCO_3$ equivalent hardness per (10^5) parts of water.

- (5) Milli equivalent per litre (meq/L): It is defined as the number of milli equivalents of hardness present per litre.
- 1 meq/L = 1 meq of $CaCO_3$ per L of water
- = 10^{-3} * 50g of $CaCO_3$ eq. per litre of water
- = 10^{-3} * 1000 * 50 mg of $CaCO_3$ eq. per litre of water
- = 50mg of $CaCO_3$ eq. per litre of water
- = 50mg/L of $CaCO_3$ eq. per litre of water = 50 ppm
- = 50mg of $CaCO_3$ eq. per 10^6 litre of water
- = 1 mg of $CaCO_3$ eq. per 10^6 /5 mg litre of water
- = 1 part of $CaCO_3$ equivalent per 20,000 parts of water.

- Q.1) A water sample was contain $Ca(HCO_3)_2$ = 40.5 mg/lit, Calculate the carbonate in ppm
- (Given mol wt. of $Ca(HCO_3)_2$ = 162)
- Answer
- Conversion of the quantities of all salts in terms of $CaCO_3$ equivalent in ppm
- =wt of $Ca(HCO_3)_2$ X 100/ mol wt. of $Ca(HCO_3)_2$
- $= 40.5\ X\ \frac{100}{162}$
- = 25ppm

- Q.2) A water sample was contain $MgCl_2$ = 47.5 mg/lit, Calculate the hardness in ppm
- (Given mol wt. of $MgCl_2$ = 95)
- Answer
- Conversion of the quantities of all salts in terms of $CaCO_3$ equivalent in ppm
- =wt of $MgCl_2$ X 100/ mol wt. of $MgCl_2$
- $= 47.5\ X\ \frac{100}{95}$
- = 50ppm

- Q.3) A water sample was contain $CaCl_2$ = 22.2 mg/lit, Calculate the hardness in ppm
- (Given mol wt. of $CaCl_2$ = 111)
- Answer
- Conversion of the quantities of all salts in terms of $CaCO_3$ equivalent in ppm
- =wt of $CaCl_2$ X 100/ mol wt. of $CaCl_2$
- $= 22.2\ X\ \frac{100}{111}$
- = 20 ppm

- Q.4) A water sample was contain $MgCO_3$ = 42 mg/lit, Calculate the carbonate in ppm
- (Given mol wt. of $MgCO_3$ = 84)
- Answer
- Conversion of the quantities of all salts in terms of $CaCO_3$ equivalent in ppm
- =wt of $MgCO_3$ X 100/ mol wt. of $MgCO_3$
- $= 42\ X\ \frac{100}{84}$
- = 50ppm

- Q.5) A water sample was found to contain following salts:
- $Ca(HCO_3)_2$ = 40.5 mg/lit, $MgCl_2$ = 23.75 mg/lit, CO_2 = 3 mg/lit
- $MgCO_3$ = 21 mg/lit, $CaCl_2$ = 55.5 mg/lit, SiO_2 = 6mg/lit
- Calculate the carbonate, non carbonate hardness, Total hardness of the water sample.
- (Given Mol wt. of $Ca(HCO_3)_2$= 162, $MgCl_2$= 95, CO_2= 44, $MgCO_3$ = 84, $CaCl_2$= 111, SiO_2= 60)
- Answer
- Step I – Conversion of the quantities of all salts in terms of $CaCO_3$ equivalent in ppm

Sr. no.	Salt	Quantity of salt	Mol wt. of salt	Type of hardness	$CaCO_3$ equivalent in ppm
1	$Ca(HCO_3)_2$	40.5	162	Carbonate	$40.5\ X\ \frac{100}{162}$ = 25
2	$MgCl_2$	23.75	95	Bicarbonate	$23.75\ X\ \frac{100}{95}$ = 25
3	CO_2	3	44	Not contribute to hardness	-
4	$MgCO_3$	21	84	Carbonate	$21 X\ \frac{100}{84}$ = 25
5	$CaCl_2$	55.5	111	Bicarbonate	$55.5\ X\ \frac{100}{111}$ = 50
6	SiO_2	6	60	Not contribute to hardness	-

- Step II
- Calculation of carbonate or temporary hardness in ppm
- = [CaCO3 equivalent in ppm of $Ca(HCO_3)_2$ + $MgCO_3$]
- = [25+25]
- = 50 ppm
- Step III
- Calculation of noncarbonate or permanent hardness in ppm
- = [CaCO3 equivalent in ppm of $CaCl_2$ + $MgCl_2$]
- = [50+25]
- = 75 ppm
- Step IV
- Calculation of total hardness = temporary hardness + permanent hardness
- = 50+75
- = 125 ppm

- Q.6) A water sample was found to contain following salts:
- $Ca(HCO_3)_2$ = 32.4 mg/lit, $Mg(HCO_3)_2$ = 7.3 mg/lit, $CaSO_4$ = 13.6 mg/lit, $MgCl_2$ = 9.5 mg/lit Calculate the carbonate, non carbonate hardness, Total hardness of the water sample.
- (Given Mol wt. of $Ca(HCO_3)_2$= 162, $Mg(HCO_3)_2$ = 146, $CaSO_4$ = 136, $MgCl_2$ = 95)
- Answer
- Step I – Conversion of the quantities of all salts in terms of $CaCO_3$ equivalent in ppm

Sr. no.	Salt	Quantity of salt	Mol wt. of salt	Type of hardness	$CaCO_3$ equivalent in ppm
1	$Ca(HCO_3)_2$	32.4	162	Bicarbonate	$\mathbf{32.4\ X\ \frac{100}{162}}$ **=20**
2	$Mg(HCO_3)_2$	7.3	146	Bicarbonate	$\mathbf{7.3\ X\ \frac{100}{146}}$ **= 5**
3	$CaSO_4$	13.6	136	Noncarbonate	$\mathbf{13.6\ X\ \frac{100}{136}}$ **= 10**
4	$MgCl_2$	9.5	95	Noncarbonate	$\mathbf{9.5\ X\ \frac{100}{95}}$ **=10**

- Step II
- Calculation of carbonate or temporary hardness in ppm
- = [CaCO3 equivalent in ppm of $Ca(HCO_3)_2$ + $Mg(HCO_3)_2$]
- = [20+5]
- = 25 ppm
- Step III
- Calculation of noncarbonate or permanent hardness in ppm
- = [CaCO3 equivalent in ppm of $MgCl_2$ + $CaSO_4$]
- = [10+10]
- = 20 ppm
- Step IV
- Calculation of total hardness = temporary hardness + permanent hardness
- = 25+20
- = 45 ppm

Cause of poor lathering of soap in hard water

- When hard water is treated with soap solution, it forms a white curdy precipitate known as scum. When soap is added to hard water, the Ca+2Ca+2 and Mg+2Mg+2 ions present in hard water react with soap. Soaps contain the sodium salts which are converted to their respective calcium and magnesium salts which are precipitated as scum. When the scum dries on washed clothes it makes them stiff and uncomfortable. So, hard water does not form lather with soap.

Disadvantage of hard water in the boiler

- **Scale and sludges buildup** - During pressure and temperature changes, the dissolved solids in hard water will start to coat the inside of the boiler tube heat exchanger. This slowly restricts the amount of steam and water that can flow inside the tubes. It also acts as a thermal insulator which causes the boiler tubes to transfer heat less efficiently and overheat.
- **Corrosion** - Besides scale, hard water releases oxygen and changes the PH of the water, so that it reacts with the metal boiler tubes, water drum and steam drum. Over time this eats away at the metals until the boiler is no longer pressure worthy.

• Foaming and priming in boilers

- Bubbles or froth actually build up on the surface
- of the boiler water and pass out with the steam.
- This is called **foaming** and it is caused by high
- concentration of any solids in the boiler water. It
- is generally believed, however, that specific
- substances such as alkalis, oils, fats, greases,
- certain types of organic matter and suspended
- solids are particularly conducive to foaming.

- .
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- **Priming** is the carryover of varying amounts of droplets of water in the steam (foam and mist), which lowers the energy efficiency of the steam and leads to the deposit of salt crystals on the super heaters and in the turbines. Priming may be caused by improper construction of boiler, excessive ratings, or sudden fluctuations in steam demand. Priming is sometimes aggravated by impurities in the boiler-water.

- The most common measure to prevent foaming and priming is to maintain the concentration of solids in the boiler water at reasonably low levels.

Water softening techniques

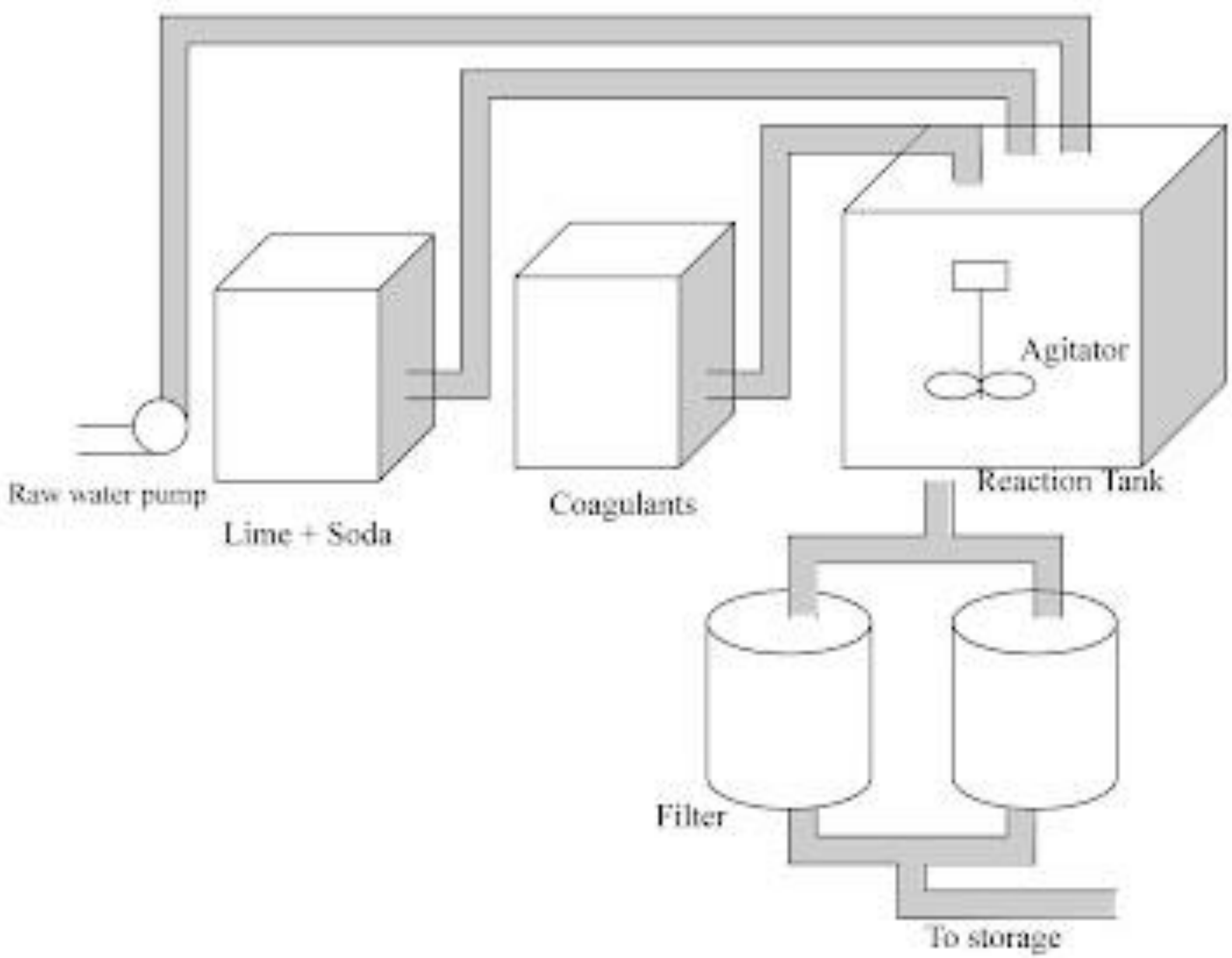
- Soda lime process
- Permute Method
- Ion exchange method

Lime-Soda Water Softening Process

- Process Soda lime is a process used in water treatment to remove Hardness from water.
- This process is now obsolete but was very useful for the treatment of large volumes of hard water.
- Addition of lime (CaO) and soda (Na_2CO_3) to the hard water precipitates calcium as the carbonate, and magnesium as its hydroxide.

What is Soda lime processes

- Standard water-softening process.
- Carried out either hot or cold
- The lime-soda uses lime, Ca $(OH)_2$ and soda ash, Na_2CO_3, to precipitate hardness from solution.
- In this process Calcium and Magnesium ions are precipitated by the addition of lime ($Ca(OH)_2$) and soda ash (Na_2CO_3). Also used in the preperation of caustic soda (NaoH) by mixing slaked lime Ca $(OH)_2$ with soda and filtering off the preciitated calcium carbonate $CaCO_3$



Agitator
Raw water pump
Lime + Soda
Coagulants
Reaction Tank
Filter
To storage

Hot and Cold Lime Soda Process

Hot Lime Soda Process	Cold Lime Soda Process
1. It is carried out at high temperature(95-100 c)	1. It is carried out at room temperature(25-30 c)
2.It is a rapid process	2.It is a slow process
3. No coagulant required	3. coagulant required
4.Filtration is easy as viscosity of water is low	4.Filtration is not easy
5. Residual hardness is 15-30 ppm	5. Residual hardness is 60 ppm
6. Dissolved gases are removed	6. Dissolved gases are not removed
7. It has high softening capacity	7. It has low softening capacity

- **Soda lime process-**
- In this process lime $Ca(OH)_2$ and soda Na_2CO_3 Are used. By this process both permanent and temporary hardness removed.
- Carbonate and bicarbonate removed by lime while sulphates removed by soda.

- $Ca(HCO_3)_2 + Ca(OH)_2 \quad\quad 2CaCO_3 + 2H_2O$
- $Mg(HCO_3)_2 + Ca(OH)_2 \quad\quad CaCO_3 + MgCO_3 + 2H_2O$

- $MgCO_3 + Ca(OH)_2 \quad\quad CaCO_3 + Mg(OH)2$

- If water contains sulphates and chloride of magnesium then both soda and lime process required.

- $MgSO_4 + Na_2CO_3 + Ca(OH)_2 \quad\quad CaCO_3 + Mg(OH)_2 + Na_2SO_4$
- $MgCl_2 + Na_2CO_3 + Ca(OH)_2 \quad\quad CaCO_3 + Mg(OH)_2 + 2NaCl$

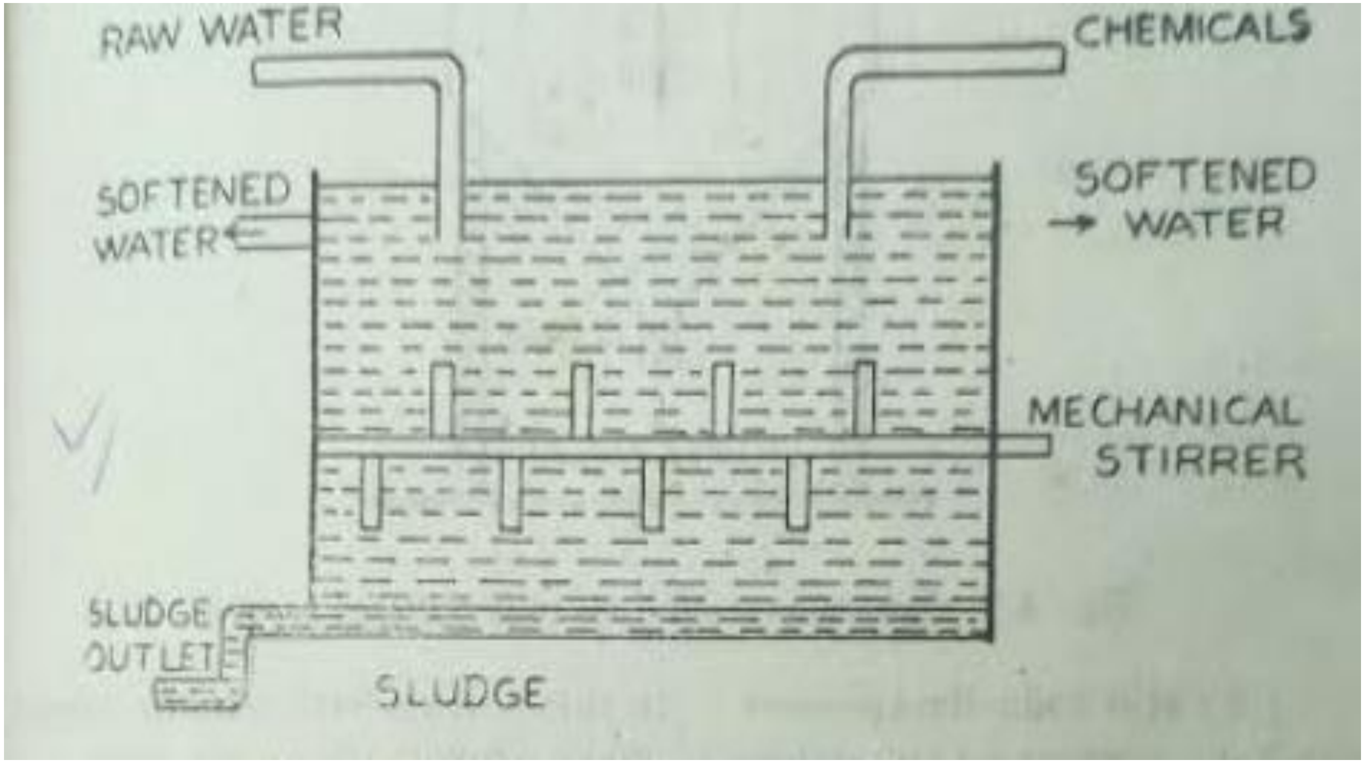
- If water contains sulphates and chloride of calcium then soda process required.
- $CaSO_4 + Na_2CO_3 \quad\quad CaCO_3 + Na_2SO_4$
- $CaCl_2 + Na_2CO_3 \quad\quad CaCO_3 + 2NaCl$

- Lime soda process carried out in cold water and in hot water. If the process carried out in cold water, it is called as cold soda lime process. If the process carried out in hot water, it is called as hot soda lime process.

- **1) cold soda lime process-**
- In this method lime and soda mixed with water so precipitate obtained and small quantity of alum should be used. Removal of precipitate remove by filtration gives soft water. The process carried out by two methods

A) Batch Process –

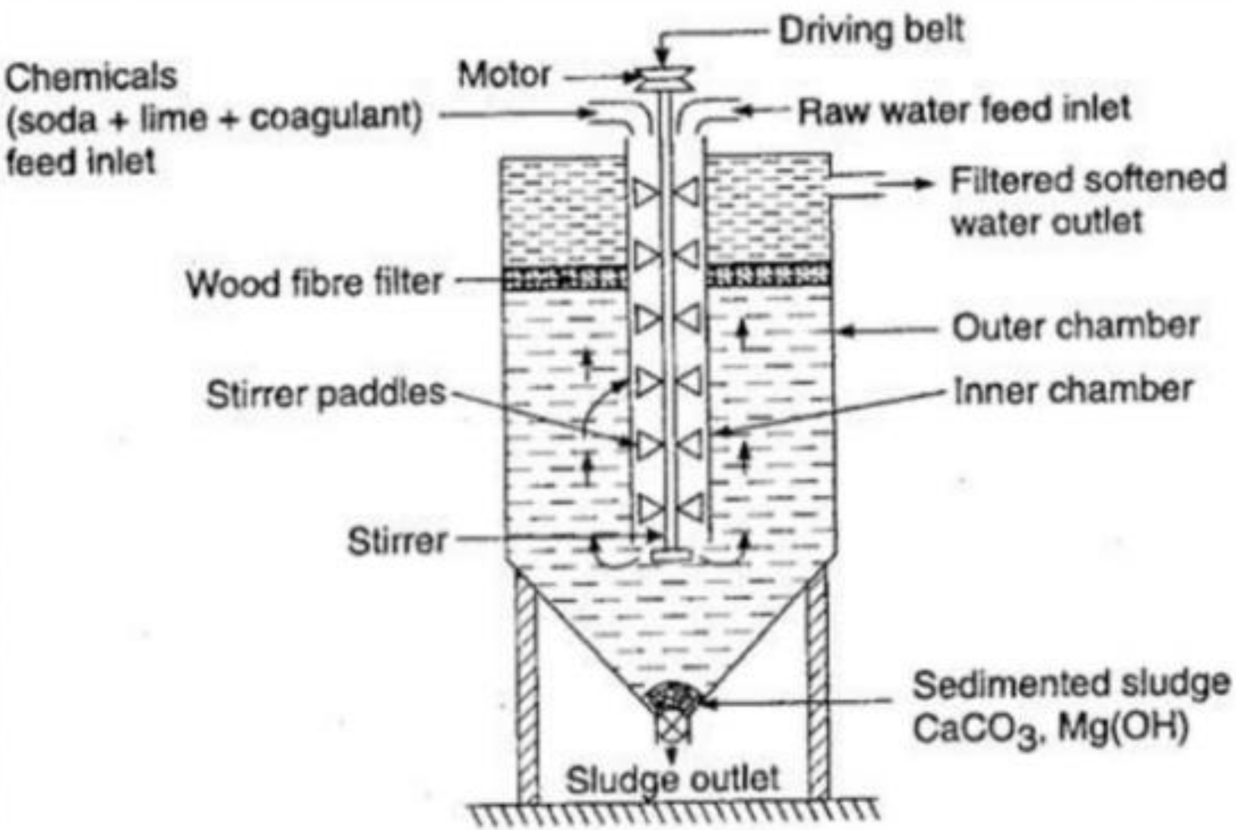
- In this method lime and soda mixed with water in large tank and stir well. The stirring is stopped and water is allowed to stand. A suitable sodium aluminate or Alum is added to coagulate the precipitate of the impurities settle at the bottom. The water is pumped out and allowed to pass through a filter unit of sand and coal. After filtration the soft water is obtained. After removal of sludge the tank is washed with water. The same procedure repeated again.


RAW WATER
CHEMICALS
SOFTENED WATER
SOFTENED WATER
MECHANICAL STIRRER
SLUDGE OUTLET
SLUDGE

B) Continuous process-

- This process is continuous so time is not wasted during the process. In this process hard water mixed with (soda+ lime+ coagulant) are fed from the top into the inner vertical circular chamber. As the hard water and chemicals flow down, there is a vigorous stirring and continuous mixing takes place. The softened water comes into the outer chamber rises upwards. The heavy sludge settle at the bottom of outer chamber and removed through outlet. The softened water passes through filter.

Cold lime soda process



2) Hot soda lime process-

In this method hard water is treated with lime soda at 80 to 150^{0}C, since speed of reaction increases and the process is completed in 15 min. The hot soda lime process is better than cold soda lime process.

The coagulant not needed for precipitation.

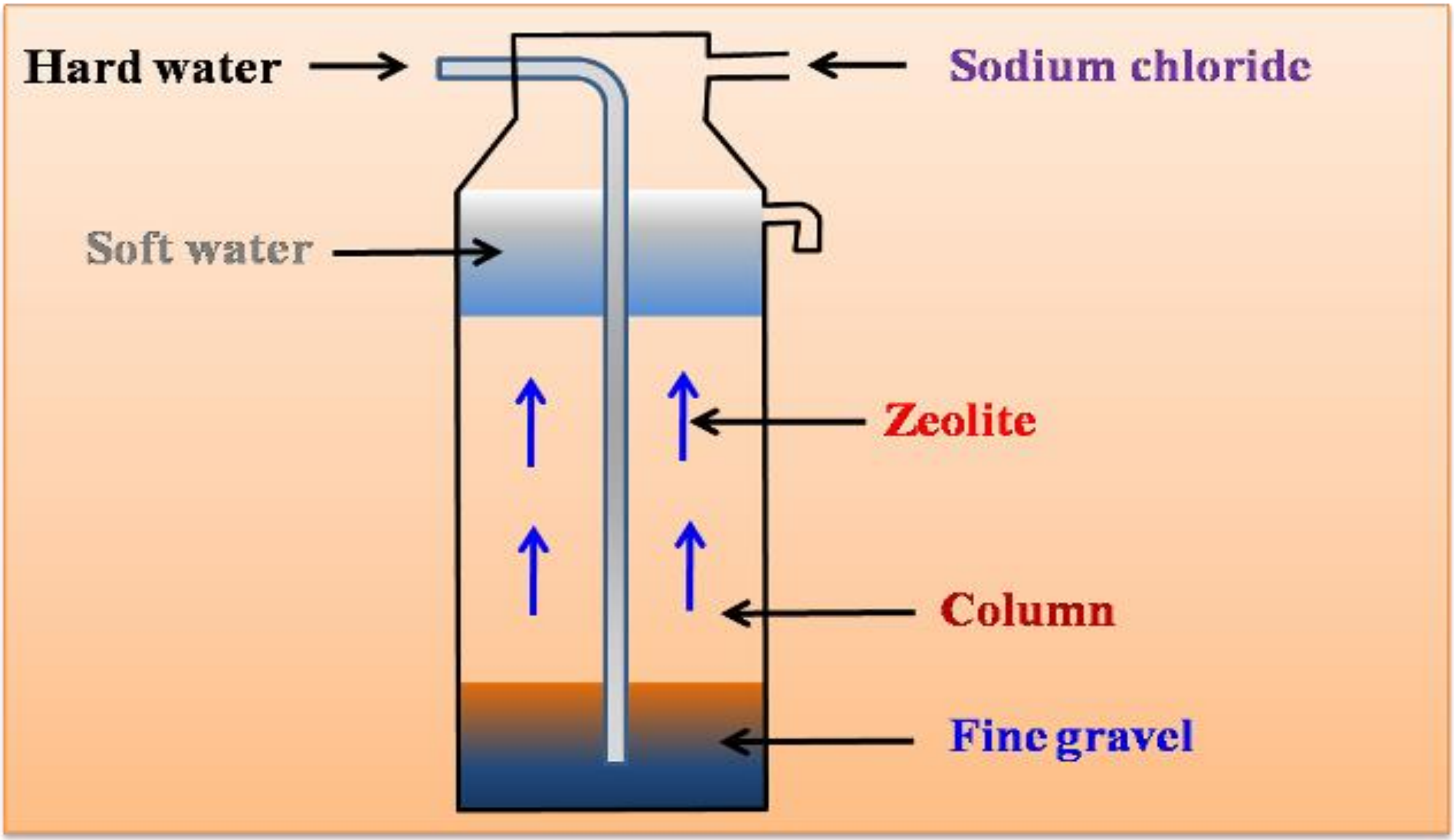
The dissolved gases removed at high temp.
The obtained water is more soft than cold process.
The softening capacity of this process is much higher than cold soda lime process.

A) Batch process
B) Continuous process

Limitation of Soda Lime Process:

- Lime soda softening cannot produce a water at completely free of hardness because of the solubility (little) of $CaCO_3$ and $Mg(OH)_2$.
- Thus the minimum calcium hardness can be achieved is about 30 mg/L as $CaCO_3$, and the magnesium hardnessis about 10 mg/L as $CaCO_3$.
- We normally tolerate a final total hardness on the order of 75 to 120 mg/L as $CaCO_3$, but the magnesium content should not exceed 40 mg/L as $CaCO_3$

Permutit Method



The process use for removing both temporary and permanant hardness of water permutit or zeolite are Complex silicate of serval metallic and non-metallic oxide. They have approximate chemical formula $Na_2Al_2 Si_2O_8 6H_2O$ is silicated holds Na usely hence this are Called Na permutit or Na zolite. where permitut and ~~zo~~ zeolite stands for $Al_2 Si_2 O_8 6H_2O$

The property of Na permitut is that when it comes in Contact with hard water it exchanges Na ions with Ca and Mg ions to form insoluble calcium permitut and mg permitut

Na permitut is placed in suitable of Container hard water is passed through it the Ca and mg Salt react with it forming insoluble Ca and mg permitut this salts retain in filter belt and water after reaction free from Ca and mg salts only the harmless Na salt are lake in

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water the following reactions takes place in this process

Temperatuary hardness water.

$Ca(HCO_3)_2 + Na_2P \longrightarrow CaP + 2NaHCO_3$
$Mg(HCO_3)_2 + Na_2P \longrightarrow MgP + 2NaHCO_3$

Permanant hardness of water

$CaCl_2 + Na_2P \longrightarrow CaP + 2NaCl$
$MgCl_2 + Na_2P \longrightarrow MgP + 2NaCl$

when process is continused for above 12 hrs. all sodium ions from the perminst are replaced by Ca and mg ions and it is formed that the permutir stop working and water is no more soften when permutis is exosted it is regenarated by treating with 10% NaCl solution for few minutes Na permitut is formed the reaction is regenaration can be shown as follows :

$$CaP + 2NaCl \longrightarrow Na_2P + CaCl_2$$

$$MgP + 2NaCl \longrightarrow Na_2P + MgCl_2$$

* Limitation.

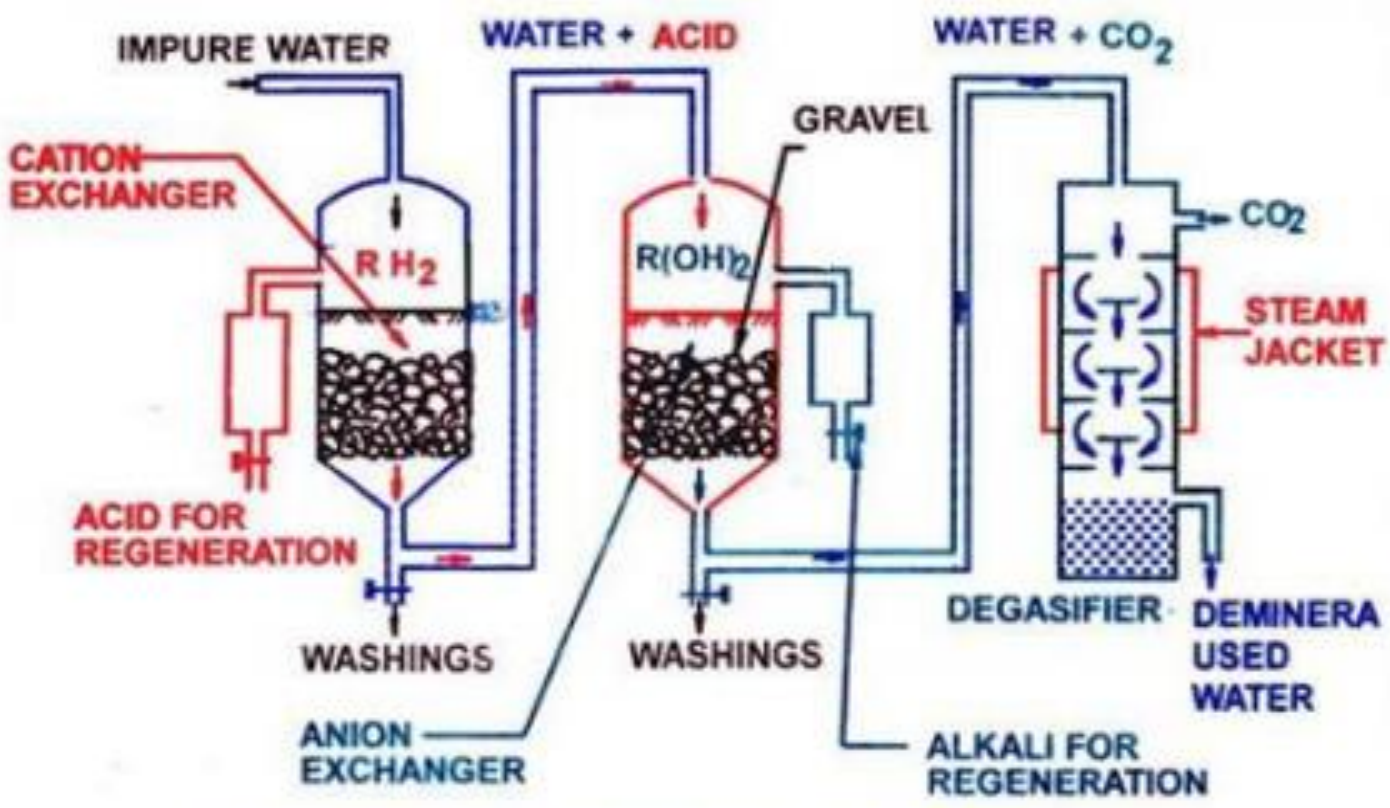
1) If hard water contains large quantity of colour ions like mg and fe ions this ions formed mg or ion permitut can't be regenarated easily if hard water contains mineral acids then it may distroyed permitut.

2) If hard water is turbed then turbidity may lock The pores of permitut and it stop the flow of water.

- Advantages

1) It removes the hardness completly
2) The equipment is used is Compact thus occupieng small space
3) The process automatically adjust itself for different hardness of incoming water
4) It is required loss time.

Ion exchange method



DEMINERAISATION PROCESS BY ION-EXCHANGE

This is morden method of water softning system. organic compounds are capable of exchanging ions such organic compounds are known as rezins. Their are two types of rezins.

1) Cations exchange rezins
2) Anions exchange rezins

1) Cation exchange rezins :- This rezins are Capable of exchanging rapidly cations by H^+ ions. Cation exchange rezins can be represented as RH_2 and their exchange reaction with cations is

$$RH_2 + Ca^{+2} \longrightarrow RCa + 2H^+$$

2) Anion exchange rezins :- This rezins are Capable of exchanging rapidly anions can be by the OH^- ions. Anion exchange rezins Can be represented as $R(OH)_2$ their exchange reaction with anions is

$$R(OH)_2 + SO_4^{-2} \longrightarrow RSO_4 + 2OH^-$$

water Produces is free from all ions and it distilled from the water is ~~finaly~~ free from desolved gas like CO_2 By passing it a degastier which is a tower whose sides are heated which was Connected to vaccum pump high temperature and low pressure was reduces the quantity of desolved of CO_2 and water such a softens is used for the industrial purpose.

- Reganaration :-

when Cations exchange rezins get exusted then it is reganarated by passing sutable dil. acids like HCl or H_2SO_4 through cations exchange rezins towers

$$RCa + 2HCl \longrightarrow RH_2 + CaCl_2$$
$$RMg + 2HCl \longrightarrow RH_2 + MgCl_2$$

Similar when anions exchanges rezins get enosted then it is regenarated by passing suatable alkali like NaOH or KOH through anions ~~cations~~ exchange rezins towers

$$RCl_2 + 2NaOH \longrightarrow R(OH)_2 + 2NaCl$$
$$RSO_4 + 2NaOH \longrightarrow R(OH)_2 + Na_2SO_4$$

Coagulation - It is the process of removing coalidlle particle by addition, certain chemical known as Congulant before

the sedimantation. Actually a collidle particle present in water either don't seral down at all or take a very long time in order in certain chemical are added to setting of the particle known as Coagulant. The commanly use Congulant of salt of ions Aluminium of ion. Coagulant reacts with $FeSO_4$ Coagulant reacts with the bio-Carbonates present in water or form bulky gelatinious

Municipal water treatment

Filtration

Coagulation

Sedimentation

Sterilization

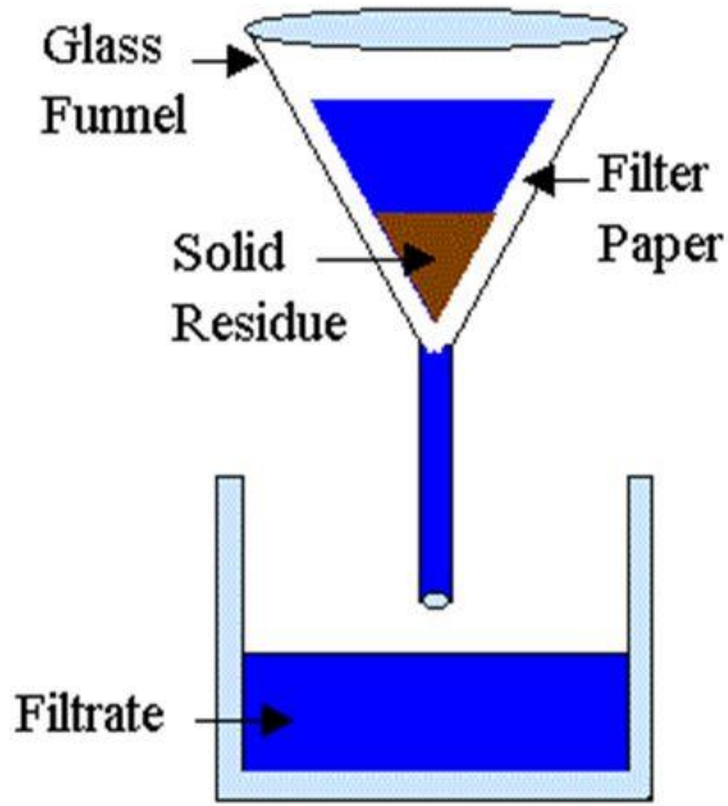
Filtration is a method for separating an insoluble solid from a liquid. When a mixture of sand and water is filtered:

the sand stays behind in the filter paper (it becomes the **residue**)

the water passes through the filter paper (it becomes the **filtrate**)

Example

- The solid remaining in the filter paper is called the residue.
- The residue can be dried by spreading it out on the filter paper and allowing the liquid to evaporate.
- The liquid which has passed through the filter paper is called the filtrate.



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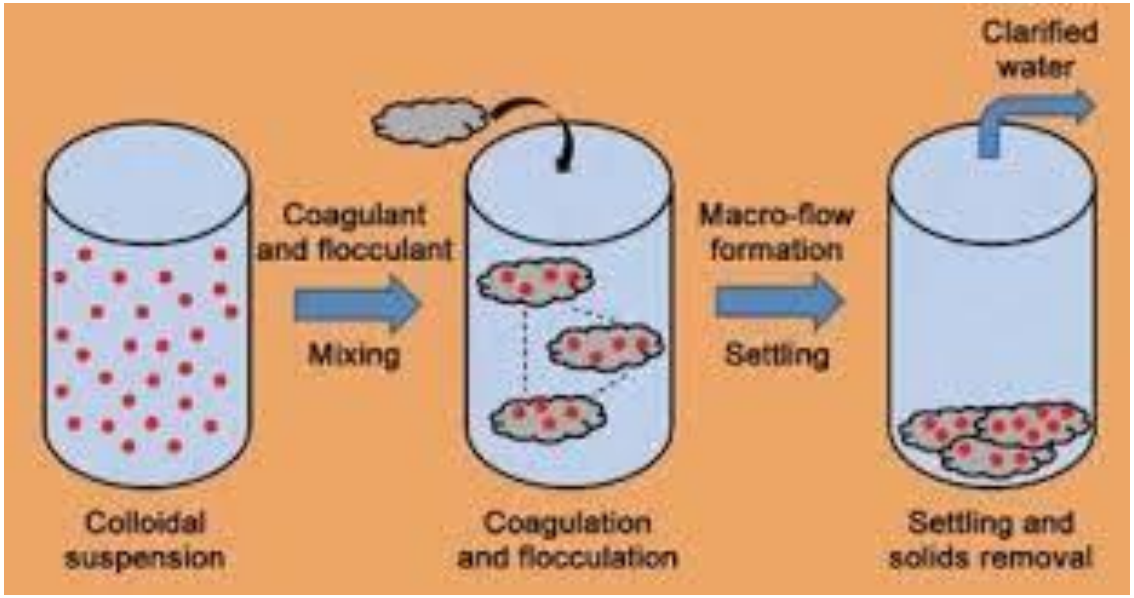
1) $Al_2(SO_4)_3 + 3Ca(HCO_3)_2 \longrightarrow 2Al(OH)_3 + 3CaSO_4 + 6CO_2\uparrow$

2) $FeSO_4 + Mg(HCO_3)_2 \longrightarrow Fe(OH)_2 + MgCO_3 + H_2O + CO_2\uparrow$

$Fe(OH)_2 + 2H_2O + O \longrightarrow 4Fe(OH)_3\downarrow$

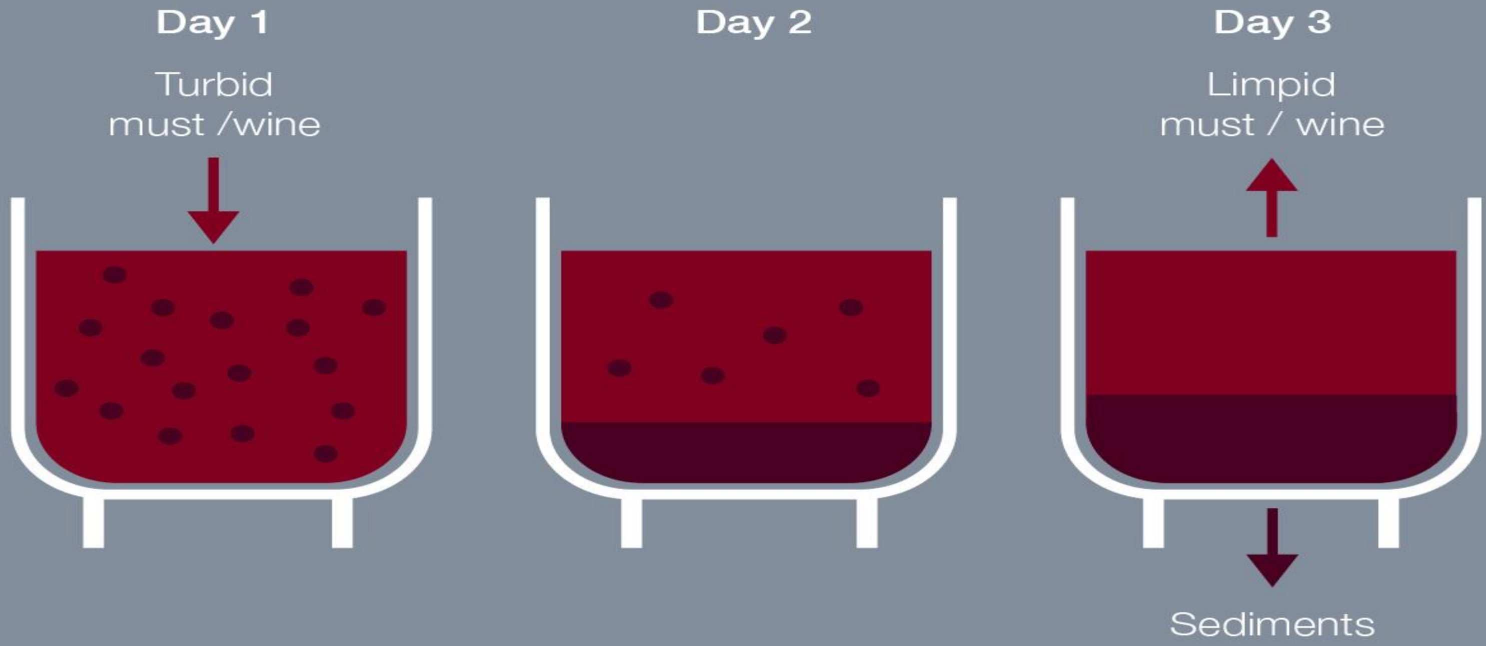
Coagulation Processes



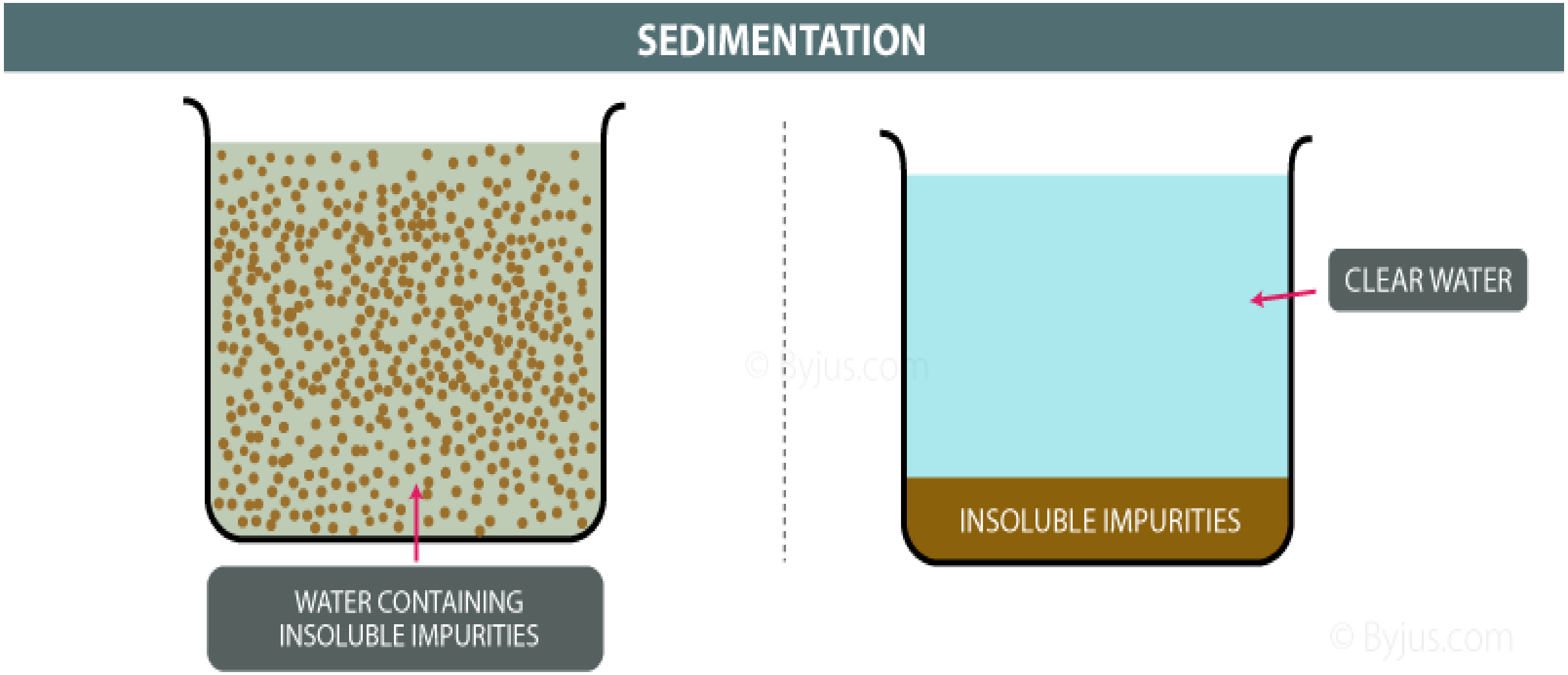
Sedimention - It is the process of removing Suspended impurities passing water in large tank to stay undesturbed for Some times when most of suspended particle sataled down due to force of gravity the clear water can be taken out from tank with the help of pump The process of sedimentation is generaly carried out continues flow type tank in which water flow in horizantal and Verical direction and uniform fill

Sedimentation

The particles suspended in the liquid, heavier than this one, are more attracted by gravity and therefore, in a certain period of time, precipitate on the bottom of the container.



Sedimentation



• Steralization - The process by which this is producing bacteria and microorganisms etc. from water get destroyed or kill is known as steralization or desinfaction

following methods are used to carry out steralization process of water :

Boiling :- All ~~this~~ disease is producing bacteria and micro organisms from water are easily killed after boiling the water for 10 to 15 minutes. This method is very cosraly and hence use for small scale particularly for household purpose.

2 chlorination :- The addition of chlorine gas or bleaching powder or ~~ch~~ cloromile use use to carry out the process of chlorination

a] by using chlorine - The addition of chlorine to water to produce hyperchlorous acid and nascent oxygen which are powerful germisides.

$$Cl_2 + H_2O \longrightarrow \underset{\text{Hypoclorous acid}}{HOCl} + HCl$$

$$HOCl \longrightarrow HCl + \underset{\text{nascent oxygen}}{[O]}$$

$$\text{Germs} + [O] \longrightarrow \text{Germs are oxidised.}$$

However chlorine produce unpleasant odour test if it is added is axis. hence ddding of acisc of chlorine Should be avoided.

b] by adding bleaching powder [$CaOCl_2$]
The addination of bleaching powder to water produce hypoclorous acid and nascent oxygen after passing the mixture of bleaching powder and water to stay undesturbed to severall hours. Both

hypoclorous acid and nascent oxygen are powerfull germilised and hence they kill germs and other harmful bacteria from water.

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

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

$$HOCl \longrightarrow HCl + [O]$$

Germs [O] $\longrightarrow$ germs are oxidized.

chloremine is stable compound gives good test to water it remove irating (bad) smell of water which may be formed due to axis of chlorine. Hence it consider as better germiside than chlorine, chloromine tablets are used in army to for stabilizing the water. chloromine tablets are added along with Na. Try D sulphate in individual bottles. Containing water to remove ascis of chlorine. $Cl_2 + NH_3 \rightarrow ClNH_2 + HCl$

$ClNH_2 + H_2O \rightarrow HOCl + NH_3\uparrow$

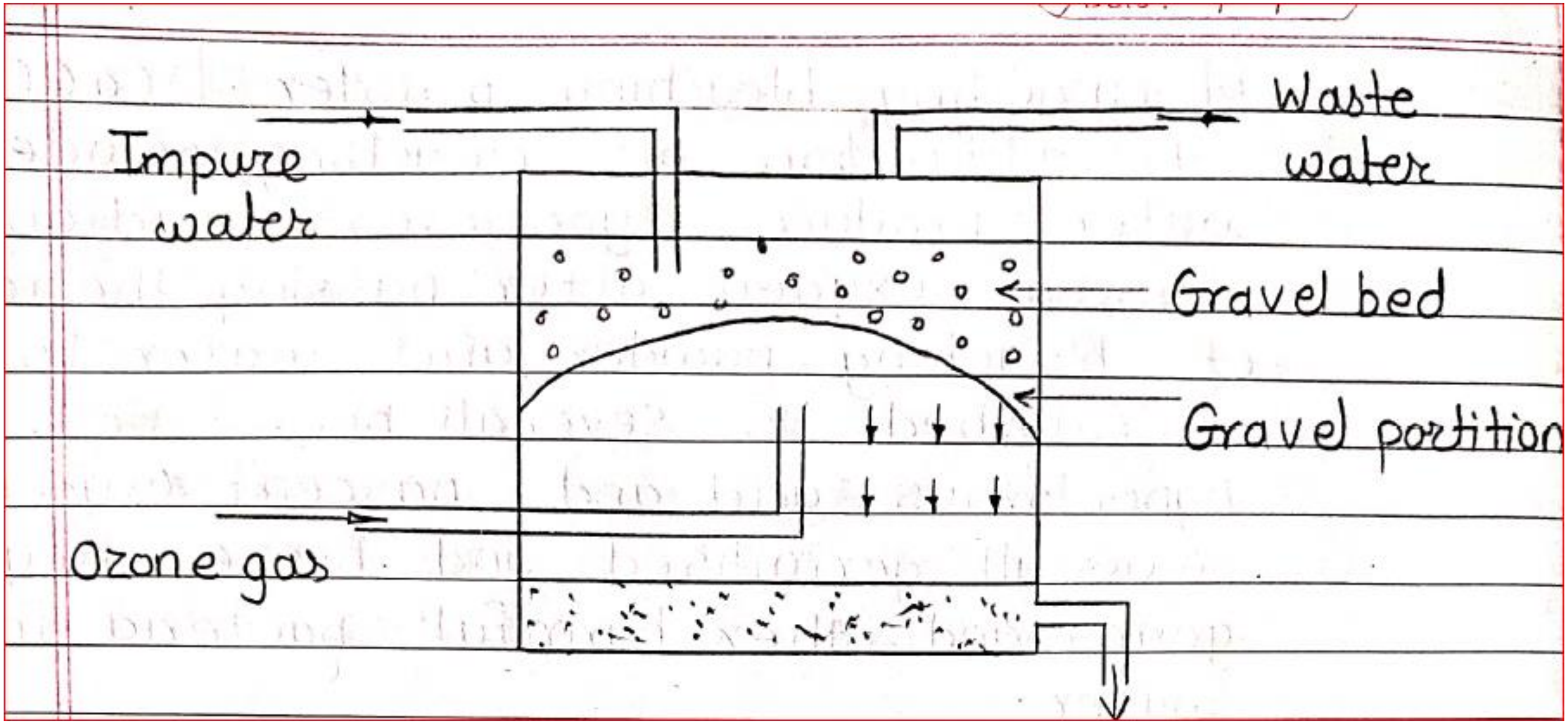
$HOCl \rightarrow HCl + \cancel{NH_3}\ [O]$

- $Cl_2 + NH_3 \rightarrow ClNH_2 + HCl$
- $ClNH_2 + H_2O \rightarrow HOCl + NH_3$
- $HOCl \rightarrow HCl + (O)$

3 Ozonisation - ozone molecule produce oxygen and nascent on decomposition it is unstable in nature.

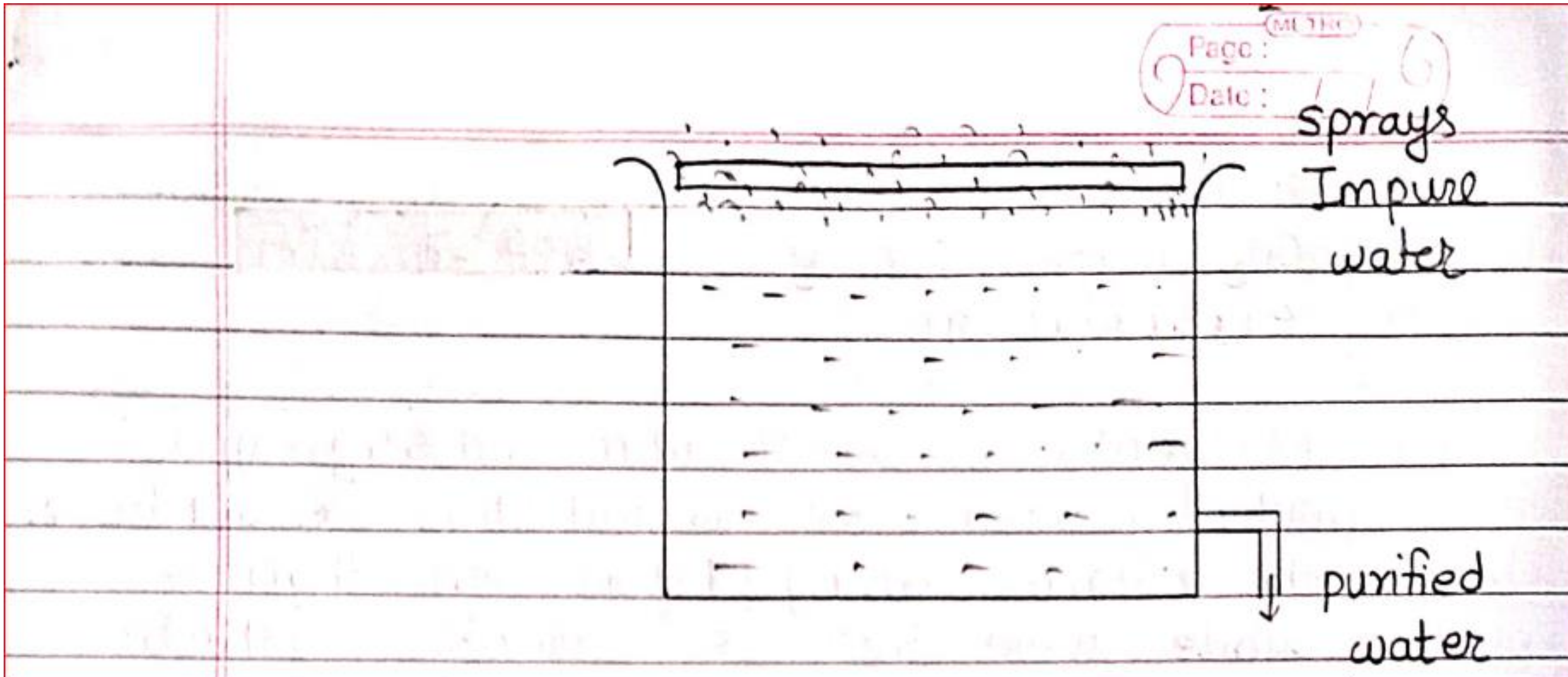
$$O_3 \longrightarrow O_2 + [O]$$

$$[O] + \text{Germs} \longrightarrow \text{Germs are oxidized.}$$


Impure water
Waste water
Gravel bed
Gravel partition
Ozone gas

Oxonization carried in starulizing tank having curved shape. Perfordted particle. Hence Here water is passed from the top of the tank to parcolate and ozone is intrudise from the bottom of the tank. When both water and ozone come in ~~tank~~ contact in tank ozone kills germ and bacteria present in water thus stralizing water this staralized water this was collected from bottle of tank as shown in fig. ozone removes colour and odour of water and give good taste to the water. It is not harmful to water. It use in qais because it was unstable and eaisily get decomposes to form nascent oxygen and oxygen molecule. It is an expenlienipe method it is not used for stardlization municiple water supply.

4 Arration - The process in which water in form of find water droplets spread into atmosphere ~~in~~ is known as arration.



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sprays
Impure water
purified water

In this process water is sprayed into air through perforated pipe under pressure pressure. It reacts with atmospheric oxygen and expose to UV rays of the sun The oxygen oxidised organic matter UV rays ins bacteria present in it. as the result the water become pure and is collected in shallow tank place below. When water in springs and reverse fall from the certain of height or slowly flows in its bed natural ereaction takes places to purify the water.

5 UV rays - Generally sweaming pool water doesn't required any chemicals to mix in water for its purification hence unvisible UV rays methods use for 8 caralization ~~as~~ or desinfication of sweaming pool water. as it is effective in killing all types of bacteria in order to kills bacterias on micro- organism present in sweaming pool water UV rays from mercury lamp are focus on flowing water of the pool. however us a method.