UNIT - I / WATER AND ITS TREATMENT

1.7 MUNICIPAL WATER TREATMENT / POTABLE WATER TREATMENT

1.8 WASTE WATER TREATMENT

1.7 Municipal water treatment / Potable water treatment

Municipal water / Potable water

Municipal water is tap water that is sent to various industries and homes through underground pipes. This water is fully treated and processed and is safe for domestic and drinking purposes.

Municipal water supply

A public water supply system or water supply network including water treatment facilities, water storage facilities (reservoirs, water tanks and water towers) and a pipe network for distributing the treated water to customers including residential, industrial, commercial or institutional establishments.

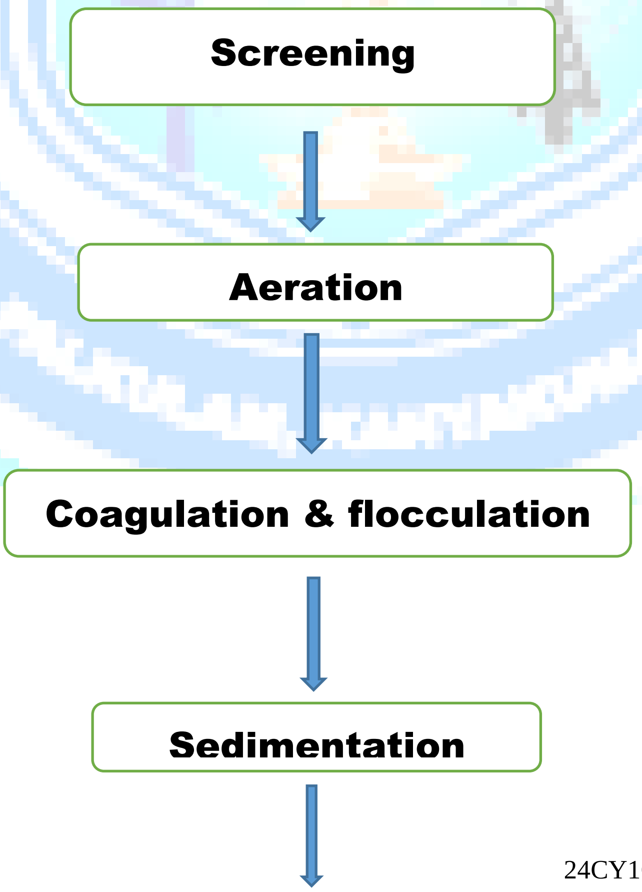
Municipal water treatment

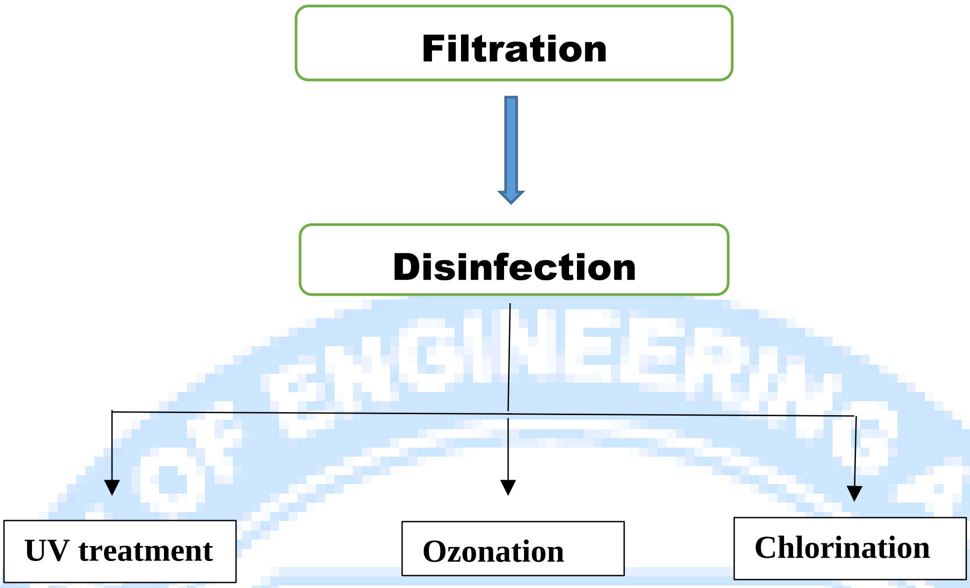
Water treatment *is the process of removing all physical, chemical or biological impurities that are potentially harmful for human and domestic use. This treatment helps to produce safe, palatable, clear, colourless and odourless water.*

The need for municipal water treatment

In urban areas, there is large demand for water. As the urban population is increasing, there is a need to find new sources to meet the growing demand. If groundwater is available this can often be used with minimal treatment but any surface water source will need to be treated to make it safe. For towns and cities, the water supply is then best provided by large mechanized water treatment plants that draw water from a large river or reservoir, using pumps. The treated water is then distributed by pipelines.

Stages of municipal water treatment





1. **Screening**

It is the process of using screens to remove large floating and suspended solids that are present in the flowing water. These floating materials include leaves, twigs, paper, rags and other debris. There are coarse and fine screens.

Suspended matter as small as algae and plankton (microscopic organisms that float with the current in water) can be trapped by using fine screens.

Aeration

After screening, the water is aerated (supplied with air). This helps to expel soluble gases such as carbon dioxide and hydrogen sulphide and also expels any gaseous organic compounds that might give an undesirable taste to the water.

2. **Coagulation and flocculation**

After aeration, **coagulation** takes place, to remove the fine particles (less than 1 µm in size) that are suspended in the water. A chemical called a **coagulant** (with a positive electrical charge) is added to water, and this neutralises the negative electrical charge of the fine particles. Since their charges are neutralised, the fine particles come together, forming soft, fluffy particles called 'flocs'. Two commonly used coagulants are aluminium sulphate and ferric chloride.

The next step is flocculation. Here the water is gently stirred by paddles in a flocculation basin and the flocs come into contact with each other to form larger flocs. Chemicals called flocculants are added to enhance the process. Organic polymers called polyelectrolytes can be used as flocculants.

3. **Sedimentation**

The water (after coagulation and flocculation) is kept in the tank for several hours (2-6) for sedimentation to take place. The material accumulated at the bottom of the tank is called sludge; this is removed for disposal.

4. Filtration

Filtration is the process where solids are separated from a liquid by passing the water through beds of sand and gravel.

5. Disinfection/sterilization

The process of removal, or killing of pathogenic microorganisms is called disinfection. It is otherwise termed as sterilization. If microorganisms are not removed from drinking water, it may cause illness of people.

The three main methods of disinfection are UV treatment, Ozonation and chlorination.

a) UV treatment

UV rays produced from the mercury vapour lamp is an effective disinfectant due to its strong germicidal ability; UV rays can break the chemical bonds and kill microbes.

b) Ozonation / Ozonisation

Ozone is a form of oxygen (O_2) with the molecular formula O_3. It is a powerful oxidant and one of the most powerful disinfectants available in water treatment. Ozone is effective in removing colour, organic chemicals and odour causing contaminants in wastewater.

c) Chlorination

- The most commonly used disinfectant is chlorine.
- It can be used in the form of a liquid (such as sodium hypochlorite, NaOCl) or as chlorine gas.
- It is relatively cheap, and simple to use.

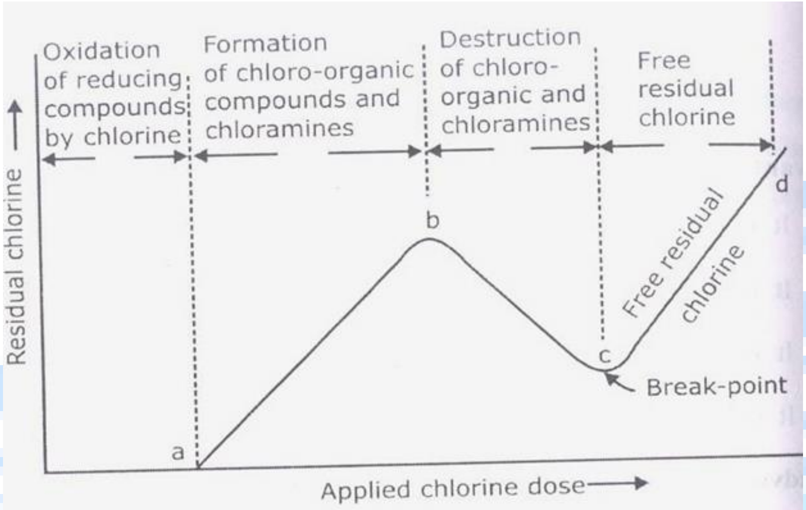
When chlorine is added to water it reacts with any pollutants present, including micro-organisms, over a given period of time, referred to as the contact time. The amount of chlorine left after this is called residual chlorine. This residual chlorine stays in water all the way through the distribution system, protecting it from any micro-organisms that might enter it, until the water reaches the consumers.

Breakpoint chlorination

Combined chlorine (CC) is free available chlorine that has combined with wastes containing nitrogen or ammonia (also known as chloramines). Combined chlorine will cause a noticeable "chlorine odour" and can cause skin, eye, and mucous membrane irritation.

Breakpoint chlorination is a technique used to remove combined chlorine by adding free available chlorine. To reach breakpoint, sufficient chlorine must be added to raise the free available chlorine level to 10 times the amount of combined chlorine.

Break point is a point where all the impurities present in the water such as reducing compounds, organic compounds and ammonia are oxidised by chlorine and the chlorine further added acts as a disinfectant to kill the pathogens.



Source Fig 1.7.1-Engineering Chemistry –I by Dr.Ravikrishnan

Advantages of break point chlorination: (Significance)

i) It is used to remove Bacteria, Ammonia, Organic impurity (sewage) Inorganic salt impurities (Effluents, H_2S, Fe salts) from water.

ii) It prevents the growth of any weeds in water.

Municipal water treatment

Treatment	Done by	Purpose
Screening	Screening shutterswith variable size holes	Removes floating material likewood, plastic, papers
Aeration	Mechanical aerator	Removes Oxygen, Carbon-di- oxide , toxic gases, Mn salts
Sedimentation	Allowing the water to stand for 2 – 6 hrs. in a settling tank.	Removes 75% of suspended impurities
Coagulation	Adding alum, $Al_2(SO_4)_3 \rightarrow Al(OH)_3$	Removes 100% suspended and colloidal impurities, clay,silica
Filtration	Filter bed	Removes bacteria, colour, odour, small dust particles
Sterilization/ Disinfection	Boiling, ozone,chlorine, radiation	Destroys bacteria

1.8 WASTEWATER TREATMENT

Objectives of waste water treatment

The main objectives of waste water treatment are

1. To convert harmful compounds into harmless compounds.
2. To eliminate the offensive smell.
3. To remove the solid content of the sewage.
4. To destroy the disease producing microorganisms.

Treatment process

The sewage (or) waste water treatment process and involves the following steps.

1. Preliminary treatment

In this treatment, coarse solids and suspended impurities are removed by passing the waste water through bar and mesh screens .

2) **Primary treatment (or) settling process**

In this treatment , greater proportion of the suspended inorganic and organic solid are removed from the liquid sewage by settling. In facilitate quick settling coagulants like alum, ferrous sulphate are added. These produce large gelatinous precipitates, which entrap finely divided organic matter and settle rapidly.

$Al_2(SO4)_3$ +6$H_2$0 ----------->2 $Al(OH)_3$ + 3H_2SO_4

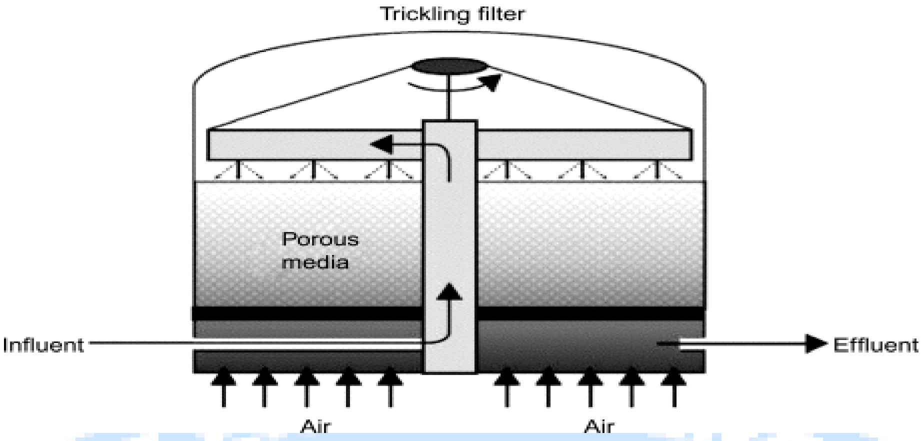
3) **Secondary (or) biological treatment**

In this treatment ,biodegradable organic impurities are removed by aerobic bacteria. It removes up to 90% of the oxygen demanding wastes. This is done by trickling filter or activated sludge process.

1. Trickling filter process

Trickling filter is a circular tank and is filled with either coarse of crushed rock. Sewage is sprayed over this bed by means slowly rotating arms.

When sewage starts percolating downwards, microorganisms prevent in the sewage grow on the surface of filtering media using organic material of the sewage as food . After completing of aerobic oxidation the treated sewage is taken to the settling tank and the sludge is removed. This process removes about 80 – 85 % of BOD.



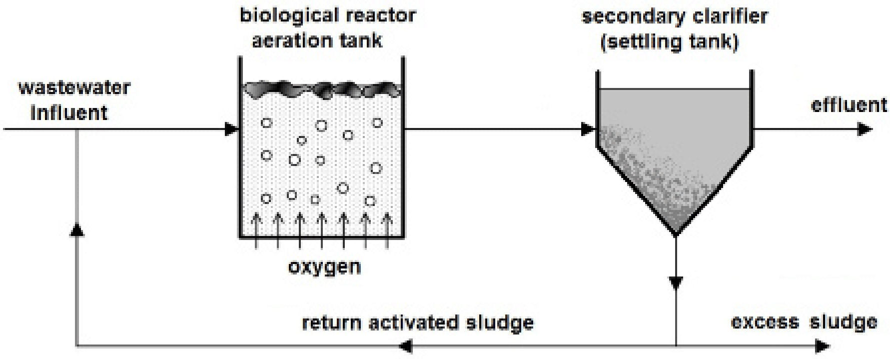
Source Fig 1.8.1- Engineering Chemistry –I by Dr.Ravikrishnan

2. Activated sludge process

Activated sludge is biologically active sewage and it has a large number of aerobic bacteria's , which can easily oxidize the organic impurities .

The sewage effluent from primary treatment is mixed with the required amount of activated sludge. Then the mixture is aerated tank under these condition organic impurities of the sewage get oxidized rapidly by the micro-organism.

After aeration, the sewage is taken to the sedimentation tank. Sludge settle down in this tank, called activated sludge, portion of which is used for seeding fresh batch of the sewage . This process removes about 90-95% of BOD



Source Fig 1.8.2- Physical Chemistry by Dr.Arun Paul

3. Tertiary treatment

After the secondary treatment the sewage effluent has a lower BOD (25ppm)which can be removed by the tertiary treatment process

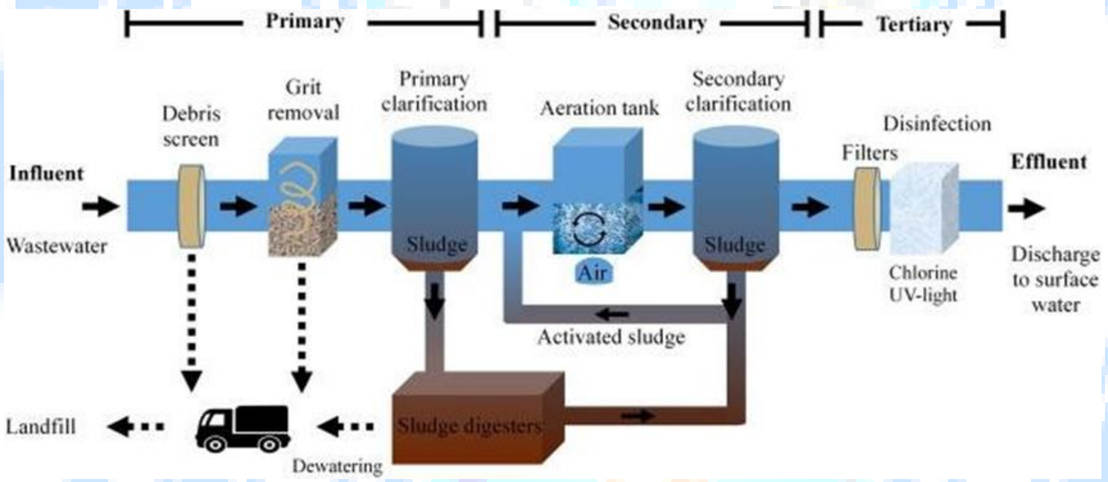
In the tertiary treatment, the effluent is introduced into a flocculation tank, where lime is added to remove phosphates . From the flocculation tank the effluent is led to ammonia stripping tower where pH is maintained to 11 and the NH4+ is converted to gaseous NH3 . Then the effluent is allowed to pass through activated charcoal column, where minute organic wastes are absorbed by charcoal . Finally the effluent water is treated with disinfectant (chlorine)

5 disposal of sludge

This is the last stage in the sewage treatment. Sludge formed from different steps can be disposed by

1 . dumping into low-lying areas

1. Burning of sludge
2. Dumping into the sea ,
3. Using it as low grade fertilizes



Source Fig 1.8.2- Physical Chemistry by Dr.Arun Paul