

The available raw water must be treated and purified before they can be supplied to the general public for their domestic, industrial or any other uses.

- ⇒ The extent of treatment required to be given to a particular water depends upon the characteristic and quality of water.
- ⇒ Various methods which are used to make the water safe and attractive to the consumers are described below.

Methods of purification

- (i) Screening
- (ii) Aeration
- (iii) Sedimentation
- (iv) Coagulation
- (v) flocculation
- (vi) filtration
- (vii) Disinfection
- (viii) Softening
- (ix) Miscellaneous treatment

Screening :-

- ⇒ Screens are generally provided in front of the pumps or the intake works, so as to exclude the large sized particles.
- ⇒ Coarse screens are sometimes placed in front of the fine screens.
- ⇒ Coarse screen consists of parallel iron rods placed vertically or at a straight slope, at about 2.5 to 5 cm apart.
- ⇒ The fine screens made of woven wire mesh with openings not more than 6 mm^2 .
- ⇒ The coarse screen remove the bigger floating bodies and the fine screen remove the fine suspended solids.

- The fine screen normally get clogged and are to be cleaned frequently.
- The coarse screen are normally kept inclined at about 45° - 60° to the horizontal, so as to increase the opening area to reduce the flow velocity.

Aeration :-

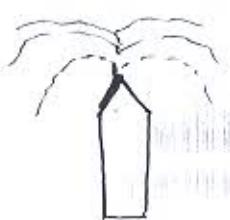
- Under the process of aeration, water is brought in intimate contact with air, so as to absorb oxygen and to remove carbon dioxide gas.
- Also helps in removing H_2S gas, iron and manganese to a certain extent.
- But the rate of removal is very slow. Hence only used when high concentration is present.
- This process increases acidity of water.

The aeration can be carried out in one of the following ways.

(i) By using spray nozzle:-

In this method water is sprinkled in air or atmosphere through special nozzles which breaks the water into droplets.

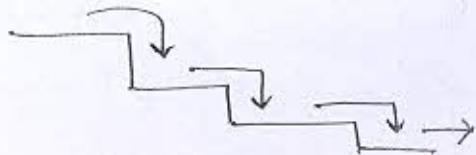
- CO_2 gas is considerably removed upto 90% in this method.



(ii) Cascade Aeration :-

In this method, the water is made to fall through a certain height over a series of steps.

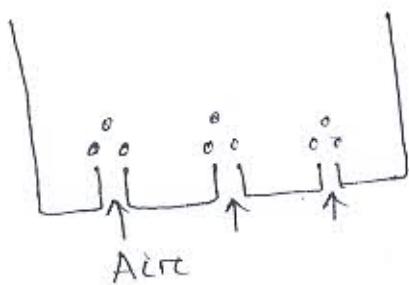
- They will take large quantities of water in a comparatively small area at low head.



(cascade)

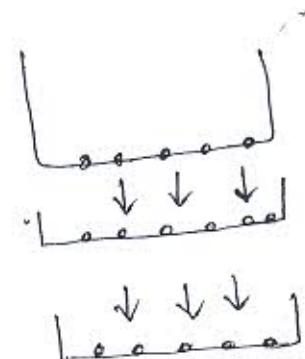
(iii) By air diffusion :-

In this method, compressed air is bubbled through the water, so as to thoroughly mix it with water.



(iv) By using trickling bed :-

→ Perforated bottomed trays are kept in series and water is allowed to move through this.



→ This method gives better result than the cascade aeration method but is less effective than spray nozzle method.

Sedimentation :-

- Suspended particles in water remain in turbulence as flow velocity. All the particles whose specific gravity is more than that of water have a tendency to settle down. But turbulence and flow velocity offer resistance.
- Plain sedimentation is the method of removing particle in water by controlling turbulence and flow velocity, giving rise to particle settlement by virtue of their own mass.
- The settlement of a particle in water brought to rest, is opposed by the following factors,
 - (i) The velocity of flow
 - (ii) Viscosity of water
 - (iii) The size, shape and specific gravity of the particle.
- The settling velocity of a spherical particle is expressed by Stoke's Law.

$$V_s = \frac{g}{18} (G-1) \frac{d^2}{\eta} \quad \text{for } d < 0.1 \text{ mm}$$

$$V_s = \left[\frac{4}{3} g d \frac{(G-1)}{C_D} \right]^{1/2}$$

C_D = coeff. of drag

$$C_D = \frac{24}{Re} \quad \text{for laminar flow}$$

$$= \frac{24}{Re} + \frac{3}{\sqrt{Re}} + 0.34 \quad \text{for transition flow}$$

$$= 0.4 \quad \text{for turbulent flow}$$

Open channel flow

$$Re < 500$$

$$500 < Re < 1500$$

$$Re > 1500$$

Pipe flow

$$Re < 2000$$

$$2000 < Re < 4000$$

$$Re > 4000$$

Laminar

Transition

Turbulent

Sedimentation Tank

Three forces which control the settling tendency that is velocity, viscosity, size and shape. Out of this viscosity is left uncontrollable.

→ Types of sedimentation tank :-

The sedimentation tanks can basically be divided into two types,

- (i) horizontal flow tank
- (ii) Vertical or up flow tanks

Horizontal Flow Tank

→ In the design of horizontal flow tanks, the aim is to achieve, as nearly as possible, the ideal condition of equal velocity at all points lying on each vertical line in the settling zone.

→ The direction of flow in the tank is substantially horizontal.

→ Among the horizontal flow tanks, we may have different type of designs such as :-

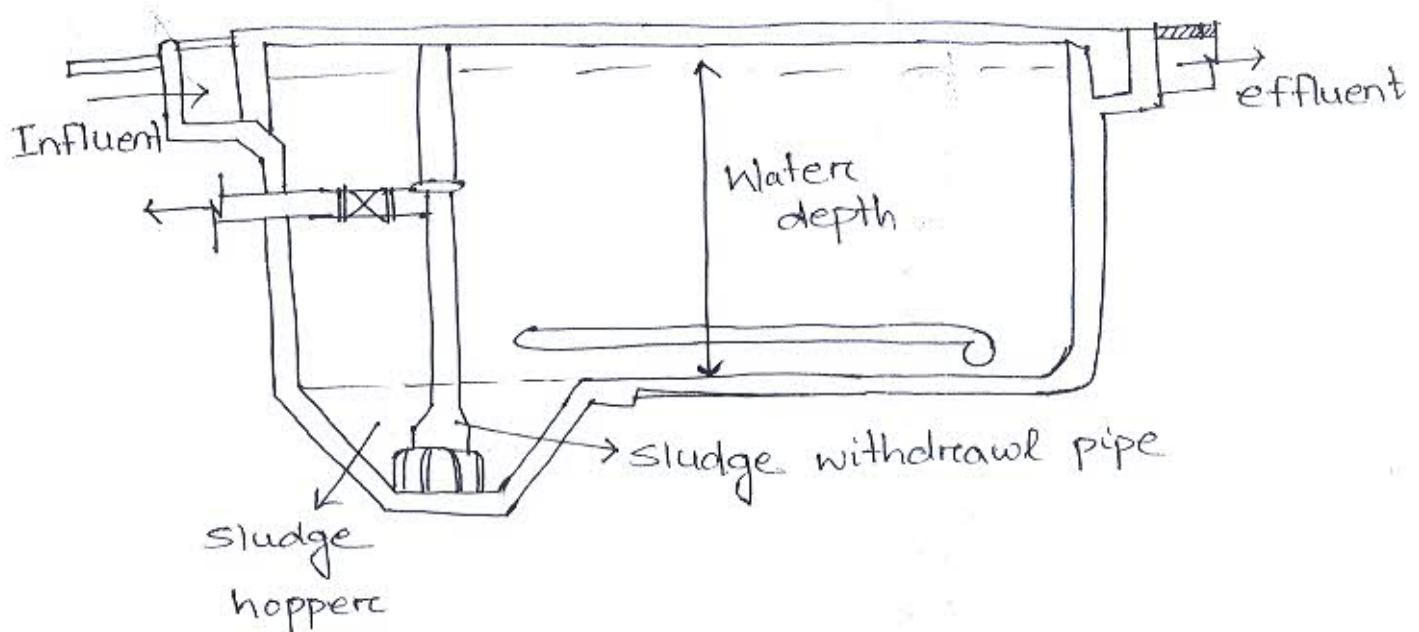
(i) Rectangular tanks with longitudinal flow :-

→ These are provided with mechanical scrapping devices to scrap the sludge to the sludge pit located usually towards the influent end from where it is continuously removed, without stopping the working of the tank.

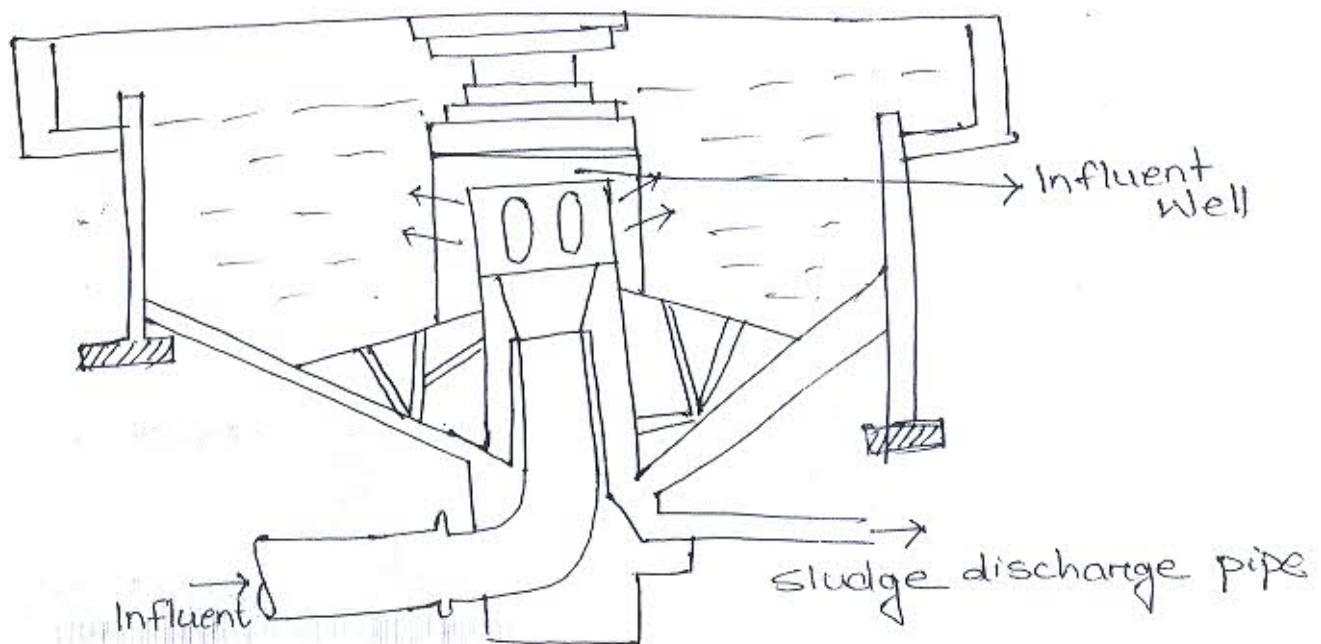
→ Such tanks are known as continuous flow type of sedimentation tank.

→ In other type of such tanks, mechanical scrapper may not be provided and the tank may have to be cleaned by stopping the operation of the tank.

→ In such intermittent type of sedimentation tank raw water is stored for some time.



[Rectangular Sedimentation Tank]



[Circular sedimentation Tank]

(ii) Circular flow tank with radial flow

- In such a tank, the water enters at the centre of the tank into a circular well provided with multiple ports.
- Thus, water flows horizontally and radially from the centre towards the periphery of the circular tank, from where the water is withdrawn.
- The sludge is scraped to the central sump mechanically and continuously.

Vertical or Upflow settling Tanks :-

Vertical flow tanks usually combine sedimentation with flocculation, although they may also be used for plain sedimentation.

- When used with coagulants, the flocculation takes place in the bottom of the tank leading to formation of blanket of floc.

Design Parameters :-

- (i) Surface over flow rate or over flow rate or over flow velocity.
- It is the volume of water applied in unit time / unit surface area of settling tank.
 - Represented by V_0 (SOR)

→ V_0 is the flow velocity at which the tank is designed to operate.

$$SOR = V_0 = \frac{\text{discharge}}{\text{surface area}}$$

$$= \frac{\text{Volume} / \text{Time}}{\text{surface area}}$$

$$= \frac{\text{surface area} \times \text{depth} / \text{Time}}{\text{surface area}}$$

$$= \frac{\text{depth}}{\text{Time}}$$

(ii) Settling Velocity (V_s)

→ The velocity related to sedimentation of particle is called as settling velocity.

→ Particles are captured when $V_s > V_0$.
escaped when $V_s < V_0$.

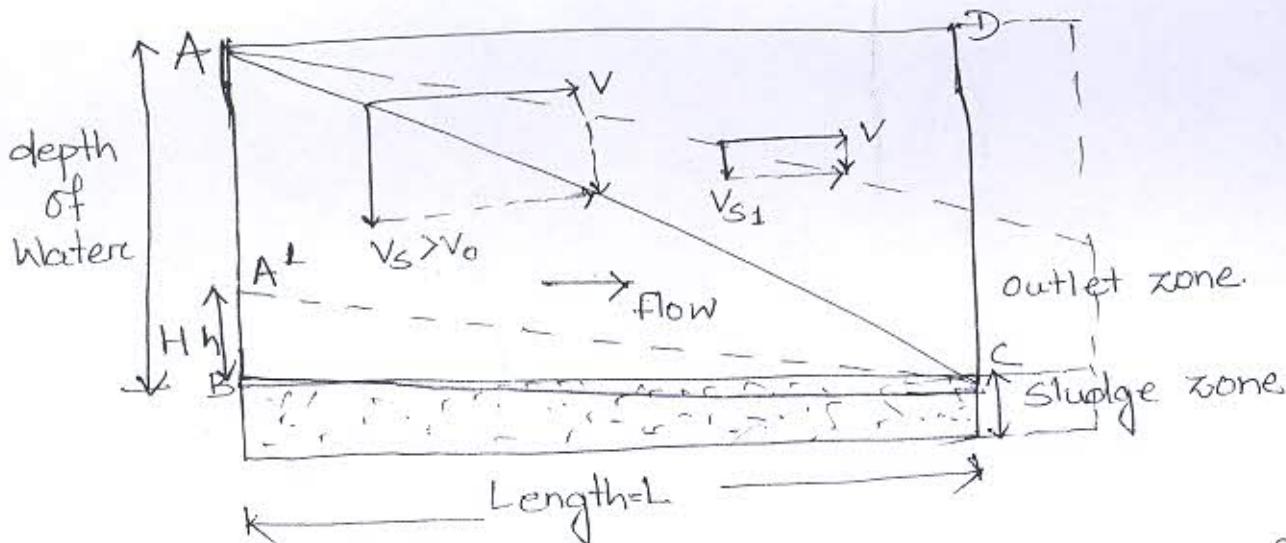
→ Let at uniform velocity V water containing uniformly distributed sediment enters the tank.

$$V = \frac{Q}{BH} \quad B = \text{width of tank}$$

$$H = \text{depth of water}$$

$$V_s = \frac{Q}{B \cdot L} = \frac{Q}{A_s} = V_0$$

If V_0 increases then efficiency of settling tank decreases.



If particle entering at lesser height and if reach at bottom through its $V_s < V_o$, partial removal of lighter particles may occur.

→ Thus removal of heavier particles ($V_s > V_o$) and partial removal of smaller sized particles ($V_s < V_o$) occurs.

$$Pe = \frac{V_s}{V_o} \times 100$$

Pe = % of lighter particles ($V_s < V_o$) that can be removed.

Design data:-

(i) Over flow rate :- $12-18 \text{ m}^3/\text{day}/\text{m}^2$ for plain sedimentation tank.
 $\Rightarrow 24-30 \text{ m}^3/\text{day}/\text{m}^2$ for sedimentation + coagulation.

$$\text{(ii) Plan area} = \frac{Q_{\text{design}}}{\text{Overflow rate}}$$

(iii) Detention time : $4-8 \text{ hrs}$ for plain sedimentation
 $2-4 \text{ hrs}$ for sed. + coagulation

$$t_d = \frac{\text{Water depth}}{V_s}$$

$$\text{Volume of tank} = Q_{\text{design}} \times t_d$$

$$\text{Depth} = \frac{\text{Vol. of tank}}{\text{Area}}$$

Length of tank = Velocity \times t_{ad}

(iv) Depth = 3 to 4.5m [1.8m taken as minimum and 6m as maximum]

(v) Width = 10-12 m normally

Generally, $\frac{\text{length}}{\text{width}} = 4 \text{ times}$

(vi) Sedimentation tank should be designed for maximum daily flow = 1.8 times \times Avg daily flow.

(vii) For tank without mechanical sludge removal equipment additional 0.8-1.2m is provided for sludge zone.

$$\Rightarrow \text{Retention time for circular tank} = \frac{d^2(0.11d + 0.785H)}{Q}$$

d = dia of tank

H = Vertical depth at wall or side water depth.

(Q) Two million liters of water per day is passing through a sedimentation tank which is 6m wide, 15m long and having a water depth of 3m. (a) find the detention time for the tank (b) what is the average flow velocity through the tank (c) If 60 ppm is the concentration of suspended solids present in turbid raw water, how much dry solids will be deposited per day in the tank, assuming 70% removal in the basin, and average specific gravity of the deposit as 2.

(d) Compute the over flow rate.

$$\Rightarrow \text{(a) The capacity of the tank} = L \times B \times D \\ = 15 \times 6 \times 3 \\ = 270 \text{ m}^3$$

$$\text{Discharge} = Q = 2 \text{ million liters per day} \\ = 2 \times 10^6 \text{ lit/day} \\ = \frac{2 \times 10^6}{24} \text{ lit/hr.}$$

$$\text{Detention time} = \frac{\text{capacity of the tank}}{\text{discharge}} \\ = \frac{270}{83.33} \\ = 3.24 \text{ hrs}$$

(b) Average velocity of flow

$$= \frac{\text{discharge}}{\text{c/s area i.e. BH}} \\ = \frac{83.33}{6 \times 3} \\ = \frac{83.33}{6 \times 3} \times \frac{100}{60} \\ = 7.72 \text{ cm/min.}$$

(c) Quantity of water passing per day,

$$= 2 \times 10^6 \text{ lit}$$

concentration of suspended solids = 60 ppm

Quantity of suspended solids entering per day

$$\text{Q}_{\text{suspended}} = 2 \times 10^6 \times \frac{60}{10^6} \text{ l}$$
$$= 120 \text{ lit}$$
$$= 0.12 \text{ m}^3$$

Avg. specific gravity of the deposited material

as 2,

$$\text{So, } \rho = 2000 \text{ kg/m}^3$$

(density)

Mass of suspended solids deposited with 70% removal per day

$$= 0.12 \times 0.7 \times 2000$$
$$= 168 \text{ kg}$$

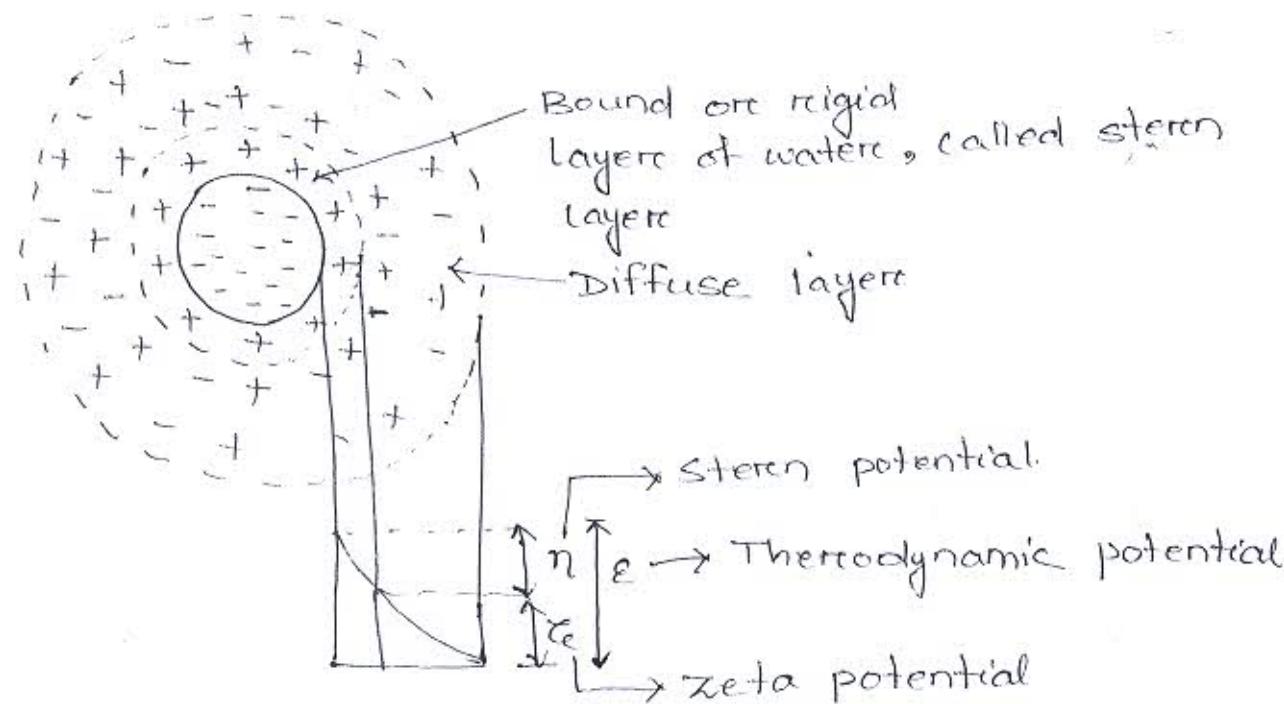
(d) over flow rate :-

Discharge per unit plan area

$$= \frac{Q}{BL}$$
$$= \frac{83.33 \times 10^3 \text{ lit/hr}}{6 \times 15}$$
$$= 926 \text{ lit/hr/m}^2$$

Coagulation :-

- Sedimentation aided with coagulant is employed to capture suspended particles which escape plain sedimentation along with colloidal particles.
- Colloidal particles are charged particles resulting from preferential absorption or from ionisation of chemical groups on the surface.
- These are very charged. The stationary charged layer on the surface is surrounded by a bound layer of water.



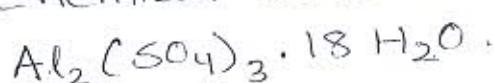
Chemicals used for coagulation :-

- Various chemicals, such as alum; iron salts like ferric sulphate, ferric chloride, ferric sulphate etc are generally used as coagulants.
- These chemicals are most effective when water is slightly alkaline.
 - In the absence of such alkalinity in raw water, external alkaline like sodium carbonate or lime etc. are added to the water.

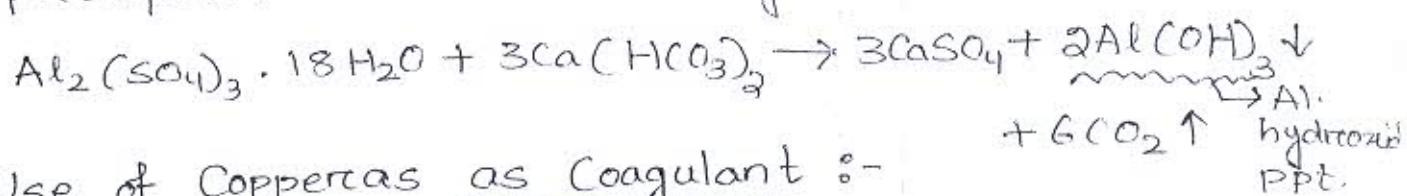
The important coagulants are described below,

1) Use of Alum as Coagulant :-

⇒ Chemical name of alum is aluminium sulphate

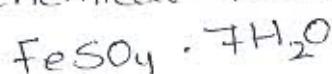


⇒ When alum added to raw water, reacts with the bicarbonate alkalinites so as to generate precipitate of aluminium hydroxide.

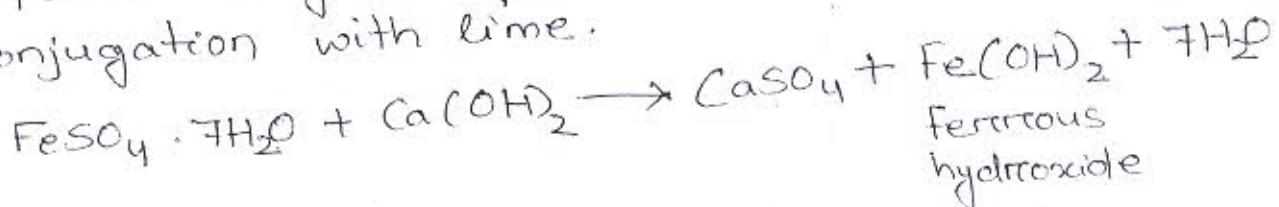


2) Use of Copperas as Coagulant :-

⇒ Chemical name of copperas is ferrous sulphate,



⇒ Copperas is generally added to raw water in conjugation with lime.

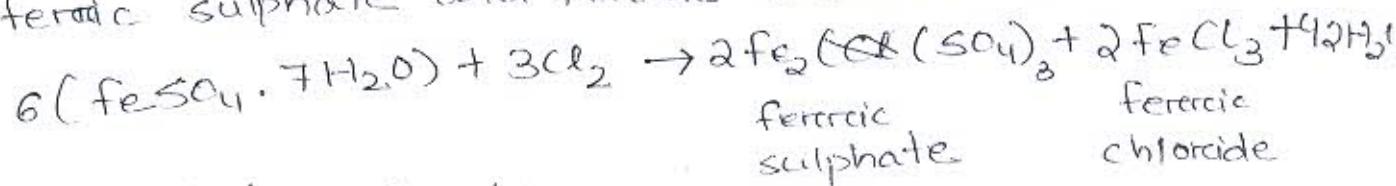


⇒ It is extensively used as a coagulant for raw waters that are not coloured.

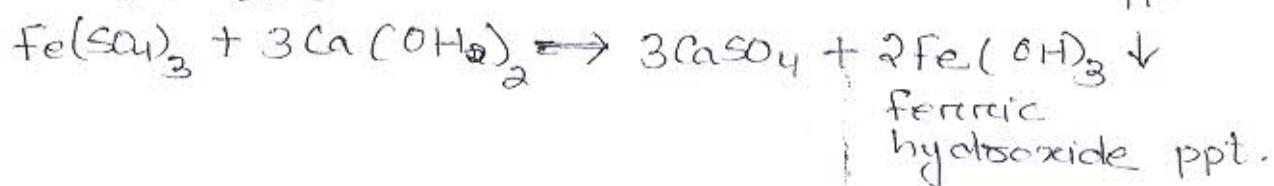
⇒ It is generally cheaper than alum, and function effectively in the pH range of 8.5 and above.

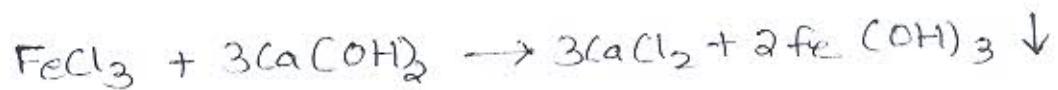
3) Use of chlorinated Copperas :-

When chlorine is added to a solution of copperas, ferric sulphate and ferrous chloride are formed.



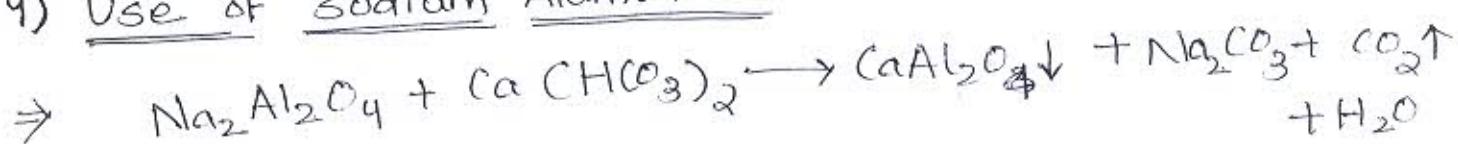
The resultant combination of ferric sulphate and ferrous chloride is known as chlorinated copperas.





→ It is very effective coagulant for treating low pH water.

4) Use of sodium Aluminate :-



→ This coagulant is about $1\frac{1}{2}$ times costlier than alum.

6th Nov.

Comparison of Alum and Iron Salts

- (i) Iron salts produce heavy floc and can therefore remove much more suspended solids than the alum.
- (ii) Iron salts, being good oxidising agents, can remove H_2S and its corresponding tastes and odour from water.
- (iii) Iron salts can be used over a wider range of pH values.
- (iv) Iron salts impart more corrosiveness to water than that which is imparted by alum.
- (v) The handling and storing of iron salts require more skill and care whereas no skill is required for handling alum.

Q) Determine the quantity of alum required in order to treat 13 million liters of water per day at a treatment plant, whence 12 ppm of alum dose is required. Also determine the amount of carbon dioxide gas which will be released per liter of water treated.

Given,

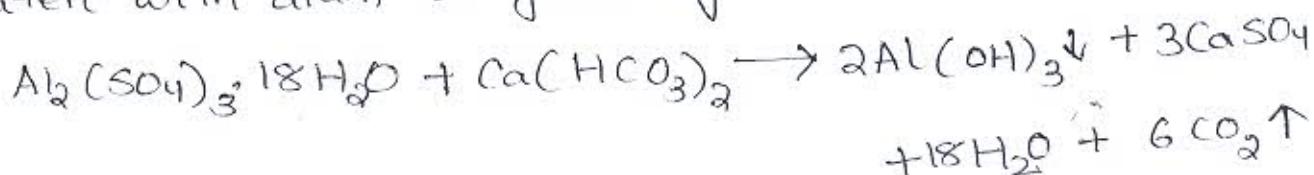
$$\text{Quantity of water to be treated} = 13 \times 10^6 \text{ lit/day}$$

$$\text{Alum dose required} = 12 \text{ PPM}$$

$$\text{Amount of water required per day} = 13 \times 10^6 \times 12 \times 10^{-6}$$

$$= 156 \text{ kg}$$

The chemical reaction which is involved in treating water with alum is given by,



Molecular mass of Alum

$$= 2 \times 26.97 + 3 [32.066 + 4 \times 16] + 18 [2 \times 1 + 16]$$

$$= 666.246 \approx 666$$

Molecular mass of CO_2 ,

$$= 12.01 + 2 \times 16 = 44$$

It means that 666 mg of alum, if used, will release

$$= 6 \times 44 \text{ mg of } \text{CO}_2$$

$$12 \text{ mg of alum produce} = \frac{6 \times 44}{666} \times 12$$

$$= 4.76 \text{ mg}$$

Flocculation :-

6th Nov

Flocculation is the slow mixing technique which promotes the agglomeration of the destabilised particles.

The constituents of a coagulation sediment plant :-

- The coagulation sedimentation plant, sometimes called simply a coagulation or a clariflocculator, contains the following four units.
- (i) Feeding device
 - (ii) Mixing device
 - (iii) Flocculation tank
 - (iv) Settling or sedimentation tank.

Feeding device :-

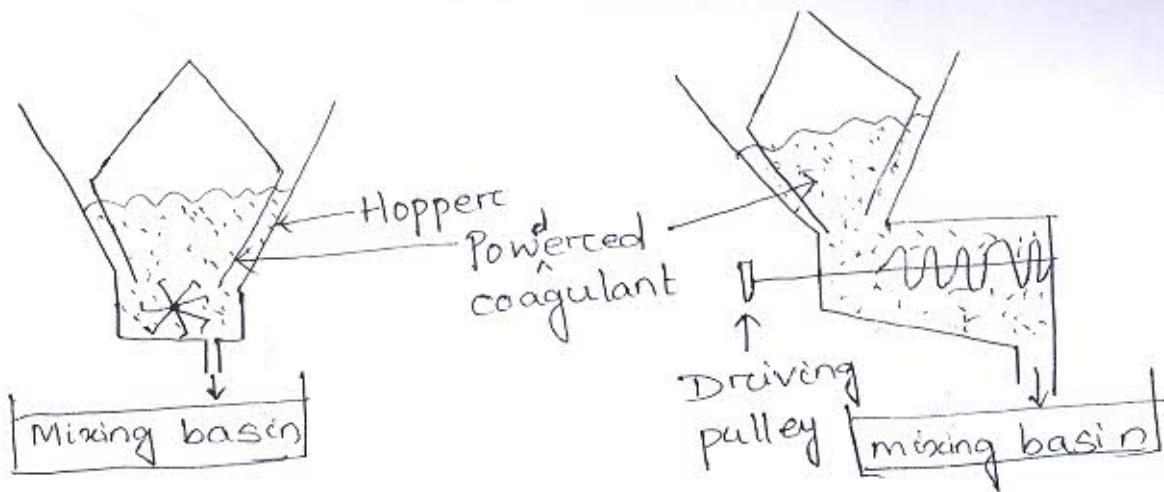
The chemical coagulant may be fed into the raw water form either in a powdered form or in a solution form.

- The feeding devices are of two type
- (i) Dry feeding device
 - (ii) Wet feeding device

Dry feeding Device :-

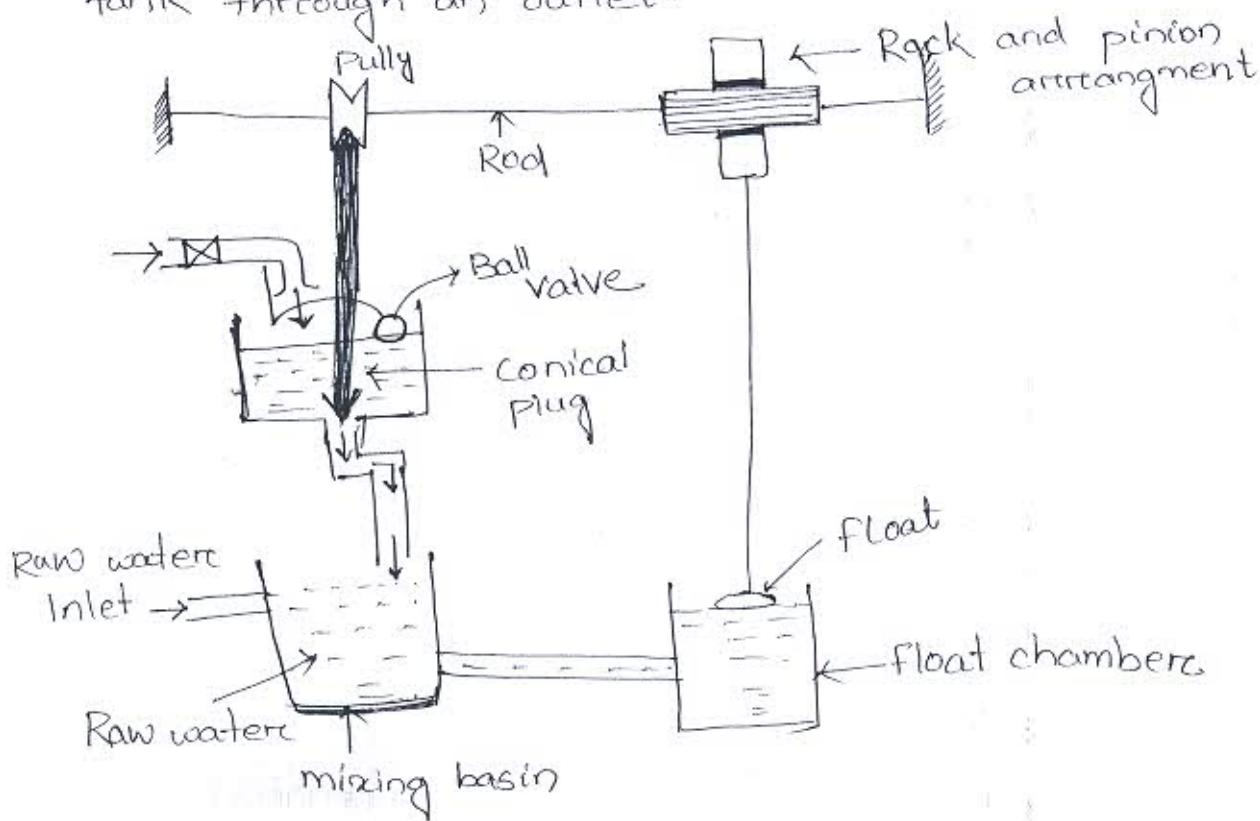
They are in the form of hoppers. Agitating plates are placed inside the tank. The coagulant, in the powder form, is filled in the tank, and is allowed to fall in the mixing basin.

- Its dose is regulated by the speed of toothed wheel or a helical screw.



Wet feeding Device

→ In wet feeding, the solution of required strength of coagulant is prepared and stored in a tank, from whence it is allowed to trickle down into the mixing tank through an outlet.

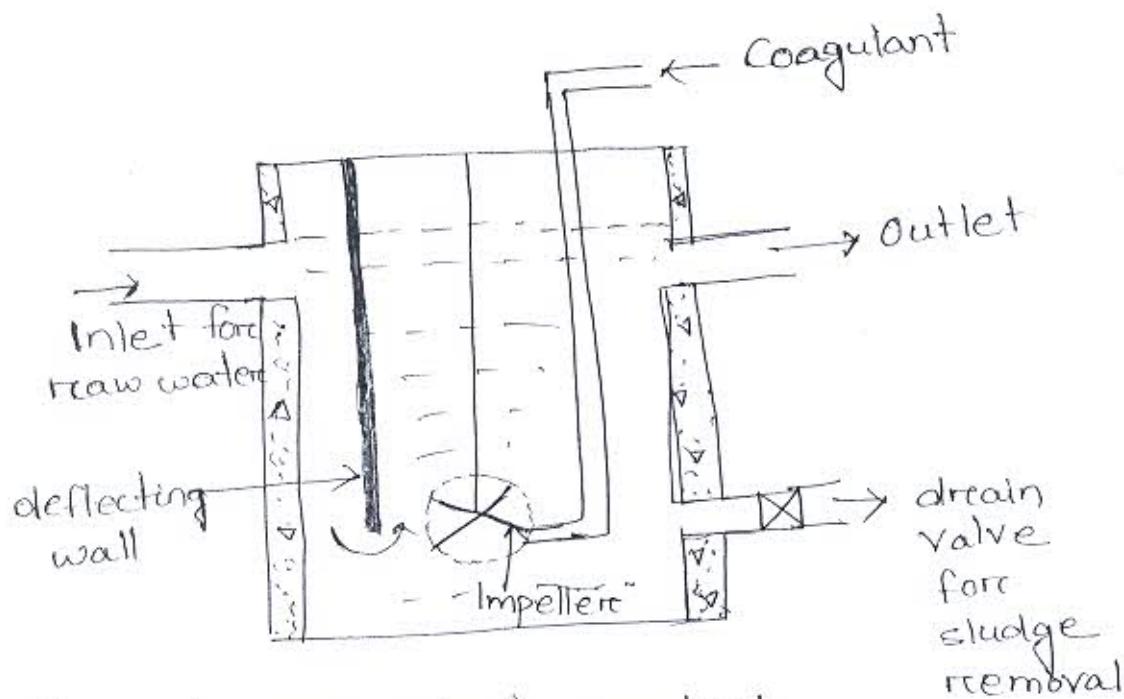
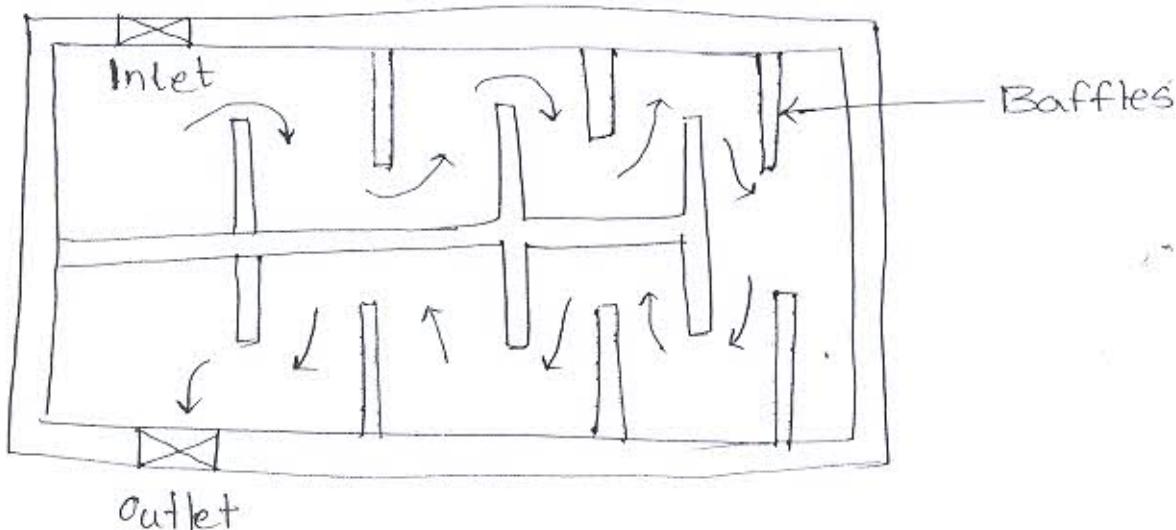


Mixing devices :-

After the addition of the coagulant to the raw water, the mixture is thoroughly and vigorously mixed, so the coagulant gets fully dispersed into the entire mass of water.

→ There are two type of mixing basin.

- (i) Mixing basin with baffle walls
- (ii) Mixing basin equipped with mechanical devices.



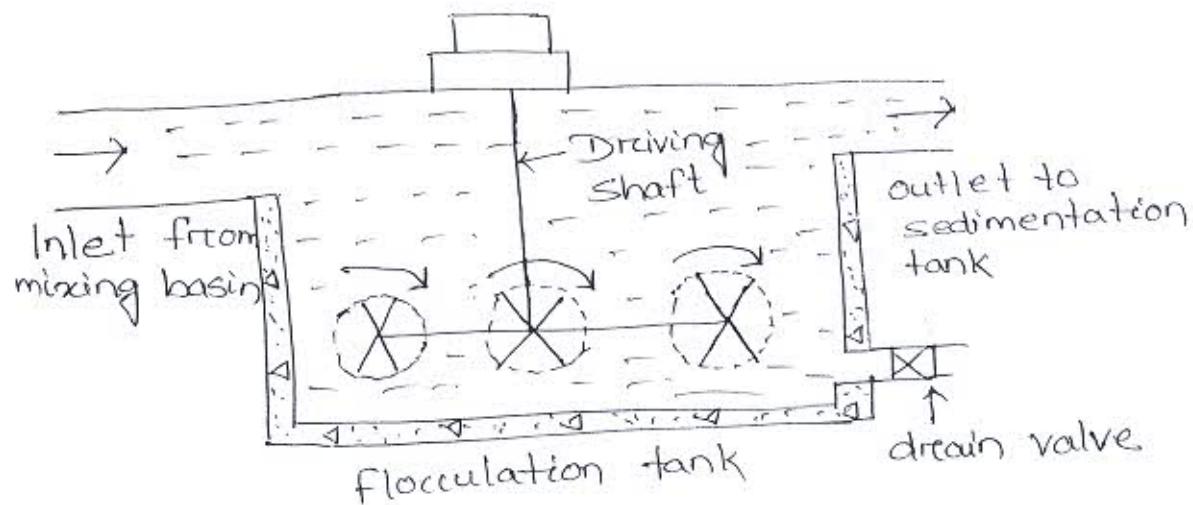
Temporal mean velocity gradient,

$$G' = \left[\frac{P}{\mu V} \right]^{1/2}$$

G' = Velocity gradient (Per second)
 P = Power dissipated in watts i.e.
 μ = dynamic viscosity
 V = Vol of water

Nm/s

Flocculation tank or a Flocculator :-



- The best floc will form when the mixture of water and coagulant are violently agitated followed by a relatively slow and gentle stirring to permit build up of the floc particles.
- From the mixing basin the water is therefore taken to the flocculation tank called a flocculator, whence it is given a slow stirring motion.
- A typical flocculator fitted with slowly moving paddles. The paddles usually rotate at a speed of about 2 to 3 rpm.

Sedimentation Tank

This tank is designed on the same assumptions as a plain sedimentation tank, except a lower value of detention period. Also higher rate of surface loading rate.

Laboratory testing for determining optimum Coagulant quantity :-

- The common test which is performed to determine this approximate optimum quantity of coagulant is known as jar test.
- The sample of raw water to be tested is placed in number of jars each having a capacity of about 1 lit. Normally six jars are used.
- Different amounts of coagulant are then added to each jar. The driving unit is started. The paddles placed inside the jars, and connected with the driving shaft through vertical stirring rods, and thus made to rotate.
- The formation of the floc in each jar is noted. The amount of coagulant in the jar which produces a good floc with the least amount of coagulant, indicates the optimum dosage.

Date - 12th Nov.

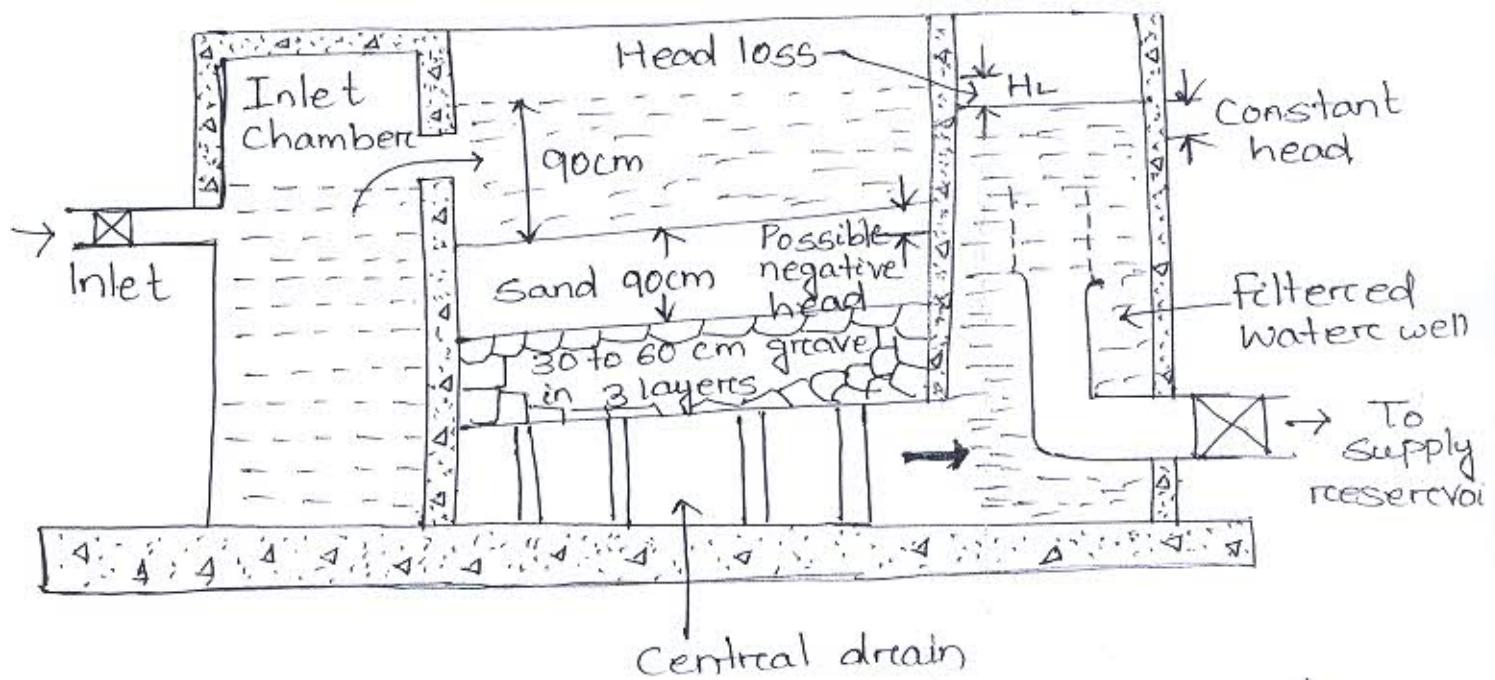
Filtration :-

The process of passing the water through the beds of such granular materials is known as filtration.

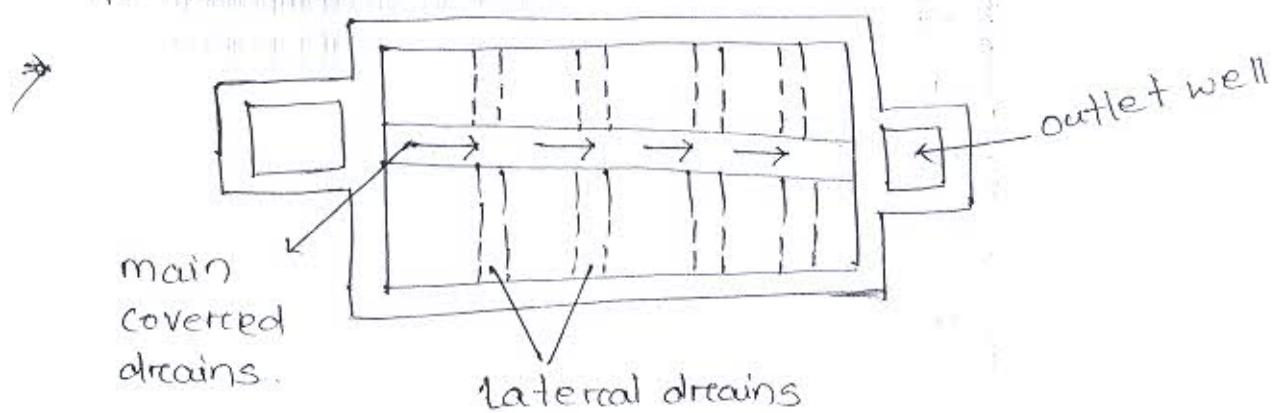
- Filtration may help in removing colour, odour, turbidity and some pathogenic bacteria from the water.
- Two types of filters are commonly used.
 - (i) The slow sand gravity filters
 - (ii) The rapid sand gravity filters

Slow sand filters

- It consists of an open water-tight rectangular tank.
- The filtering media consists of sand layers about 90 to 110 cm in depth, and placed over a gravel support.
- The effective size (D_{10}) of sand varies from 0.2 to 0.4 mm.



- ↗ The base material is gravel, and it supports sand. Generally three to four layers each of 15-20 cm depth are used.
- ↗ The coarsest gravel is used in the bottom most layer and the finest gravel is used in the top most layers.
- ↗ The gravel support is laid on the top of an underdrainage system. The underdrainage system consists of lateral and central drains.
- ↗ The lateral drains collect the filtered water and discharge it to main drains, which leads the water to the filtered water well.



→ A filtered water well is constructed on the outlet side in order to collect the filtered water coming out from the main drain.

Operation and Cleaning of slow sand filters

→ Treated water from the sedimentation tank is allowed to enter the inlet chamber of the filter unit and get distributed uniformly over the filter bed.

→ The water percolates through the filter media and gets purified during the process of filtration.

→ The loss of head called filter head is generally limited to a maximum value of about 0.7 to 1.2 m. When this limiting value kept as 0.7 to 0.8 times the depth of filter sand, the filter unit must be cleaned.

→ The cleaning of slow sand filter is done by scrapping and removing the 1.5 to 3 cm of top sand layer and washed with clean water.

→ After each cleaning the filter is again used and raw water is admitted into it. But the effluents that will be obtained in the beginning will not be pure and not in use for about 24 to 36 hours, until formation of a film of arrested impurities around the sand grains. This phenomenon is named as schmutzdecke.

→ However, the interval ranges between one to two month.

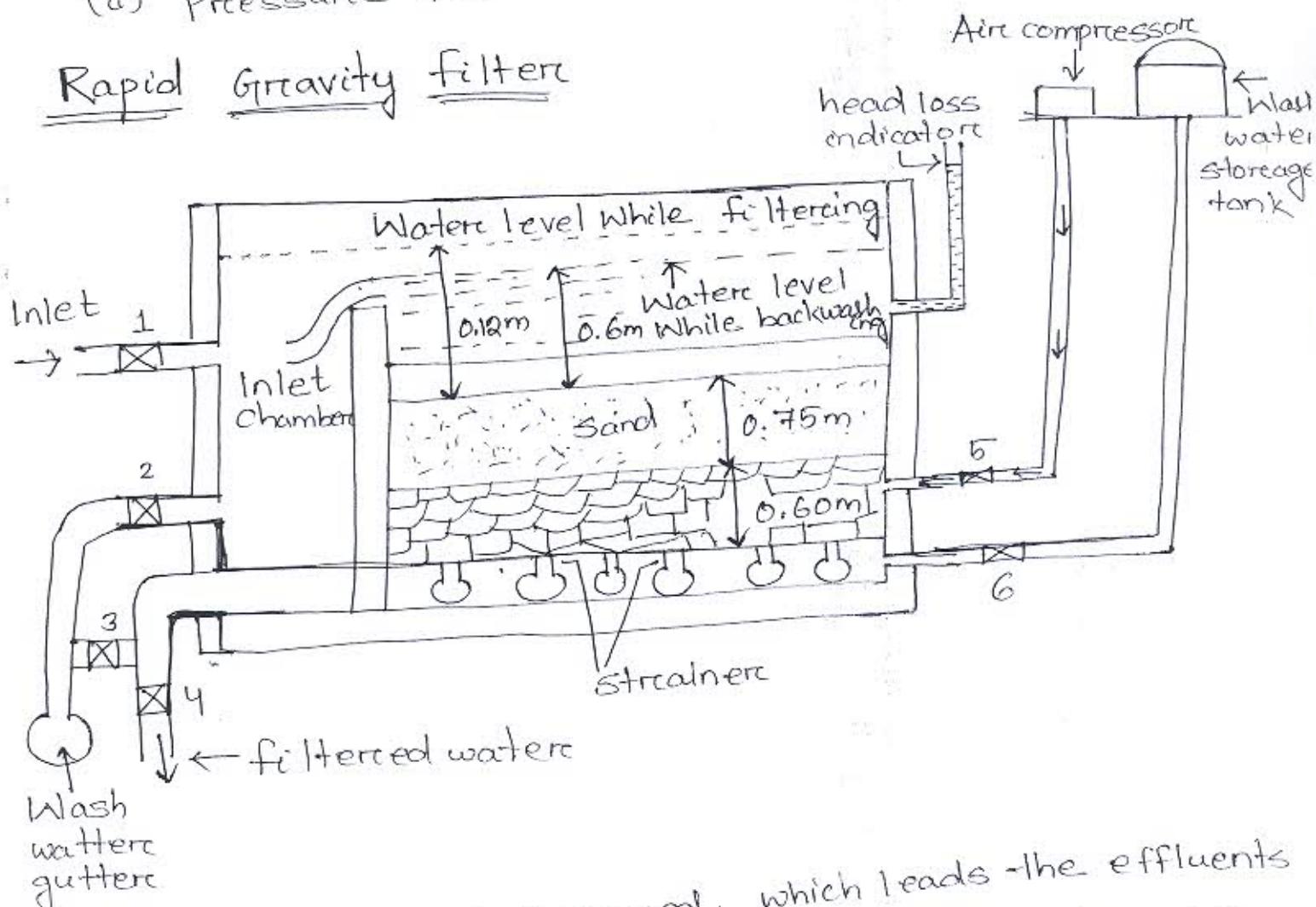
→ Rate of filtration :- 100 to 200 lit/hour/m²

Efficiency :- Bacteria removal is up to 98 to 99 %.

Rapid Sand filters

- In order to reduce the requirement of space and to increase the rate of filtration, which finally led to the development of rapid sand filters.
- The rapid sand filters are of two types.
 - (i) Rapid gravity filter
 - (ii) Pressure filter.

Rapid Gravity filter



- Valve-1 is first of all opened, which leads the effluents of the coagulation sedimentation basin, to enter the inlet chamber of the filter.
- This water gets filtered through the filter beds and the filtered water can be taken out from the main drain by opening valve 4.
- The filtered water can be taken to the disinfection unit. Thus when filter is in working condition only these two valves kept open and all others kept closed.

Back - Washing :-

- When sand becomes dirty, as is indicated by the excessive loss of head, the filters must be washed.
- At the time of cleaning, valve 1 and 4 are closed and valve 5 and 6 are opened.
- The wash water and compressed air are thus forced upward from the under-drainage through the gravel and sand beds.
- Valve 5 is closed after supplying the required amount of air. The dirty water resulting from washings overflows into the waste water and removed by opening valve 2, through inlet chamber to wash water outlet.
- The process of washing takes place 3 to 5 min.
- After washing 2 and 6 will be closed and valves 1 and 3 are opened. Filtered water is not collected in the beginning, washed through valve 3.
- Ultimately valve 3 is closed and valve 4 is opened.
- The rapid sand filters get clogged very frequently and have to be washed every 24 to 48 hours.

Rate of filtration \Rightarrow 3000 to 6000 lit/hour/m²

Efficiency \Rightarrow Less efficient in removing bacteria (80 to 90 %) but very efficient in removing colour.

No of filter units \Rightarrow $N = 1.22 \sqrt{Q}$

Q = plant capacity in million litres per day.

Operational troubles in Rapid gravity filters

(i) Aire binding :-

When the frictional resistance offered by the filter media exceeds the static head of water above the sand bed. Then bottom of the sand acts like more or less a vacuum and due to which water is get stucked without getting filtered.

- So, negative pressure is developed which tends to release the aire dissolved in water.
- It causes the formation of bubble which stick to the sand grains, and thereby seriously affect the filtering process known as aire binding.

(ii) Formation of mud balls :-

- During inadequate washing of the filters, the mud preser in sand may sink down.
- Which arrest a lot impurities and slowly go on increasing in size and weight.
- They may sink down to gravel thus interfering with the upward movement of wash water during cleaning.

(iii) Cracking of filters :-

- The fine sand contained in the top layer of the filter bed shrinks and causes the development of shrinkage cracks in the sand bed.
- The mud and other impurities in the filter penetrate deep into the filter through these cracks and thus prevent proper backwashing.

Q) Design the approximate dimensions of a set of rapid gravity filters for treating surface water required for a population of 50,000 ; the rate of supply being 180 l/d per person. The filters are rated to work 5000 lit/hrc/m². Assume the data needed.

→ The max. water demand per day = Population × Max. daily rate of sup

$$= 50,000 \times 1.8 (180)$$

$$= 16.2 \times 10^6 \text{ l}$$

$$= 16.2 \text{ million lit}$$

Water demand per hour = $\frac{16.2 \times 10^6}{24}$

$$= 675 \times 10^3 \text{ lit/hrc.}$$

Rate of filtration = 5000 lit/hrc/m²

Area of filter beds = $\frac{\text{Water demand}}{\text{Rate of filtration}}$

$$= \frac{675 \times 10^3}{5000}$$

$$= 135 \text{ m}^2$$

Since two units are required,

Area of each unit = $\frac{135}{2} = 67.5 \text{ m}^2$

Assuming, $L = 1.5B$

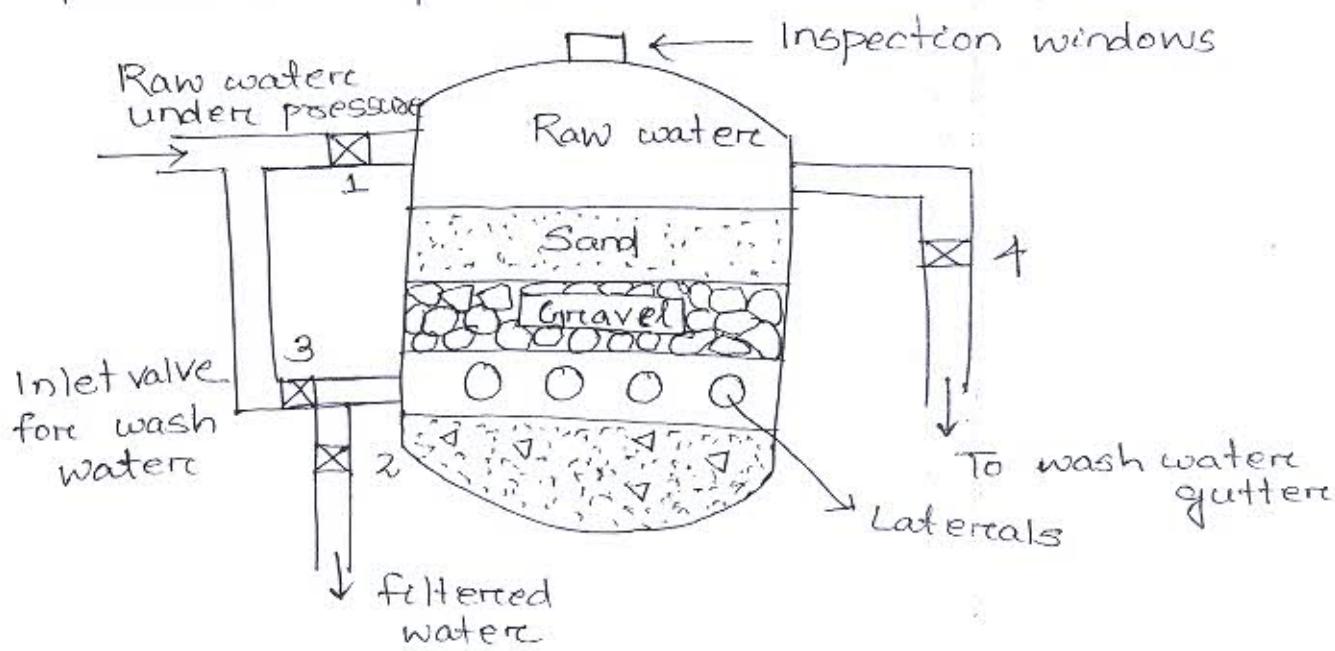
$$1.5 B^2 = 67.5$$

$$\Rightarrow B^2 = 45$$

$$\Rightarrow B = 6.75 \text{ m.}$$

Pressure filters :-

Pressure filters are just like small rapid gravity filters placed in closed vessels and through which water to be treated is passed under pressure.



- The coagulated water under pressure enters the filter vessel through the inlet valve 1, and the filtered water comes out of the outlet valve 2, all other valves are closed.
- For cleaning the inlet valve 4 and outlet valve 2 are closed and wash water valve 3 and 4 are opened.
- After the completion of cleaning these valves are closed.

Rate of filtration :- 6000 to 15000 lit/hrc/m²

Efficiency :- Very less efficient than rapid gravity filter.

Disinfection :- The filtered water which is obtained either from the slow sand filters or rapid gravity filter, may normally contain some harmful disease producing bacteria in it. These bacteria must be killed these bacteria are known as disinfectants. And the process is known as disinfection.

Minor Methods of disinfection

- (i) Boiling of water
- (ii) Treatment with excess lime
- (iii) Treatment with ozone
- (iv) Treatment with codine and bromine
- (v) Treatment with ultra-violet rays
- (vi) Treatment with potassium permanganate

Boiling of water :-

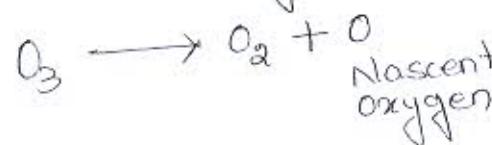
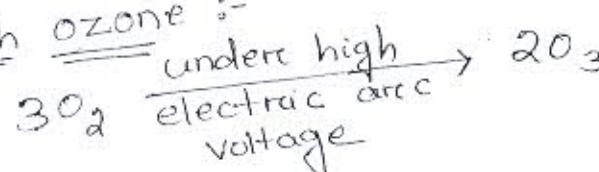
The bacteria present in water can be destroyed by boiling it for a long time.

→ This is an effective method of disinfection, but it is not practically possible to boil huge amounts of public water supplies.

Treatment with excess lime :-

Excess lime is added upto 14 to 43 ppm to remove 99.3 to 100%.

Treatment with ozone :-



The nascent oxygen is a powerful oxidising agent removes the organic matter as well as the bacteria from the water.

Treatment with iodine and bromine :-

- It helps in killing the pathogenic bacteria, and thereby disinfecting the same.
- It is limited to 8 ppm.

Treatment with ultraviolet rays :-

- Ultraviolet rays are the invisible light rays, highly effective in killing all type bacteria.

Treatment with potassium permanganate :-

- This is a very popular disinfectant generally used in well water supplies.

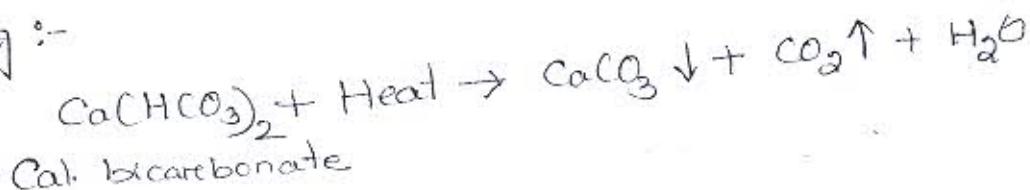
16th Nov.

Softening of Water

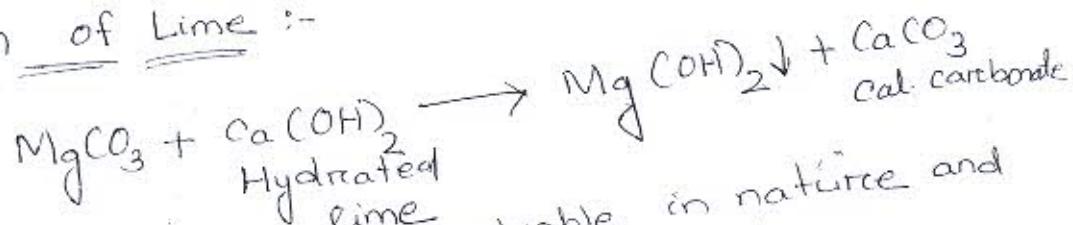
⇒ The reduction or removal of hardness from water is known as water softening.

Methods of removing Temporary Hardness

1) Boiling :-



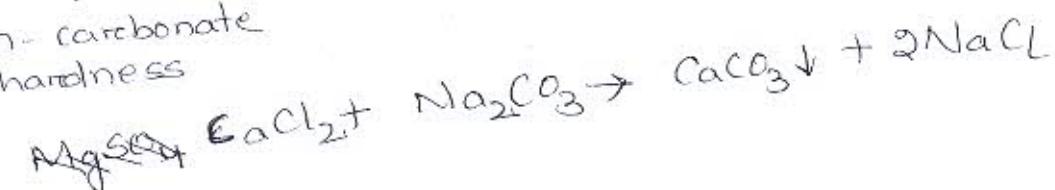
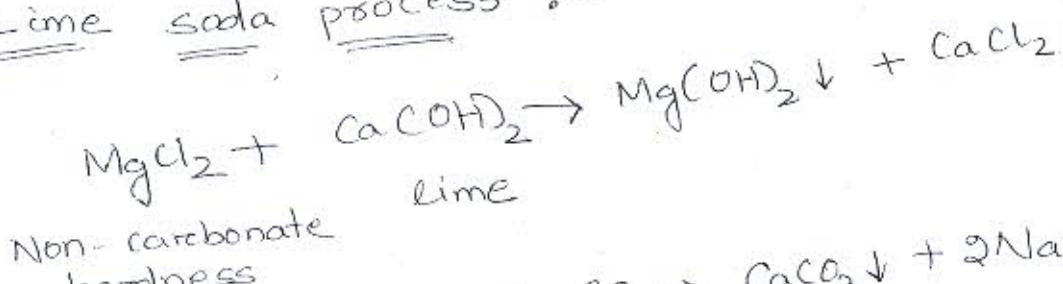
2) Addition of Lime :-



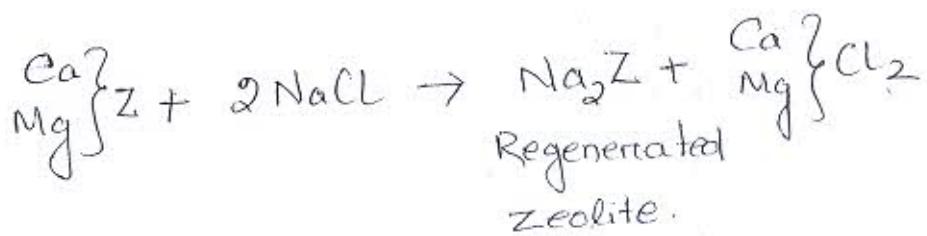
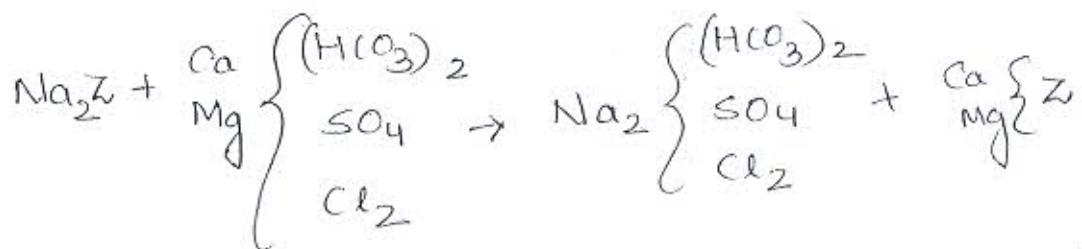
Calcium carbonate is insoluble in nature and can be removed from sedimentation tank.

Methods of removing permanent hardness

3) Lime soda process :-



2) Ion exchange on Zeolite Process



- Water of zero hardness can be obtained by using this process.
- This method is not suitable for treating highly turbid waters.

Treatment with activated Carbon Adsorption Technique

→ Activated carbon is a specially treated carbon, which possess the property of absorbing and attracting impurities, such as gases, liquids and finely divided solids.

→ Because of its excellent property of absorbing impurities, it is widely used for removing tastes and colours from public supplies.

→ Water distribution system :-

17th Nov.

- Distribution system is a network of pipelines that distribute water to the consumers.
- They are designed to adequately satisfy the water requirement for a combination of
 - (i) domestic
 - (ii) Commercial
 - (iii) Industrial
 - (iv) fire fighting purpose
- A good distribution system should satisfy the following,
 - (i) Adequate water pressure at the consumer's taps.
 - (ii) Pressure should be great enough to adequately meet fire fighting needs.
 - (iii) At the same time, pressure should not be excess that it causes the leakage.
 - (iv) Purity of water should be maintained.
 - (v) The pipelines should not be laid under highways, carriageway but below foot paths.

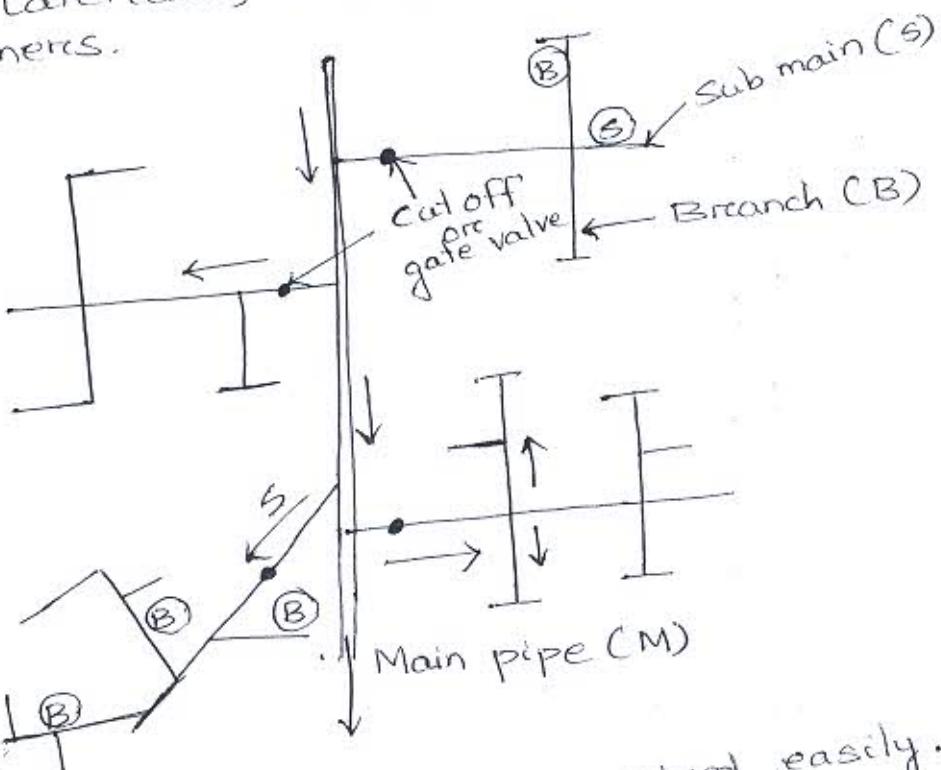
Distribution System

Depending upon the local conditions and orientation of roads, These systems are classified as,

- (i) dead end system
- (ii) Grid iron system
- (iii) Ring system
- (iv) Radial system

Dead-end system

- Also named as tree system.
- There is one main pipe, from which originates a number of submain pipe.
- Each submain pipe divides into several branch pipes, called laterals.
- From laterals, service connection are given to the consumers.



Advantage

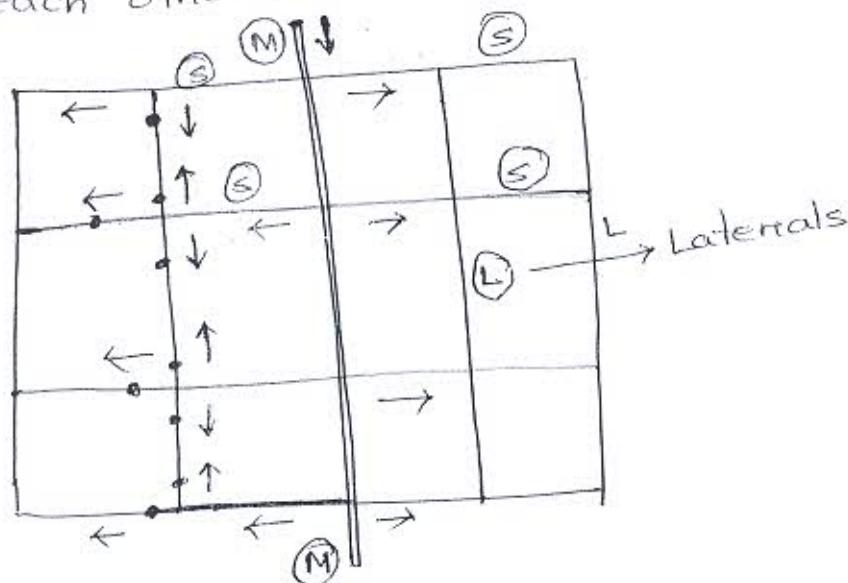
- Advantage distribution network can be solved easily.
- i) Lesser no of cutt off valve
 - ii) Shorter pipe length are needed
 - iii) It is cheap and simple.

Disadvantage

- c) Any damage in any pipe line will completely stop the water supply.
- d) There are numerous dead ends.

Grid Iron System :-

- Also known as reticulation system.
- The mains, submains and branches are all inter-connected with each other.



Advantage

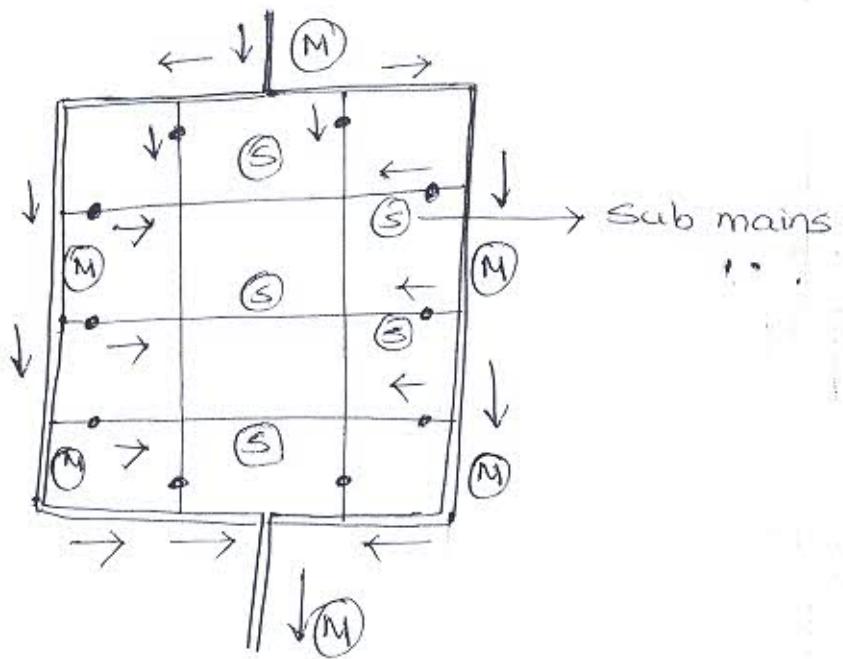
- Since water reaches at different places through more than one route, then water carried by each pipe and due to this size of pipe reduced.
- In case of repairs, very small area is devoid.

Disadvantage

- This system requires more length of pipe lines and a larger number of sluice valve.
- Its construction is costlier.

Ring System :-

- Also called circular system.
- In this system, a closed ring, either circular or rectangular of the main pipe is formed around the area to be served.



Radial System

→ If a city or a town is having a system of radial roads emerging from different centres, the pipe lines can be best laid in a radial method by placing the distribution reservoir at these centres.

