WTP = Water Treatment Plant

Water Treatment Plant (WTP) is a process of "Removing Contaminants from Water".

There are some process-including regarding WTP…
- Physical Process
- Chemical Process
- Biological Process

Physical Process:
The aim of physical process treatment is to remove the plants, leaves, stones, debris, plastic part, foil, floating wood parts etc.

At general consideration, if the solid parts are not removed then it will hamper the next process.
For WTP – the physical process helps to make the safety of ACF [activated carbon filter]
For ETP – the physical process helps as the safeguard for the next Aeration, Primary Clarifier Process.
For STP – the physical process aims to the safeguard for the next tank as the scum layer gets floated which can block the entire STP system.

Chemical Process:
The purpose of chemical process treatment is to neutralize the pH of the water. Same time the coagulation or flocculation process can take place to settle down the particle. Chlorination process can be incorporated to kill the micro-organisms.

[Note: the process designer must have the knowledge about which kind of chemical treatment is needed. It must keep in mind that, the treatment process for WTP, ETP, STP are different]

Biological Process:
Biological Process is to control the micro-organisms to the acceptable level. As for ETP, the biological system is to increase the microbiological growth which will help to get a proper MLSS. This MLSS will help to settle down the particle.

At a general the whole processing includes…
- Screening
- Aeration
- Flocculation
- Sedimentation
- Filtration
- Dis-infection
- Softening

Screening:

Screening performed to remove the heavy suspended Solid from Water. As like: plants, leaves, stones, debris etc.

Screening generally adopted for treatment of surface water. The screening system for WTP, ETP, STP can differ based on the system need.

[in case of ETP, an oil removing unit can be placed to remove the floated oil from the water. After that, the oil will undergo general waste handling system considered by the facility]

It is also to be noted that, the screened solid will undergo general waste handling system considered by the facility

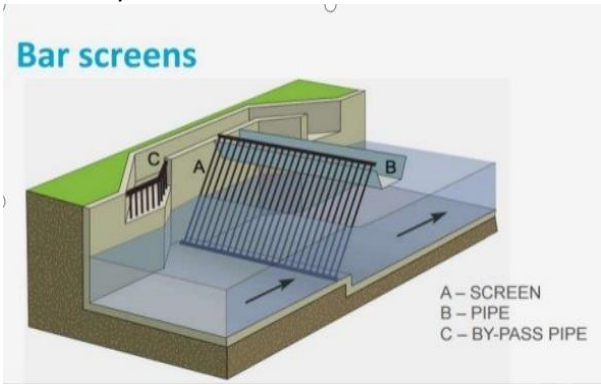
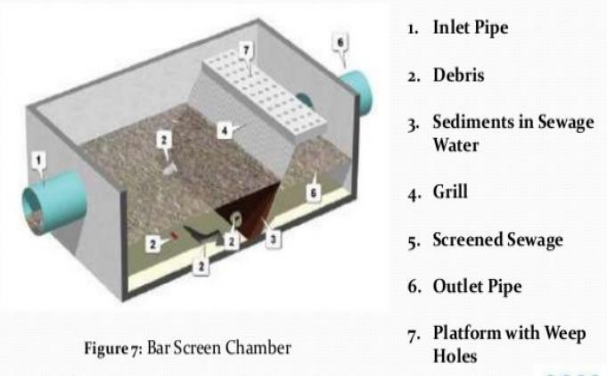


Figure: A general Bar Screen



Screening can be done by…
- Coarse Screen
- Fine Screen

Screening generally helps to remove any floating objects like leaves, branches, fishes, weeds etc. from water.

Coarse Screen: Coarse Screen can be seen in the form of bar. Bar Size 10mm-25mm. Having Spacing of 2200mm (center to center)

Figure: Coarse Screen

Fine Screen: Fine Screen can be seen in the form of wire-cruss. Wire cruss 10mm

Figure: Fine Screen

Aeration:

Aeration generally provides air in the water. Water gets intimate contact of air.

Figure: Aeration Process

Aeration removes:

Undesirable Gases (CO_2, H_2S)
Undesirable Organic Matter

On the other hand, aeration can help to proliferate microbial growth.

Coagulation:

Coagulation is essentially a chemical process by which Destabilization of colloids can be done by chemicals. The used chemicals are termed as Coagulant.

When coagulants are added on to water, the impurities get trapped. The coagulant forms precipitate by trapping the dissolved impurities. After that the trapped impurities get heavier than its normal weight. As a result, coagulant with trapped impurities settle down to bottom.

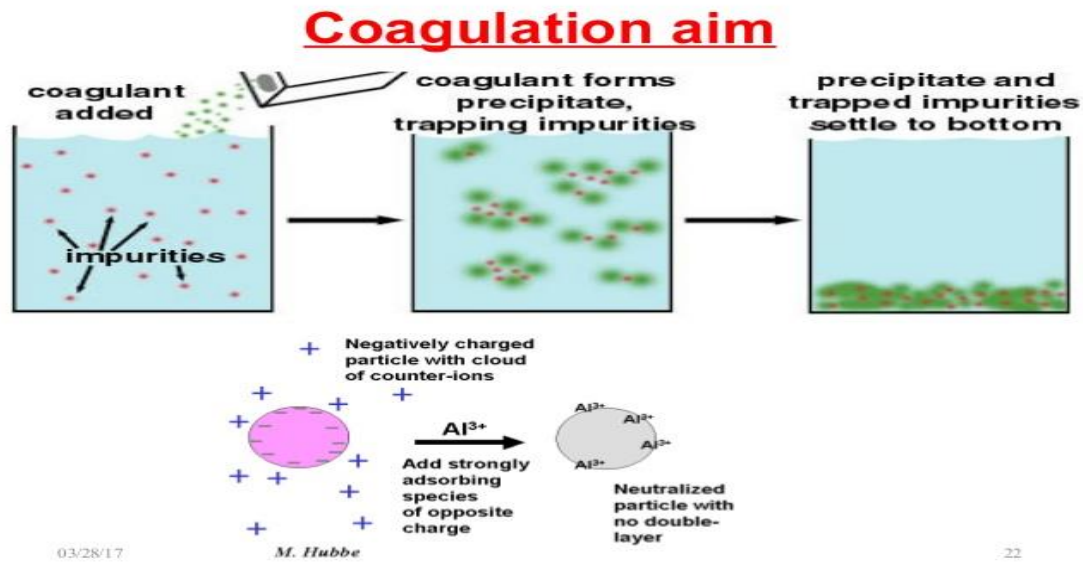


Figure: Coagulation Process

The aim of the entire coagulation process is to settle down the dissolve impurities.

Flocculation:

Flocculation is a slow mixing or agitating process in which the de-stablished colloidal particles are brought into intimate contact in order to promote floc formation

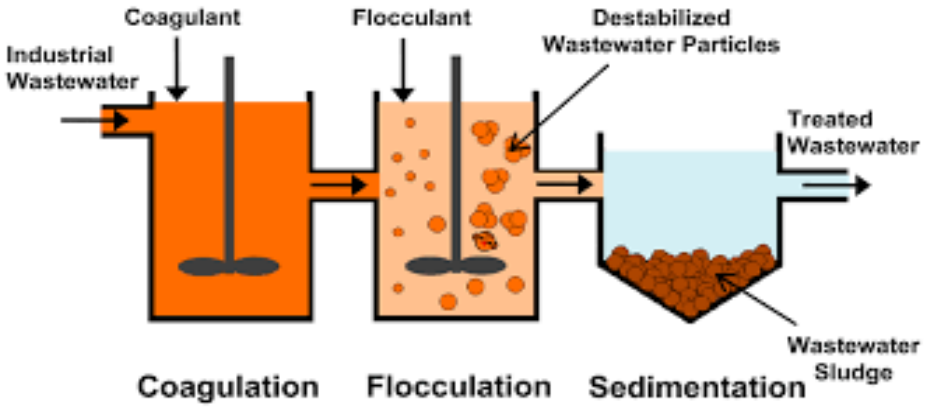


Figure: Flocculation

Rate of Flocculation Depends on:

- Types of amount of turbidity
- Types of coagulant
- Dosages of coagulant
- Mean velocity gradient in basin

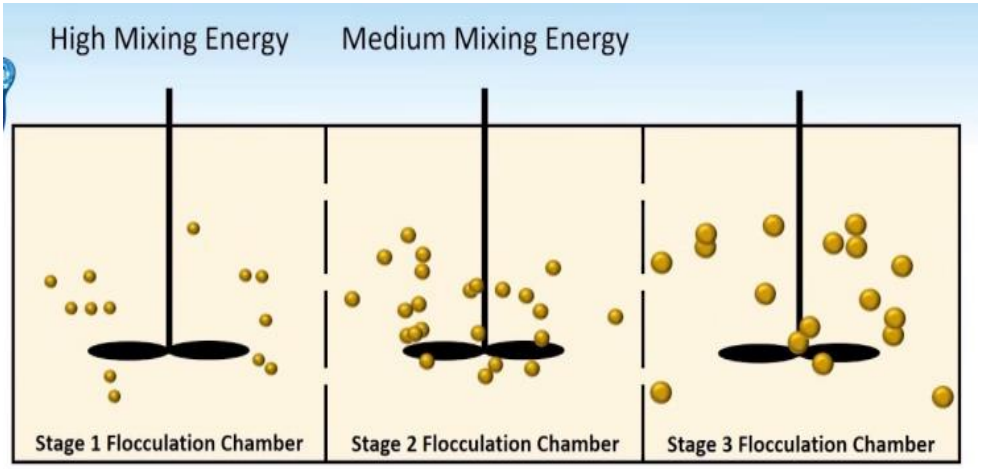


Figure: Flocculation

Flocculation is agglomeration of destabilized particles into a large size particles Known as flocs which can be effectively removed by sedimentation or flotation.

Flocculation performs to:

- Naturalize particles which are in contact
- Resulting in increasing the particle size

Flocculation - Hydraulics:

- Horizontally Baffled Tank Flocculation
- Vertically Baffled Tank Flocculation

a. Mixing basin with baffle walls

i. Horizontal or round end type:

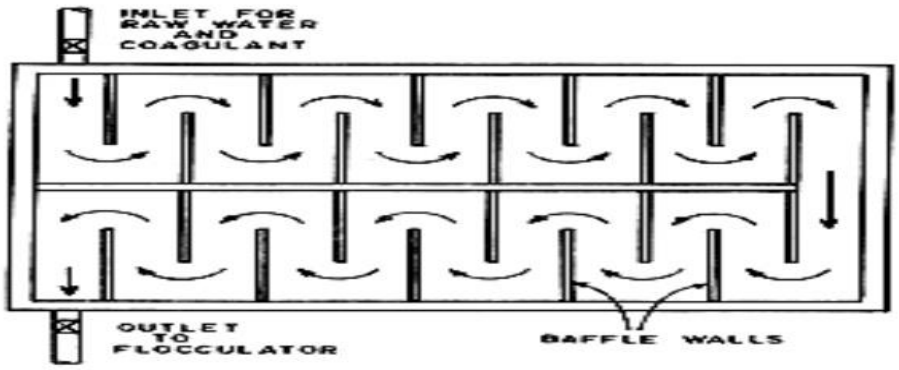


Fig 6.12 Horizontal or round type mixing basin
(Source: Modi, 1998)

Figure: Horizontally Baffled Tank Flocculation

Figure: Horizontally Baffled Tank Flocculation

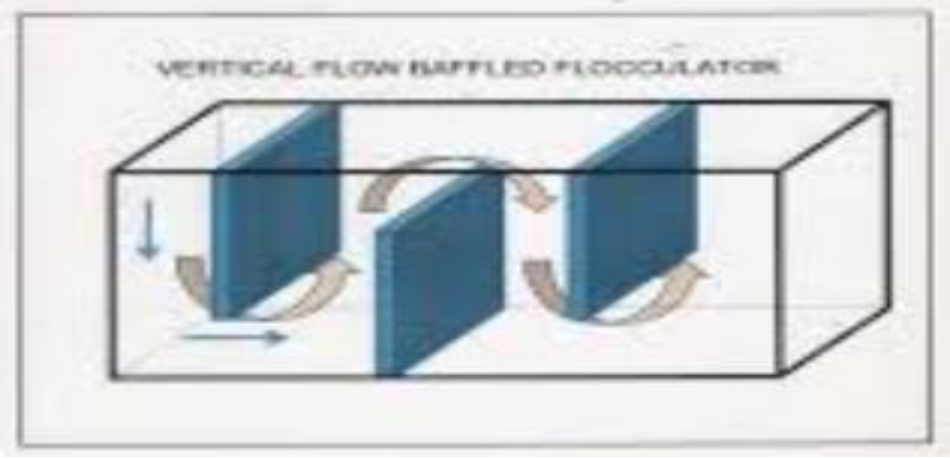


Figure: Vertically Baffled Tank Flocculation

Sedimentation:

Sedimentation generally means the removing of suspended particle from water (having higher Specific Gravity). Basically, the particle which have higher specific gravity poses the tendency to settle down on bottom.

This is also to say that; these suspended particles could not be removed by screening. Hence, sedimentation is the only process of removing them.

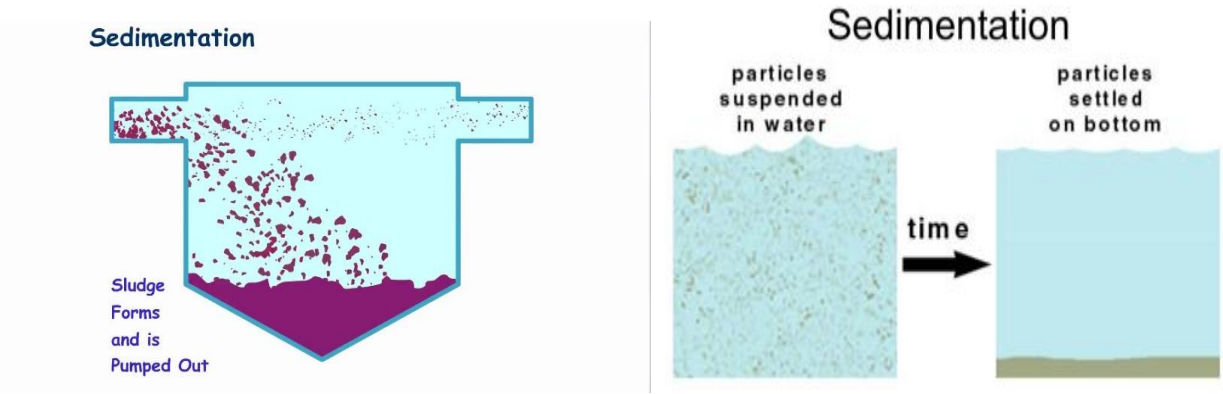


Figure: Sedimentation

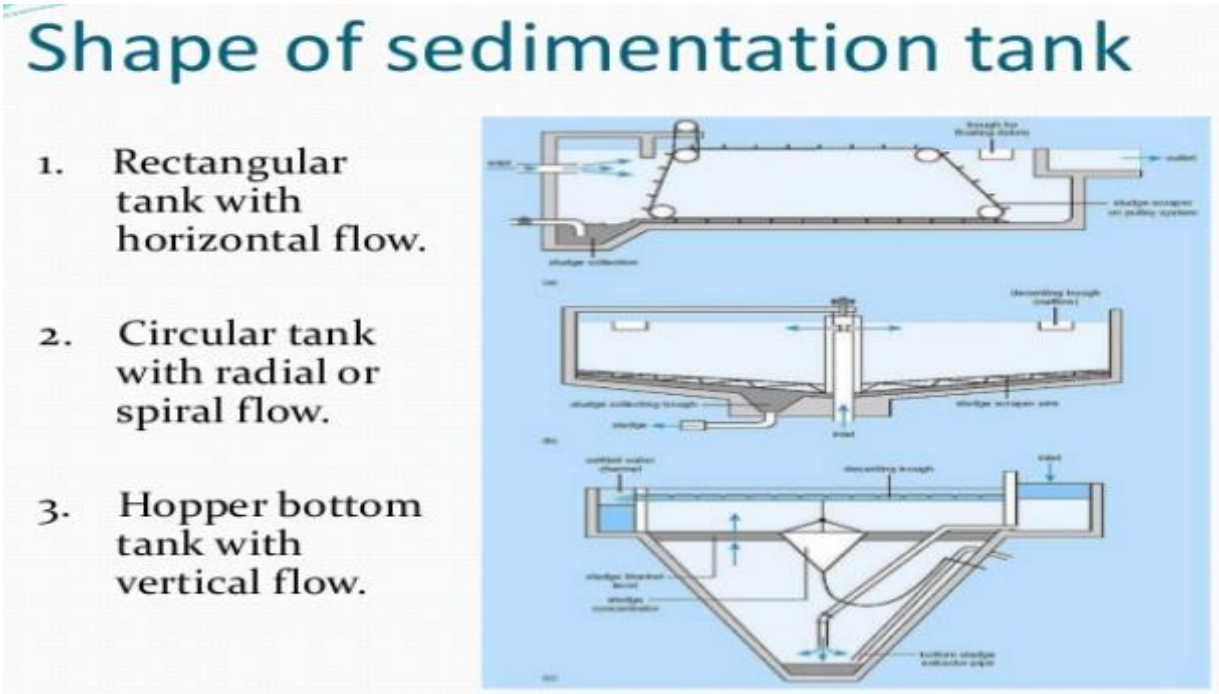


Figure: Sedimentation Tank

Filtration:

Filtration is the process of suspended particles from water. Basically, the water is letting to pass through granular beds. The granular beds can be formed with some layer of sand, gravel etc.

- Removing the fine suspended particle from water.
- Process of passing water through the granular beds.
- Also remove organic matter, microbes, minerals etc.

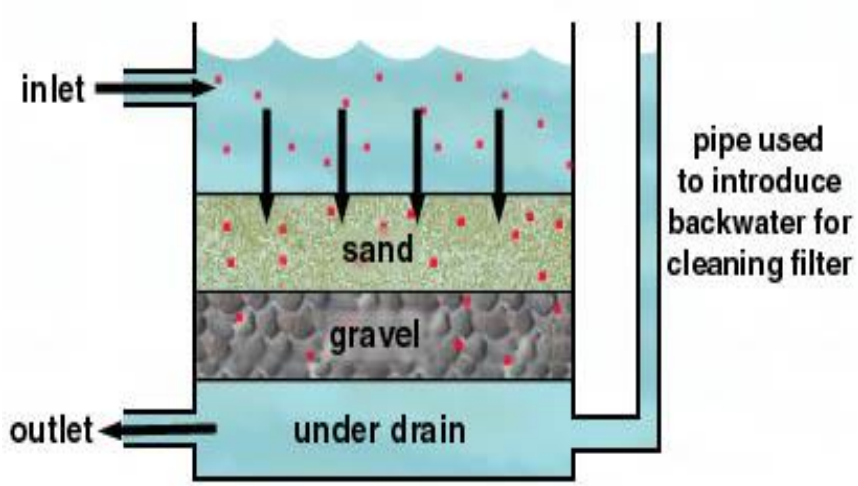


Figure: Filtration

Types of Filtration System

- Slow Sand Gravity Filter
- Rapid Sand Gravity Filter
- Pressure Filter

Slow Sand Gravity Filter

Slow Sand Gravity Filter is used for treating of "Raw water to portable water".

- Treating for raw water to portable water
- Typically, 01 – 02 meter's deep
- Periodically cleaning by removing, cleaning, replacing the upper few inches of biologically active sand

Slow sand filter (SSF)

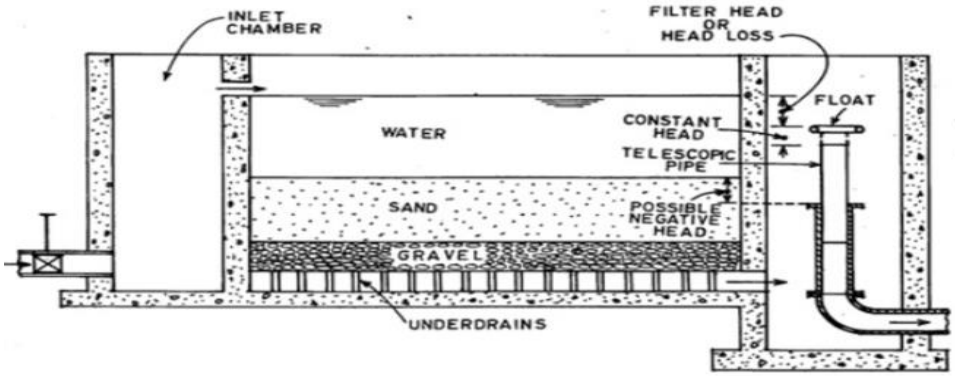


Fig 6.19 Section of slow sand filter *(Source: Modi, 1998)*

Figure: Slow Sand Gravity Filter

Rapid Sand Gravity Filter

Removal of large suspended particles

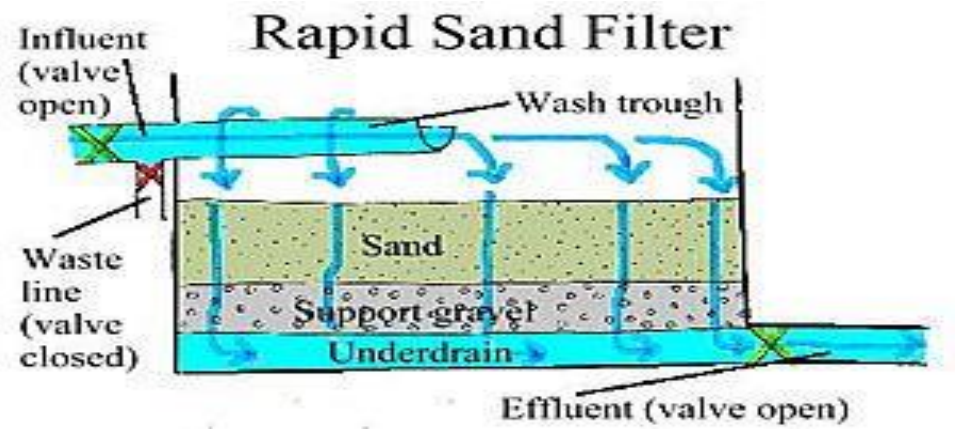


Figure: Rapid Sand Gravity Filter

Rapid Pressure Sand Filter

Rapid pressure sand filter is used for Removal of large suspended particles. In rapid pressure sand filter, the water is pumped and let the water falling from the top. The water then passes through the anthracite and then the water passes through the sand filter.

Finally, the water is collected from the bottom of the tank through a pumping system & the filtered water is taken to the next production process.

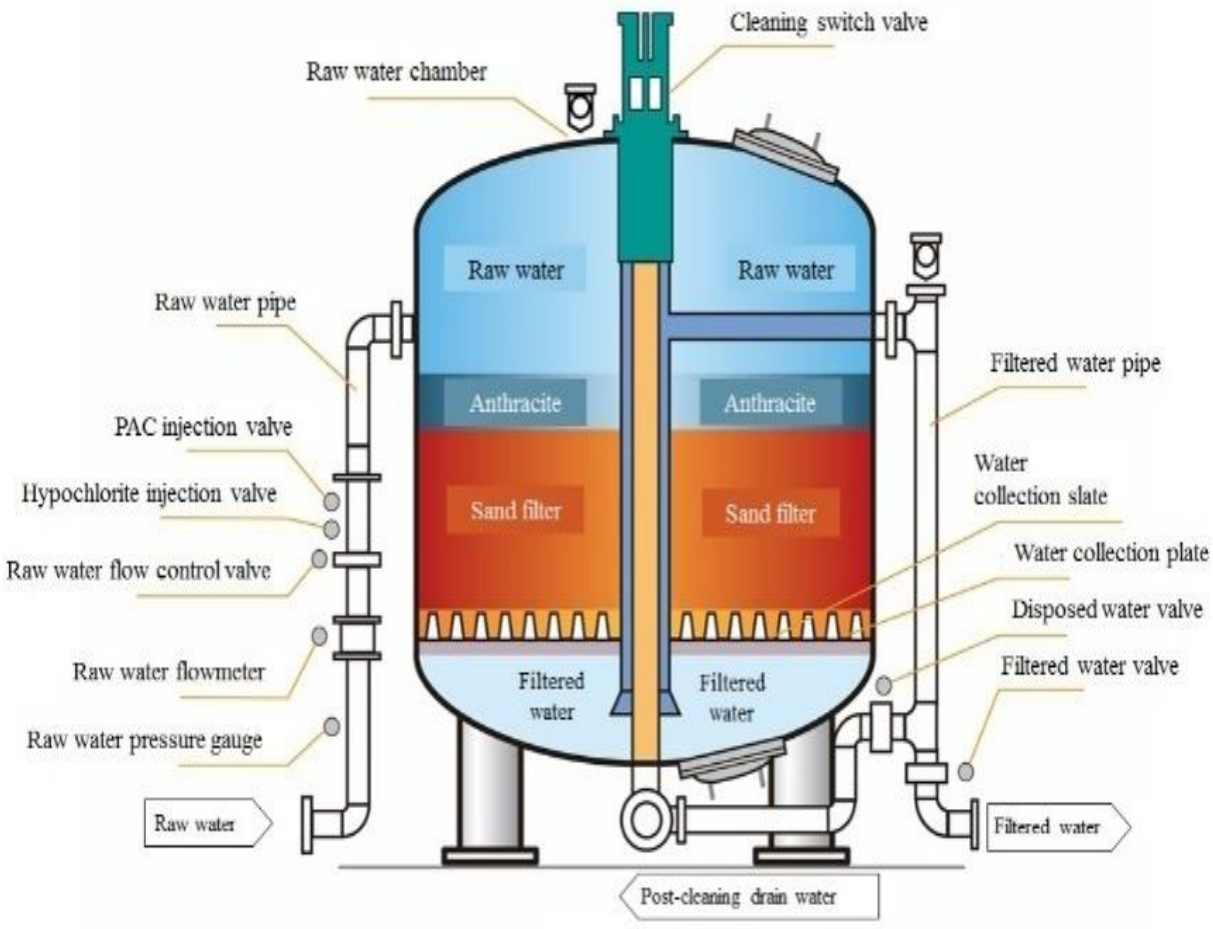


Figure: Rapid Pressure Sand Filter

Table: Types of Treatment, Treatment Unit, Impurities Removed

SN	Types of Treatment	Treatment Unit	Unit Name	Impurities Removed
01	Physical Treatment	Physical	Screening	Large submerge and floating matters
		Physical	Grit Chamber	Grit
		Physical	Clarifiers	Silt, sand and other heavy matters
02	Chemical Treatment	Chemical	Chemical Reactor	Dissolved Chemicals
03	Biological Treatment	Biological	Trickling Filter	Dissolved Organic Chemicals
		Biological	Activated Carbon	
		Biological	Digester	
		Biological	Rotating biological contactors	

Disinfection:

Chlorination, ozone, ultraviolet light, and chloramines are primary methods for disinfection. However, potassium permanganate, photocatalytic disinfection, nano-filtration, and chlorine dioxide can also be used.

Common water disinfection methods include UV, chemicals such as chlorine, unscented bleach and chloramines, distillation, ozonation and boiling [at the time of crisis]

The allowable level established by FDA for chlorine in bottled water is 4.0 mg/l (as Cl_2) (21 CFR 165.110(b)(4)(H))

In water treatment plant while receiving water from bore-well, 0.2-0.5ppm chlorine is dosed in water. After dosing the chlorinated water gets holding for about 60-90minutes. After that the water enters into the multi-grade-filter system. Afterwards the chlorine is removed by passing through activated-carbon-filter.

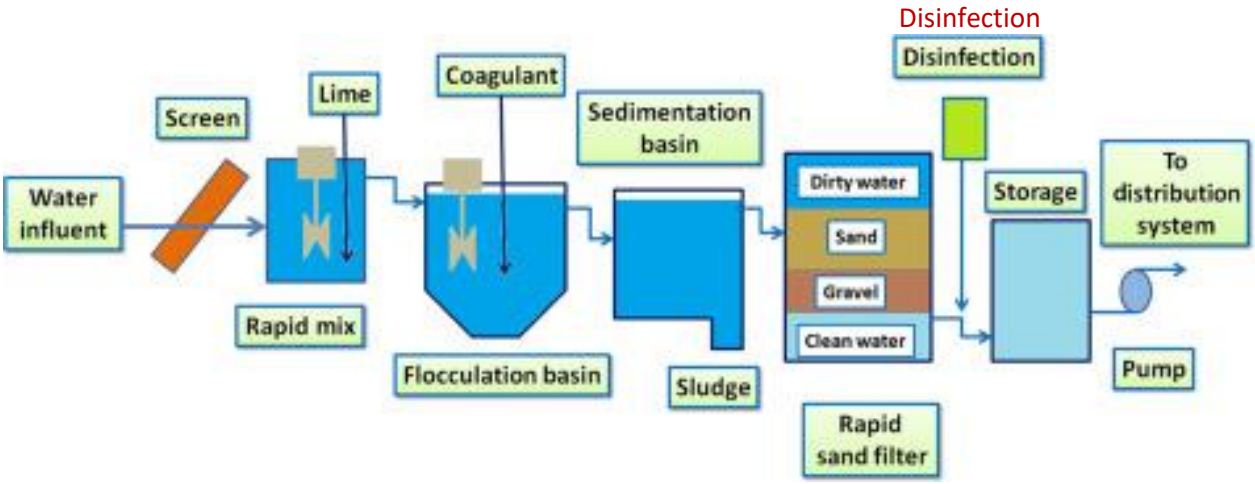


Figure: Disinfection

Softening:

The aim of softener is to remove hardness from water. Hardness caused by the presence of high concentrations of dissolved minerals, specially calcium and magnesium which are treated through Ion-Exchange. Basically, an ion-exchange resin is placed on the softener tank. Ion-Exchange resin removes calcium, magnesium and other minerals from water.

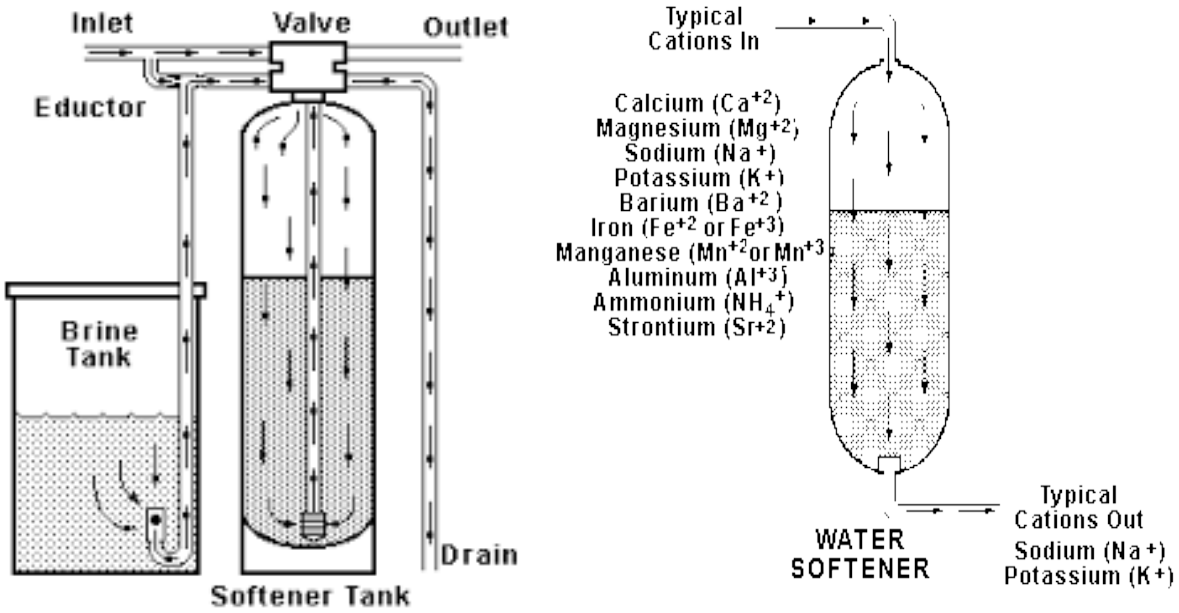


Figure: Softener

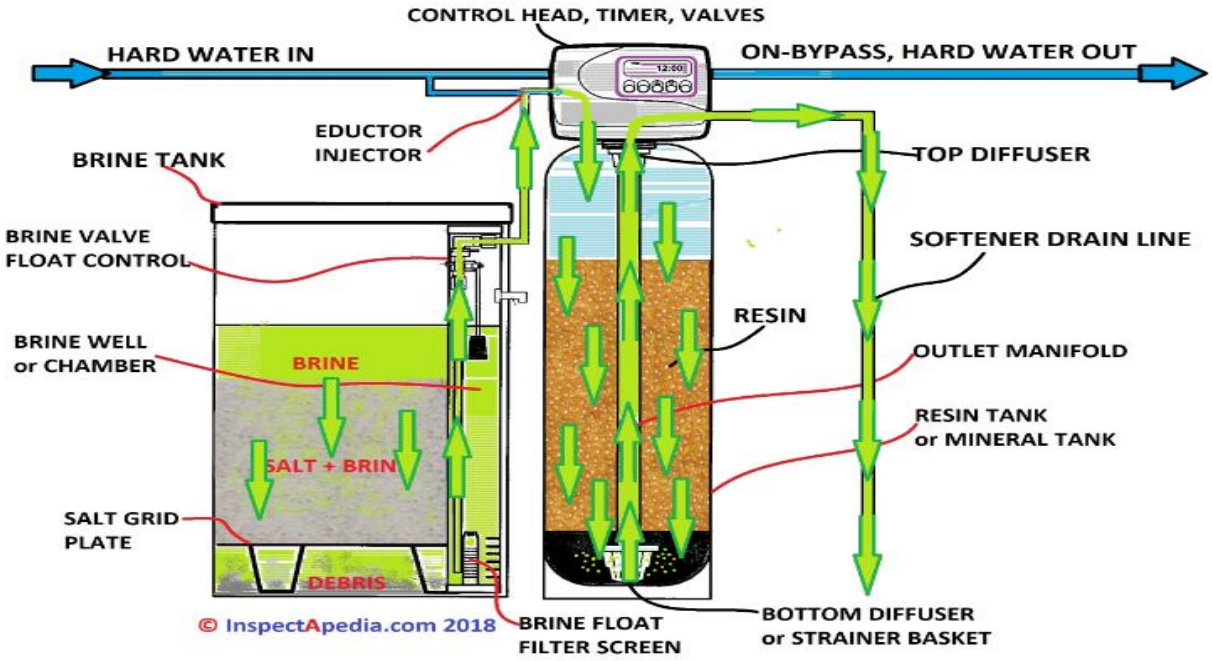


Figure: Softener

Purpose of Softener:

- To remove calcium minerals
- To remove magnesium minerals
- To remove other minerals
- To make soft water
- Extended life of water
- Less stain in utensils OR no stain in utensils
- Quicker & easier household cleaning

Softener Regeneration:

Water softener regeneration is the process through which the water softener flushes out the minerals it catches from the hard water, so it can continue to soften new water as it comes through. When hard water passes through water softener, calcium-ion and magnesium-ion in the water are replaced with sodium ions.

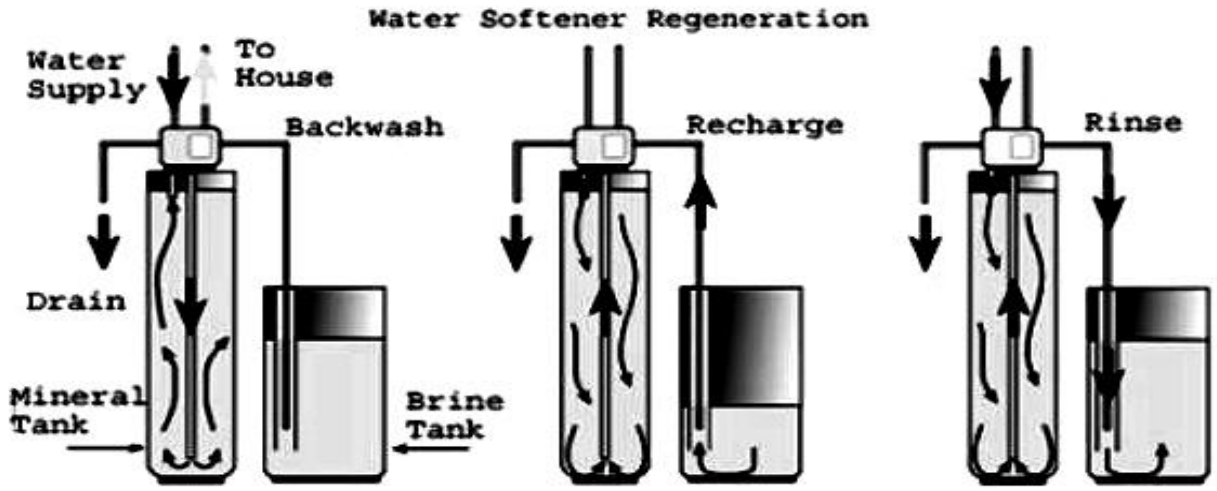


Figure: Softener Regeneration

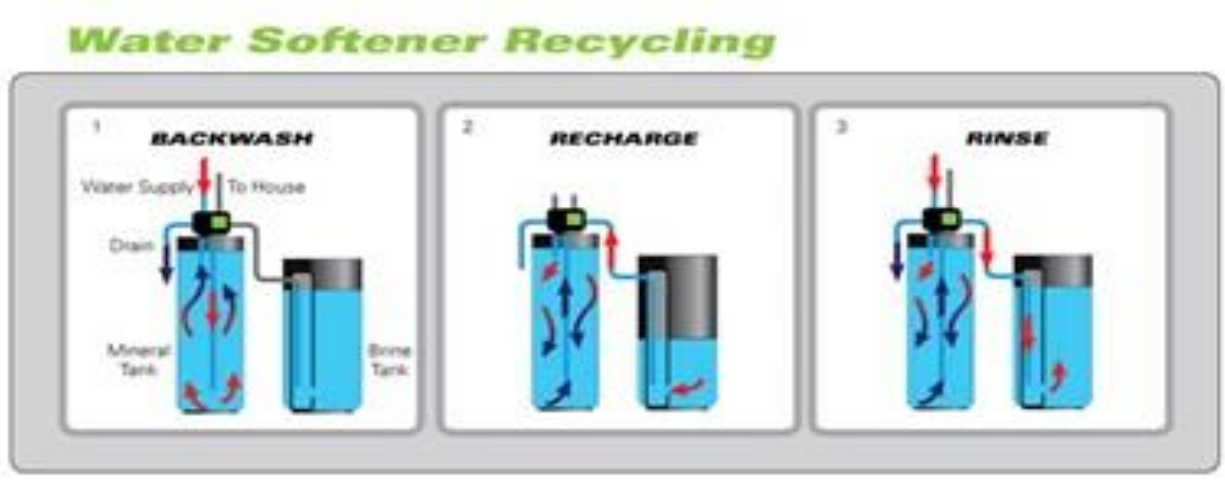


Figure: Softener Regeneration

Softener Regeneration Process:

- A brine water [strong salt water] is prepared.
- Brine solution use to flow through the resin tank. The resin beads get rinsed & exchanging of sodium ions with hardness particle is accomplished. This is done in a backwash process.
- Brine solution and hard water minerals then flushed from the tank.