WATER TREATMENT

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Water Treatment

Water treatment describes a process used to make water more acceptable for a desired end-use. These can include use as drinking water, industrial processes, medical and many other uses.

The goal of all water treatment process is to remove existing components in the water, improving it for subsequent utilization.

Flow Diagram of water treatment

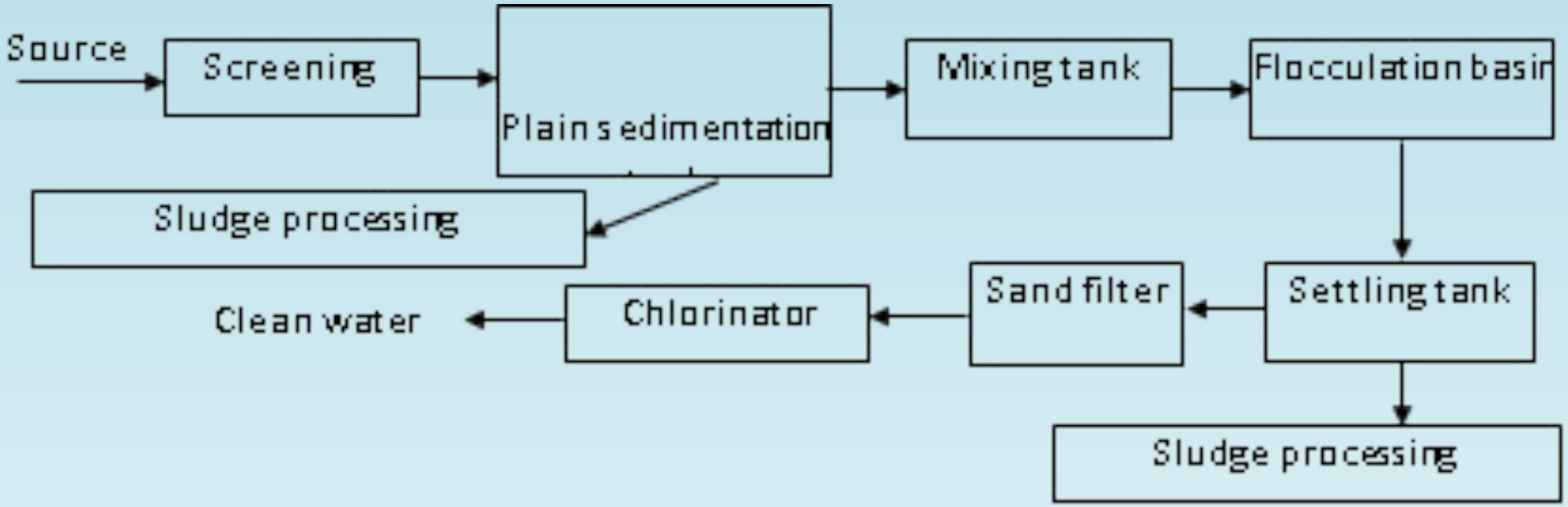

Chart: 4.8 A typical flow diagram of water treatment Plant

Steps of water treatment

Screening:

- This unit removes the relatively large floating and suspended materials from the water.

Plain Sedimentation:

- The suspended materials which are not easily removed by the screening process, can be removed easily by the process of Plain Sedimentation. In this process water is retained in a basin so that the suspended particles may settle down due to force of gravity only. After the settlement of suspended particles, the water is taken out from the basin without causing any disturbance to the settled suspended impurities.

Mixing with coagulants:

Very fine particles cannot be removed by plain sedimentation. Because they take long time for the settlement at the bottom of the tank.

To avoid this, some coagulants, such as Aluminium Sulphate or Alum is mixed to the water. This coagulants produce insoluble, gelatinous, flocculent precipitation.

Flocculation:

After mixing of coagulants in water, the next operation is flocculation. In this process, the water rotates gently with the help of horizontally or vertically movable paddles. During this time, the coagulants attracts the very fine particles present in water and produce insoluble, gelatinous **floc.** This is called flocculation.

Sedimentation:

- Flocculation process is always followed by the sedimentation process. Flocs which are produced during the flocculation process flows to the final sedimentation tank or settling tank. Due to larger size and weight, the flocs sedimented at the bottom of the tank.

Sludge Processing:

- In this process, the sedimented particles collected from bottom of both plain sedimentation tank and final sedimentation tank i.e., settling tank, is dewatered and disposed of.

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Filtration:

- Very fine particles present in water can be removed by the sedimentation with flocculation. But, very fine particles still remain present in it. Usually sand filters are used to remove that type of particles. There are two types of sand filter: (a) rapid sand filter and (b) slow sand filter.

Disinfection:

- After the filtration the water is almost free from any kind of particles. But to make it free from germs or pathogen, usually **disinfection** process is used.
- The process of killing the infective or disease causing bacteria from water and make it safe to the user is called **disinfection.**
- The chemicals or substances which are used for killing the bacteria are known as **disinfectants.**

Requirements of good disinfectants

(a) They should destroy all the harmful pathogenic organisms from the water and make it perfectly safe for use.

(b) They should not take more time in killing pathogens but do their task within the required time at normal temperature.

(c) They should be economical and easily available.

(d) They should not require high skill and costly requirement for their application.

(e) After their treatment the water should not become toxic and objectionable to the user.

(f) They should be of such a nature that their strength or concentration in the treated water can be quickly determined.

(g) Their dose should be such that it leaves some residual concentration for protection against contamination in the water during its conveyance and retention.

Different methods of disinfection

- Boiling water.
- Use of U.V. rays.
- addition of Cl, I_2 & Br.
- Ozonisation.
- Use of excess lime.
- Addition of $KMnO_4$.
- Addition of silver.

Hardness of Water

The presence of multivalent cations, mostly Ca^{2+} and Mg^{2+} and their sulphate, bi sulphate, carbonate and bicarbonate salts, is referred to as hardness of water. The degree of hardness of drinking water has been classified in terms of the equivalent $CaCO_3$.

Type of water	Equivalent Concentration as $CaCO_3$
Soft water	**0 – 60 mg/L**
Medium water	**60 – 120 mg/L**
Hard water	**120 – 180 mg/L**
Very hard water	**greater than 180 mg/L**

Classification of Hardness

Hardness may also be classified based on the **Carbonate (temporary)** and **non-carbonate (permanent)** hardness.

Temporary hardness can be removed or precipitated by **boiling**. This type of hardness is responsible for the deposition of scale in hot water pipes and kettles. Non-carbonate hardness is caused by the association of the '**hardness causing cations'** with SO_4^{2-}, Cl^- and NO_3^-. It can not be removed by boiling. Public acceptability of degree of hardness may vary considerably from community to community, depending upon the local condition.

Alkalinity

The alkalinity of water is a measure of its capacity to neutralize acids. The alkalinity of natural water is due to the salts of carbonate bicarbonate & phosphate along with hydroxyl ion (OH^-) in free state. However, the major portion of the alkalinity in natural water is caused by **hydroxide**, **carbonate** and **bicarbonate.**

Water softening

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

- There are two types of water softening. These are –

i) Removal of temporary hardness

ii) Removal of permanent hardness

Removal of temporary hardness

Temporary hardness can be removed by the following ways –

(a) Boiling: When the water has temporary hardness, it can be removed by the boiling.

The following reaction is taking place during the boiling –

$$Mg(HCO_3)_2 \xrightarrow{\text{Boiling}} Mg\,CO_3 + CO_2 + H_2O$$

(b) Addition of lime water: The temporary hardness can also be removed by addition of lime water. The following reaction takes place –

$$Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow Ca\,CO_3 \downarrow + Mg(OH)_2 \downarrow + H_2O.$$

Removal of permanent hardness

Removal of permanent hardness from the water is a difficult process as compare to the reduction or removal of temporary hardness. Following are the various methods which are commonly adopted for the removal of permanent hardness.

(a) Lime-Soda Process: **Simply addition of lime can not remove the sulphate salts of** Ca^{2+} and Mg^{2+} from the water. Hence permanent hardness removal is not possible in that way. But if Soda-ash is added in lime, the non-carbonate hardness (permanent) can be easily removed. This method is known as lime-soda process. The following chemical reactions take place –

$$Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow MgCO_3\downarrow + CaCO_3\downarrow + 2H_2O$$

$$MgCO_3 + Ca(OH)_2 \rightarrow Mg(OH)_2\downarrow + CaCO_3\downarrow$$

$$MgSO_4 + Ca(OH)_2 \rightarrow Mg(OH)_2\downarrow + CaSO_4\downarrow$$

(b)Base exchange process:

This process is also known as **Zeolite process** or **cation exchange process**. In this process, the hard water should pass through a bed of **sodium-zeolite sand**. When hard water is passes through it, the Ca^{2+} and Mg^{2+} get replaced by Na^{+} from the bed (exchanger) and water become soft. But the reactions are reversible and Zeolite bed can be recharged by passing through a solution of common salt.

Thank you!