NEC license Exam Preparation

Chapter 6: Water Supply, Sanitation and Environment

DAY:4

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Chapter Outline

6.2

- Types of intakes,
- Factor affecting selection of location of intake;
- Types and purposes of pipe materials,
- Joints, **valves and fittings;**
- Break pressure tanks;
- Service reservoirs and their capacity determination;
- Design of branch and looped water distribution systems.

Valves and Fittings

- A **valve** is a device that regulates or controls the flow of a fluid by opening, closing, or partially obstructing it.

❑ What are valves used for?

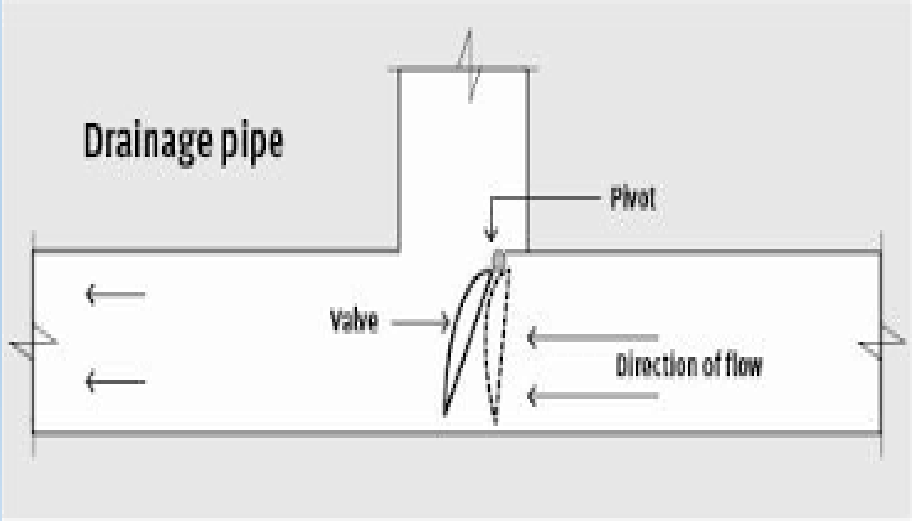
- To regulate the flow of water.
- To prevent the flow in opposite direction.
- To release excessive pressure.
- To remove or admit the air.
- To drain or washout the pipeline.

1. Sluice Valves:

- Sluice valves are also known as gate valves, cut off valves or shut off valves.
- They are required to shut off the supplies whenever desired in the water supply system.

2. Reflux Valves:

- Reflux valves are also known as check valves or non-return valves.
- It is used to make the water flow in a single direction.



3. Pressure Relief Valves:

- Pressure relief valves are also known as automatic cutoff valves or safety valves.
- When the pressure exceeds the predetermine value there exist the chance of bursting of the pipes, so pressure relief valves are used.

4. Drain Valves:

- Drain valves are also known as scour valves or washout valves or blow off valves.
- They are used to wash out the deposited sediments from the pipeline.

Fittings

Fittings are used in the pipeline during its laying for various purposes such as:-

- Connecting different pipes
- *Changing the direction of flow*
- Connecting different appurtenances
- Closing and sealing of pipe etc.

Types of Fitting

1. Bend:

- Bend is a fitting used to change the direction of a pipeline.

2. Tee:

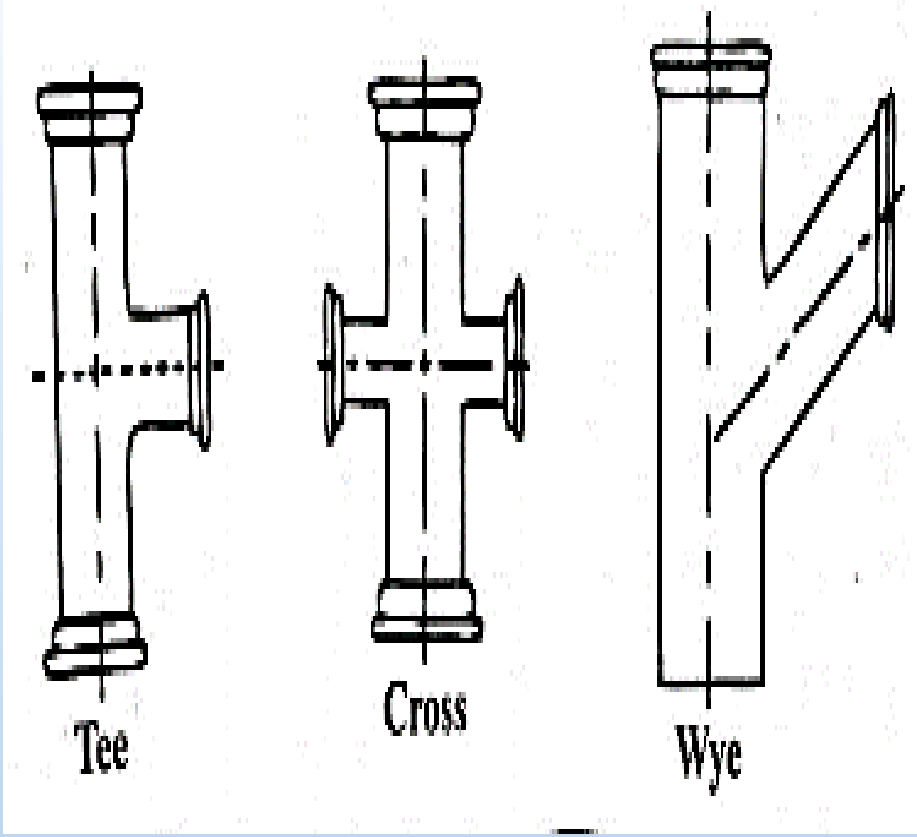
- Tee is a fitting with one inlet and two outlets.
- It is used to for connecting pipes of different diameters or for changing the direction of pipelines.

3. Cross:

- Cross is a fitting to connect four pipe sections.
- It has one outlet and three inlets or vice versa.

4. Wye:

- Wye is a fitting with two inlets or one outlet or vice versa.
- It is used to create a branch.



5. Reducer:

- To join two pipes of different diameters.

6. Socket:

- Socket is a fitting that fits over the pipe.
- It is classified as the plain and reducing socket.
- Plain socket connects two pipes of same diameters.
- Reducing sockets is used to connect two pipes of different diameters.

7. Plug:

- A plug is used to close a pipe with threads.

8. Nipple:

Nipple is a fitting (short stub of pipe) which is used for connecting two other fittings.

9. Union:

Union is a fitting to connect two pipes of the same diameter for quick and convenient disconnection.

10.Stopcock:

Stopcocks are fittings which are cut off valves of small size.

Q. To prevent the water flow in the wrong direction which of the following valve is used?

a) Safety valve
b) Drain valve
c)Both
d) Check valve

Q. Which accommodates four pipes?

a) Socket
b) elbow
c) Tee
d) cross

- Which is used for separation of joint connection that allows the assembly to be dismantled for repair operations?

a) Union

b) Tee

c) Cross

d) Elbow

Q. Air relief valves are provided in water supply mains at ….

a) Low point

b) Summits

c) Junction

d) Any of the above.

6.3 Water treatment process and technologies:

- Screening;
- Plain sedimentation;
- Sedimentation with coagulation;
- Filtration;
- Disinfection;
- Softening;
- Miscellaneous treatments (aeration, removal of iron and manganese, removal of color /odour / taste).

1. Screening

- To remove the large floating matter.
- Screening is mostly done at the intake point itself.
- The large-sized suspended particles like dried leaves, and other floating debris are removed.

Two types:

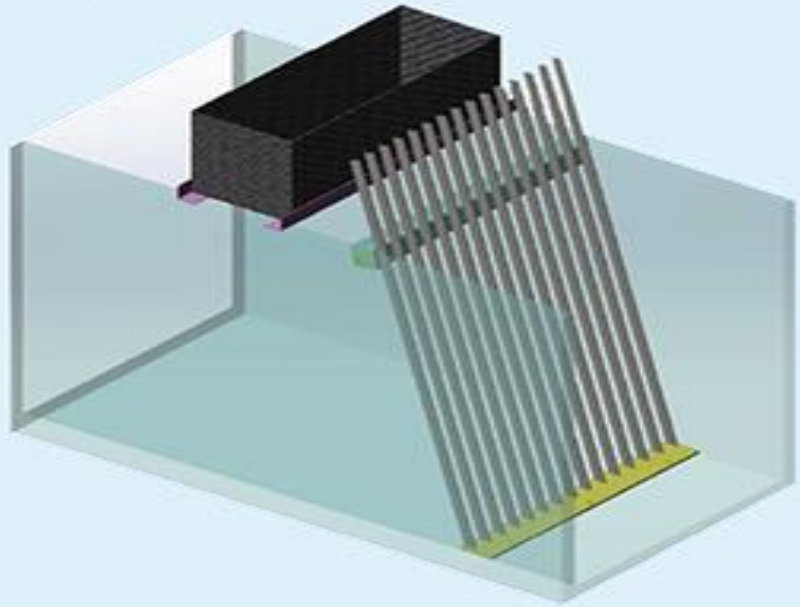
1. Coarse Screens/ Bar screens

- Mostly the bars are kept in an inclined position so that they can be cleaned easily with racks to remove the trapped particles.

2. Fine screens

Types of screen

Bar Screen	Fine screen
• Used for removal of large objects • Mostly in the form of steel bar grill which is either rectangular or circular • Circular bar sizes = Approx 25 mm • Rectangular bar size = Approx 10 mm x 50 mm • Spacing for coarse bar screen = 50 to 150 mm • Spacing for fine bar screen = 20 to 50 mm	• Made up of wire mesh of size 6 mm or more • Generally not used in water treatment plant because of problem of clogging

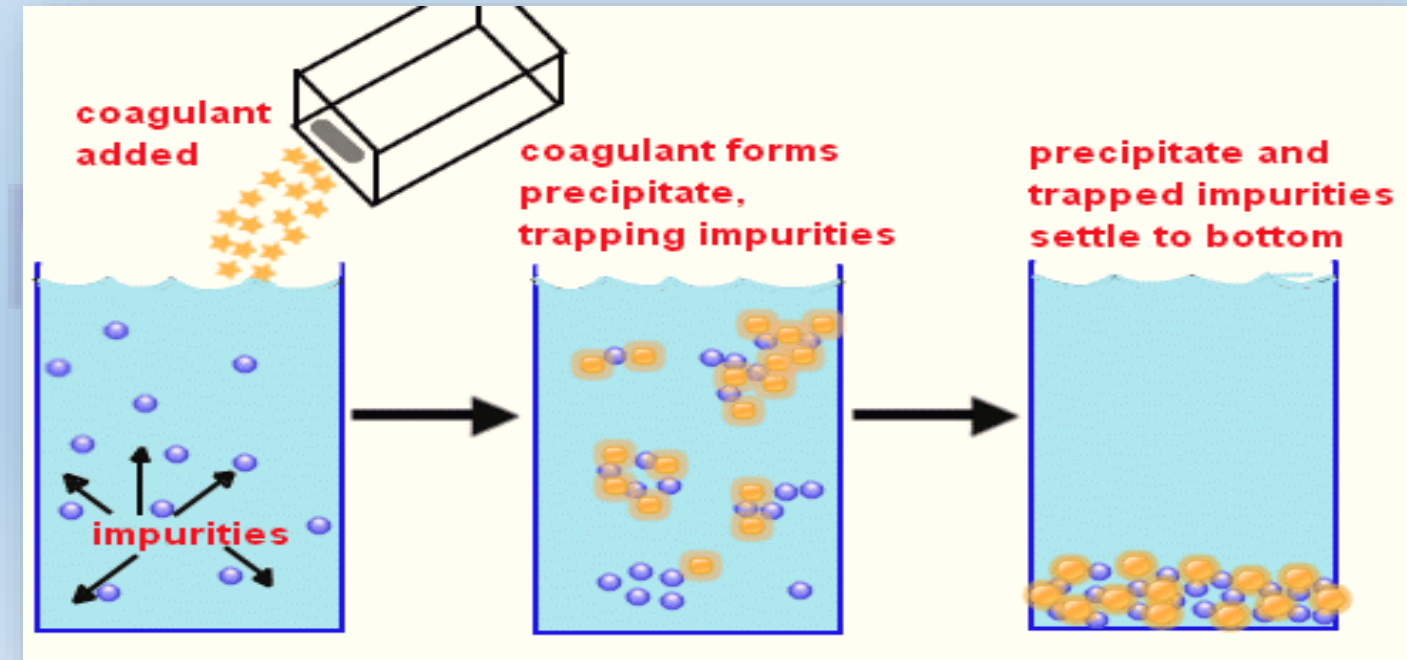


2. Sedimentation

- To remove suspended particles having density greater than water.
- A sedimentation tank is so designed that the velocity of the flowing water is reduced.
- Sedimentation is also of two types:

  Plain sedimentation

  Sedimentation with coagulation

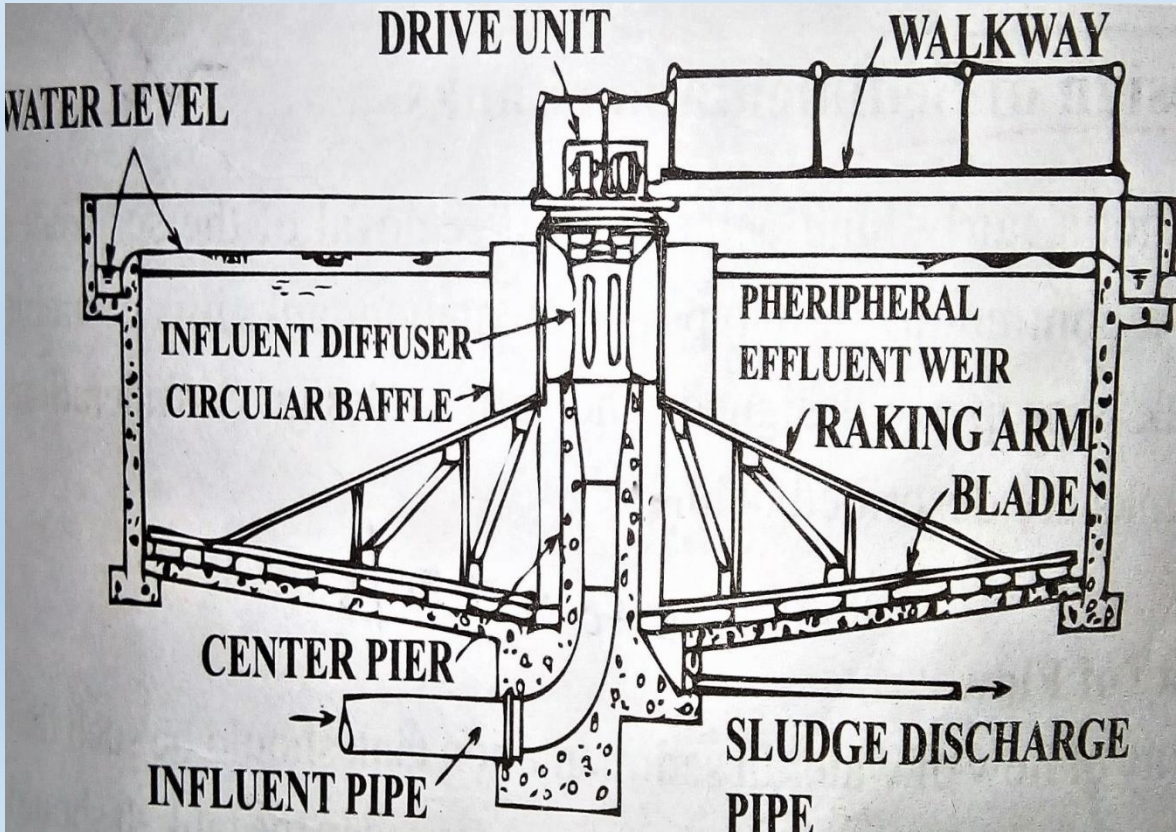


- Sedimentation tank may be of rectangular or circular type.
- Dorr clarifier is the commonly used circular tank.
- Volume of sedimentation tank with bottom sloping @ 1:12 is given by formula:

- $V = d^2(0.011d + 0.785H)$

Where,

- d= diameter of tank
- H = height of cylindrical portion



Note: In ideal sedimentation tank, the time taken for horizontal movement = time taken for vertical movement.

- The rate of loading of water in sedimentation tank is called surface overflow rate (SOR).

- Value of SOR is 15-30 cu.m/day/sq.m for plain sedimentation and 30-40 cu.m/day/sq.m for sedimentation with coagulation.

Settling velocity Calculation

S. N	Law and Equation	Applicable for range of	
		Reynolds Number (Re) $Re = \frac{V\rho d}{\mu}$	Particle size in mm, Sp.gr=2.65 And temp T=20°C
1	Stoke's (Laminar) $V_S = \frac{gd^2}{18v}(S-1)$, $C_D = \frac{24}{R_e}$	Up to 1	Up to 0.1
2	Hazen's (Transition) $V_S = \sqrt{\frac{4gd}{3C_D}(S-1)}$ $C_D = \frac{24}{R_e} + \frac{3}{\sqrt{R_e}} + 0.34$	>1 to 1000	>0.1 to 1
3	Newton's (Turbulent) $V_S = \sqrt{3.33gd(S-1)}$, $C_D = 0.4$	>1000	>1

Q. If temperature increases, then settling velocity?

Note:

- For laminar flow, the settling velocity dependent on temperature is given by Stoke's formula:
- $V_s = 418\,(S-1)d^2\left(\frac{3T+70}{100}\right)\ in\frac{mm}{s}$

$where\ d\ is\ in\ mm\ and\ T\ in\ degree\ celcius$

Types of Coagulants used in Water Treatment:

- Alum
- Ferrous sulfate and lime
- Magnesium carbonate
- Sodium aluminate

➢ Aluminium sulphate(or alum) ($Al_2(SO_4)_3.18H_2O$)

Alum is most commonly used as a coagulant.

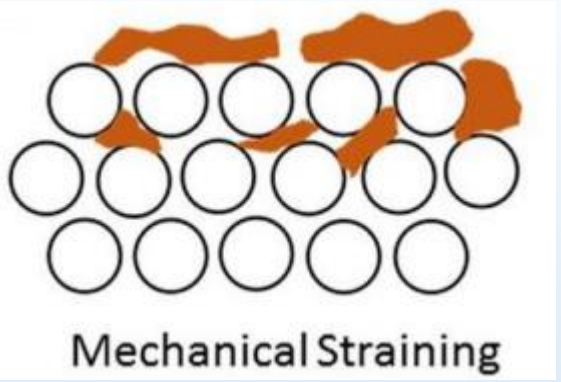
Q. Which test is used to find the optimum dose of coagulant?

Jar test

- Test done to find out the optimum content of coagulant is called jar test.
- Alum in the jars are added corresponding to 0.5,1,1.5, 2, 2.5 and 3 ppm
- First paddles are rotated @ 100 rpm for 1 to 2 minutes
- Secondly, the paddles are rotated @ 2 rpm for 20 minutes

3. Filtration

- To remove the fine sized particles and flocs.
- To remove non-settleable particles.



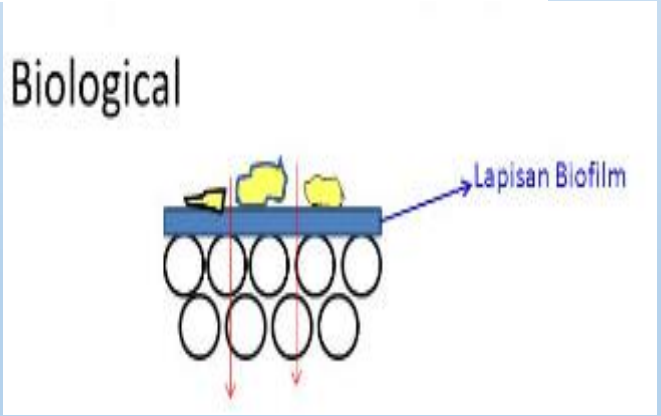
Theory of filtration

Mechanical straining

- **Sedimentation &adsorption**

Biological process

- **Electrolytic action**



Types of filters based on filtration rate

- Slow sand filters
- Rapid sand filters
- Pressure filters

Slow sand filters

Filter characteristics

Depth	2.5 – 4 m
Surface area	50 – 1000 sq. m.
Length to width	2 – 5
Filtration rate	100-200 liters per hour per sq. m.

Filter Media : sand

Depth	90-110 cm
Effective size	0.25 to 0.35 mm
Coefficient of uniformity	3 to 5

Rapid sand filters

Filter characteristics

Depth	2.5 – 5 m
Surface area	10 – 50 sq. m.
Length to width ratio	1.25 to 1.35
Filtration rate	3000-6000 liters per hour per sq. m.

Filter Media : sand

Depth	60-75 cm
Effective size	0.45 to 0.7 mm
Coefficient of uniformity	1.3 to 1.7

Slow sand Filter

- Base material: 30 to 75 cm thick gravel bed.
- Bottom layer should be of bigger size gravel

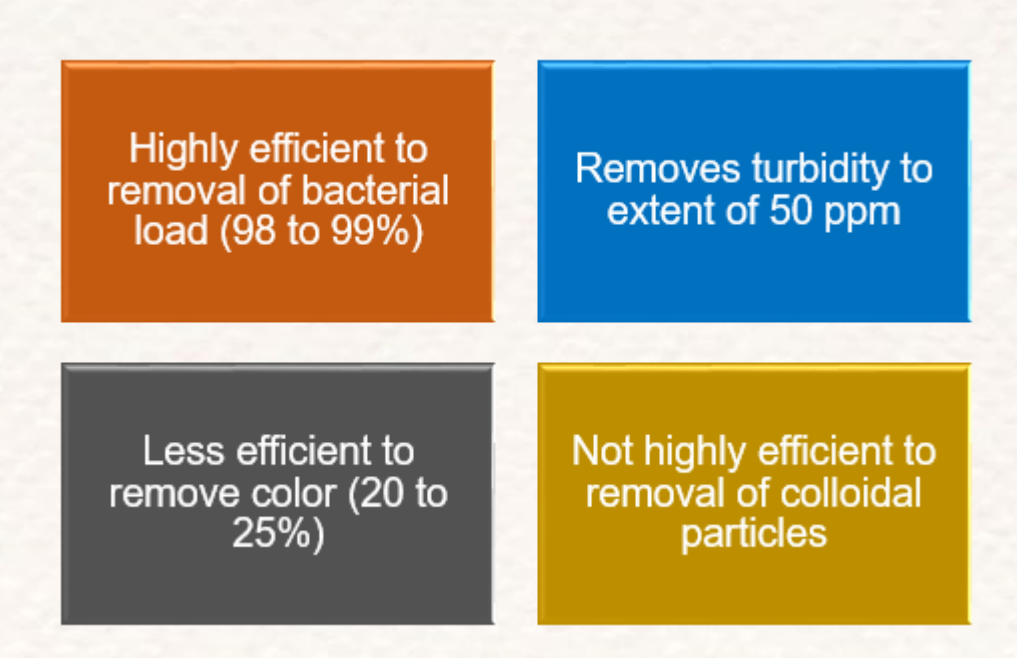
	Thickness	Size of gravel
Top layer	15 cm	3 to 6 mm
Intermediate layer	15 cm	6 to 20 mm
Intermediate layer	15 cm	20 to 40 mm
Bottom layer	15 cm	40 to 65 mm
Total	60 cm	

Rapid sand filter

- **Base material**; Gravel bed 45 to 60 cm thick

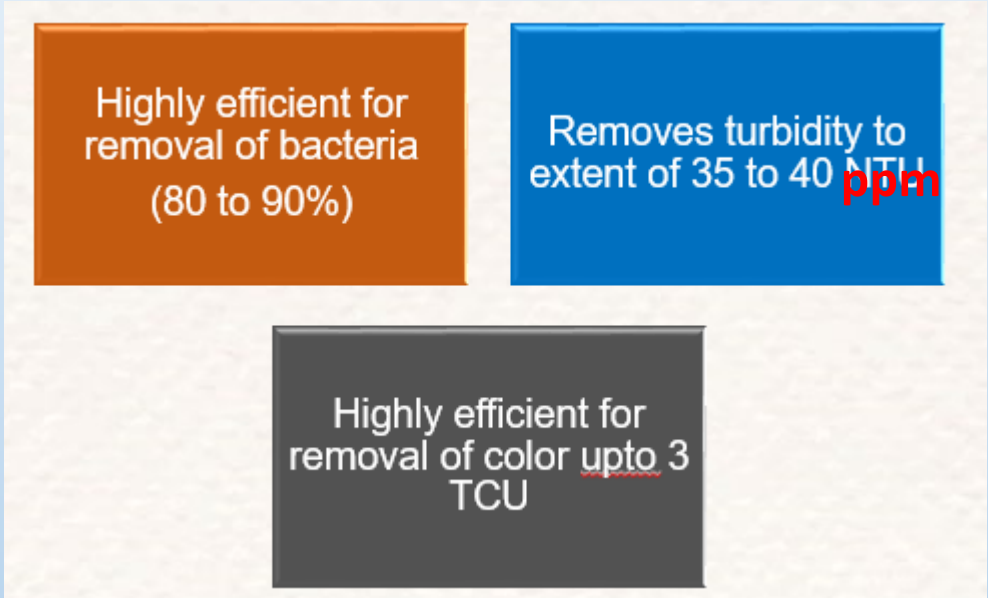
	Thickness	Size
Top layer	15 cm	2 to 6 mm
Intermediate layer	15 cm	6 to 12 mm
Intermediate layer	15 cm	12 to 20 mm
Bottom layer	15 cm	20 to 60 mm
Total	60 cm	

Efficiency of Slow sand filter



Note: 1 ppm= 3 NTU

Efficiency of rapid sand filter

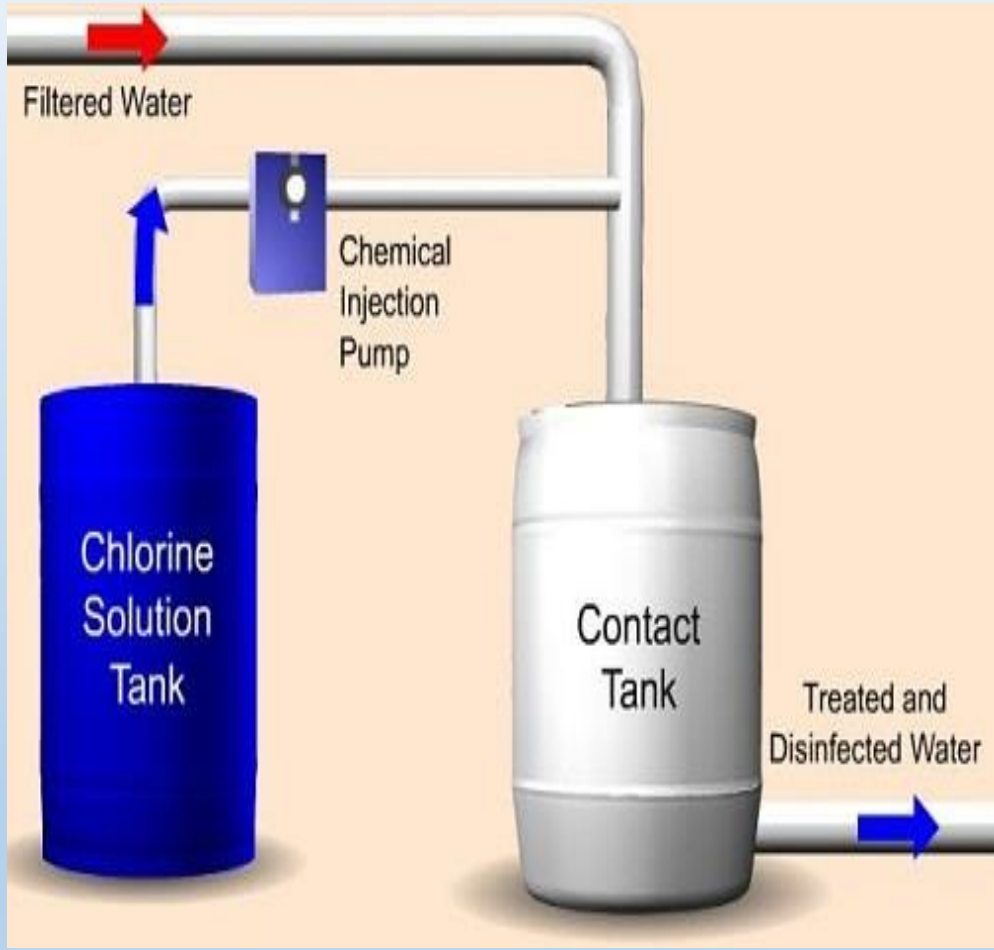


Pressure filter

- Pressure filters are the type of rapid sand filters which are in closed steel cylindrical tanks and water is passed through pressure.
- Pressure varies from 0.3 to 0.7 N/ sq. mm
- The diameter of pressure filters varies from 1.5 to 3 m.
- The height varies from 3.5 to 8 m.

4. Disinfection

- After filtration, the next step of the water treatment process is disinfection.
- Disinfection includes the inactivation of pathogenic bacteria and other microorganisms that can cause diseases.
- This step is essential to control water-borne diseases.



Forms of Chlorines for disinfection;

1. Bleaching powder/hypochlorite form:

- It was used when chlorination was first introduced.
- It contains 30-35% chlorine.
- It is not stable when stored or exposed to air. (सिमेन्ट जस्तै property)
- HTH(HIGH TEST HYPOCHLORITE): 65-70%

2. Chloramines:

- Discovered to overcome the instability of bleaching powder.
- Ammonia is added to water before the addition of chlorine.

3. Chlorine:

- It can be applied in liquid, gaseous, or even solid form.
- It is the *most popular form.*

4. Chlorine Dioxide:

- Chlorine dioxide is more effective than chlorine to kill microorganisms.
- However, it is unstable, so only used in special water treatment processes.

5. Water Softening

- Water softening is done to make the water soft.
- Ground water is more hard than surface water.

1. Temporary hardness

i. Boiling:

$Ca(HCO_3)_2 \rightarrow CaCO_3\downarrow + H_2O + CO_2$

$Mg(HCO_3)_2 \rightarrow MgCO_3\downarrow + H_2O + CO_2$

ii. Clark's Method:

Calcium hydroxide is Clark's reagent.

$Ca(OH)_2 + Ca(HCO_3)_2 \rightarrow 2CaCO_3\downarrow + 2H_2O$

2. Permanent Hardness

i. By adding washing Soda:

- $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$

- $MgSO_4 + Na_2CO_3 \rightarrow MgCO_3 + Na_2SO_4$

ii. **Zeolite method/ion exchange method:**

- In this method, a Permutit called zeolite (Sodium Aluminum Silicate) is added to the water.

- $Na_2Al_2Si_2O_8 .xH_2O + Ca^{++} \rightarrow 2Na^{+} + CaAl_2Si_2O_8.xH_2O$
- REGENERATION?

6. Miscellaneous Treatments

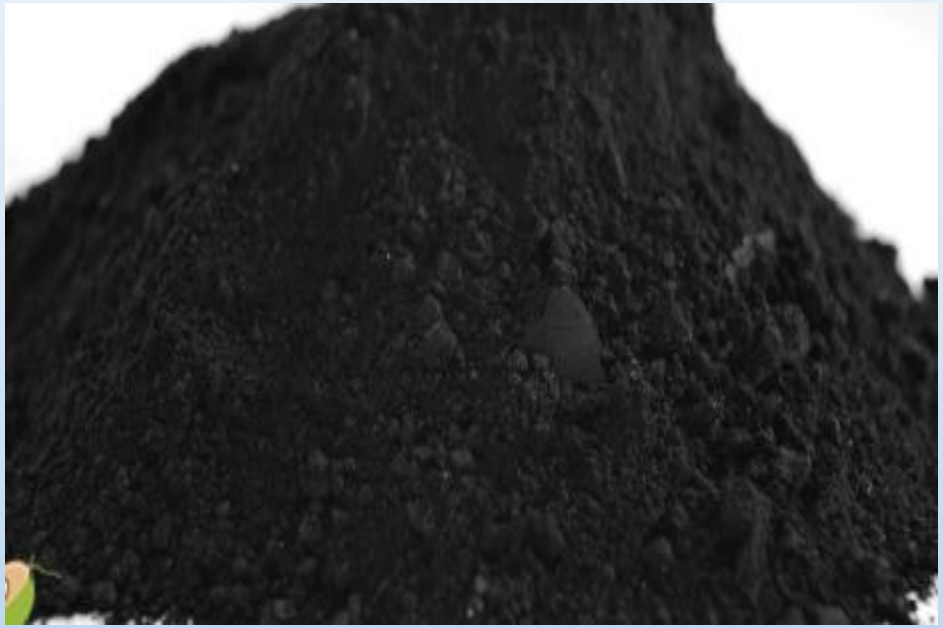
A. Removal of color, odor, and taste

1. Aeration

- In aeration, air and water are mixed intimately.
- It mostly removes the taste because of dissolved gases.
- Increase the dissolved oxygen content
- Removes H_2S gas thus removing the odour
- Decreases the CO_2 content and thus reduces the acidity/corrosion.

Other methods for removal of colour, taste and odour

- CuSO4: also removes eutrophication.
- Activated carbon
- Sedimentation with coagulation
- Chlorination
- Ozone treatment
- Ion exchange method
- Removal of iron and manganese



B. Removal of iron and manganese

A. Aeration followed by sedimentation and coagulation

B. Base exchange method / ion exchange method / zeolite method

Some important points:

Rectangular sedimentation tank

- Normally, maximum length is 30 m but upto 100 m in some cases.
- L/B= 3-5
- Effective Depth: 2.5-4 m
- Maximum Width: 12 m

Circular tank

- Normally, maximum Diameter of circular sedimentation tank=30 m
- BUT, upto 60 m is used in some cases.

MCQ's

Q. Sterilization of water helps in killing of

a. Only pathogenic bacteria
b. Only non-pathogenic bacteria
c. Only certain kind of microorganisms
d. All kind of bacteria and microorganisms

Q. Activated carbon is used in water treatment for

a. Disinfection
b. Removing hardness
c. Removing color
d. Removing corrosiveness

Q. Stoke’s law is applicable when Reynold’s number is

a. 5
b. 0
c. >1
d. Less than or equal to 1

Q. The void spaces in filtering material act like

a. Drain
b. Inlet
c. Outlet
d. Settling basin

Q. The ratio of discharge to plan area in continuous flow sedimentation tank is known as

a. Overflow rate
b. Surface loading
c. Surface overflow rate
d. All of the above

Settling velocity	Percentage of particles removed
settling velocity ≥ surface overflow rate	100% removed
Settling velocity < surface overflow rate	$\frac{V_s}{V_0} \times 100$

The efficiency of tank in removing the particles is given by,

Efficiency of tank $= \frac{V_s}{V_0} \times 100$

Q. The time taken by water particle to reach the outlet from inlet of sedimentation tank is?

Note: Detention time for plain sedimentation tank: 4-8 hours and 1-4 hrs for coagulation tank.

Q. Which of the following treatments is the most economical effective method for controlling Schistosomiasis?

a) Filtration
b) Ozonation
c) Chlorination
d) UV radiation

Chlorine works best as a disinfectant when the pH of water is around _____.

1. 9
2. 10
3. 7
4. 5

Contact Time:

- Free chlorine
- Satisfactory Contact time:10 minutes.
- Best : 30 minutes

- For combined chlorine: 1 hour

THANK YOU!