SNS COLLEGE OF TECHNOLOGY
AN AUTONOMOUS INSTITUTION

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DEPARTMENT OF FOOD TECHNOLOGY

COURSE CODE & NAME: 19FTO301 BEVERAGE TECHNOLOGY
III YEAR / V SEMESTER

UNIT : I - INTRODUCTION TO BEVERAGES

TOPIC 1 : Beverage – WATER TREATMENT

WATER TREATMENT

INTRODUCTION

- Water treatment is the process of removing contaminants from wastewater and household water.

- It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants.

- Its objective is to produce an environmentally safe fluid waste stream and a solid waste suitable for disposal or reuse .

DRINKING WATER TREATMENT PLANT

1. SCREENING
2. AERATION
3. FLOCULATION
4. SEDIMENTATION
5. FILTERATION
6. DISINFECTION
7. SOFTENING

SCREENING

❑ Screening is done to carry out the remove of heavy suspended solid from the water. like:- plants, stones, animals, trees, etc.

❑ Screening is generally adopted for the treatment of surface water.

❑ Screening is done with the help of -------

1. Coarse Screen
2. Fine Screen

COARSE SCREEN :-

- **Coarse Screen:-** Coarse Screen in the form of bar of size **10mm** to **25mm** having sepcing of 2200mm center to center.

FINE SCREEN:-

- **Fine Screen:-** Fine screen iin the form of wire cruss of size 10mm

WHAT IS AERATION ?

- **Aeration**:- It is the process in which water of brought intimate contact of air .
- It removes undesirable gases. Co2 , H2S.
- It removes undesirable organic mater.

TYPES OF AERATORS

- There are two main types of aerators based on the mechanism of aeration. They are those forming drops or thin sheet of water, exposed to atmosphere and those forming bubbles of air, which rise in water.

- Spray type, waterfall or multiple trays and cascade type are the common types coming under the first category
while diffusion aerators fall under the second category.

SPRAY TYPE AERATOR

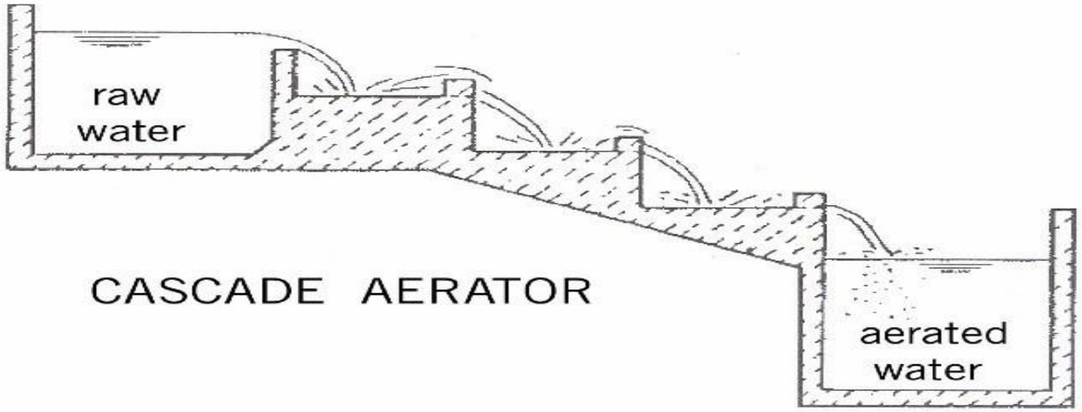
- Spray aerators have one or more spray nozzles connected to a pipe manifold.

- Water moves through the pipe under pressure, and leaves each nozzle in a fine spray and falls through the surrounding air, creating a fountain affect.

- Spray aeration is successful in oxidizing iron and manganese and increases the dissolved oxygen in the water.

CASCADE AERATORS

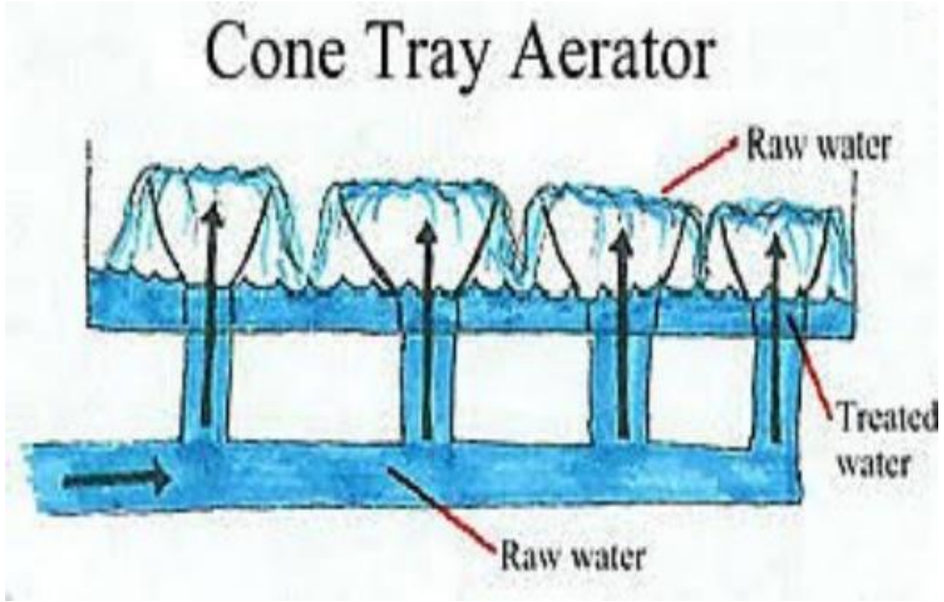
The general principle of cascade aerators is to spread the water as much as possible and let it flow over obstructions to produce turbulence and to change water surfaces in contact with the atmosphere.



Cascade Aerator

CONE AERATORS

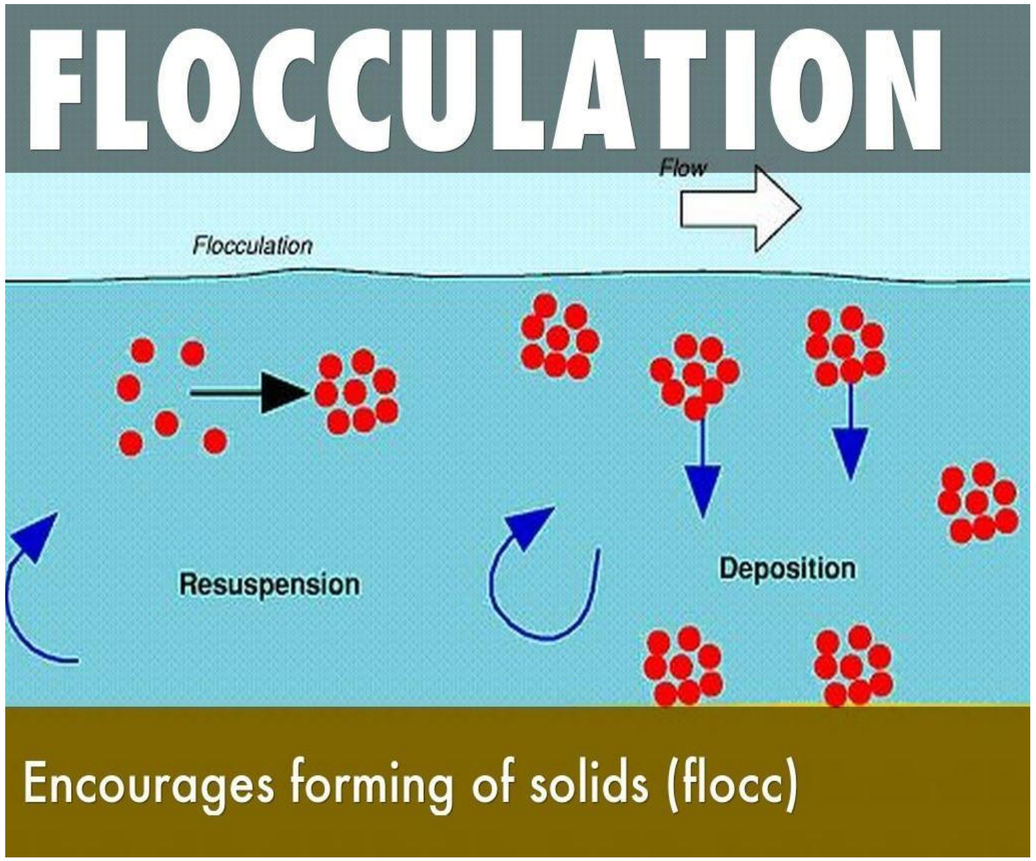
Cone aerators are used primarily to oxidize iron and manganese from the ferrous state to the ferric state prior to filtration. The design of the aerator is similar to the cascade type, with the water being pumped to the top of the cones and then being allowed to cascade down through the aerator.



FLOCULATION

❑ Flocculants, or flocculating agents are chemicals that promote flocculation by causing colloids and other suspended particles in liquids to aggregate, forming a floc.

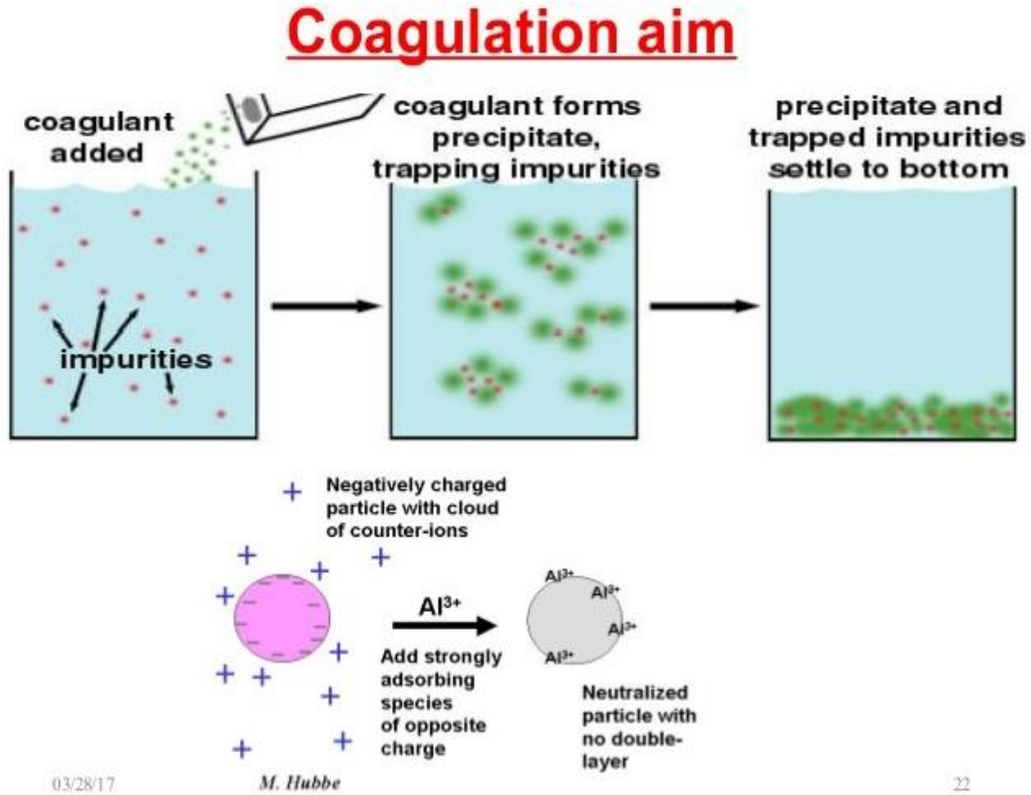
❑ Flocculants are used in water treatment processes to improve the sedimentation or filterability of small particles



COAGULATION

- Coagulation is the effect produced by the addition of chemicals called coagulants to a colloidal dispersion resulting in particle destabilization.

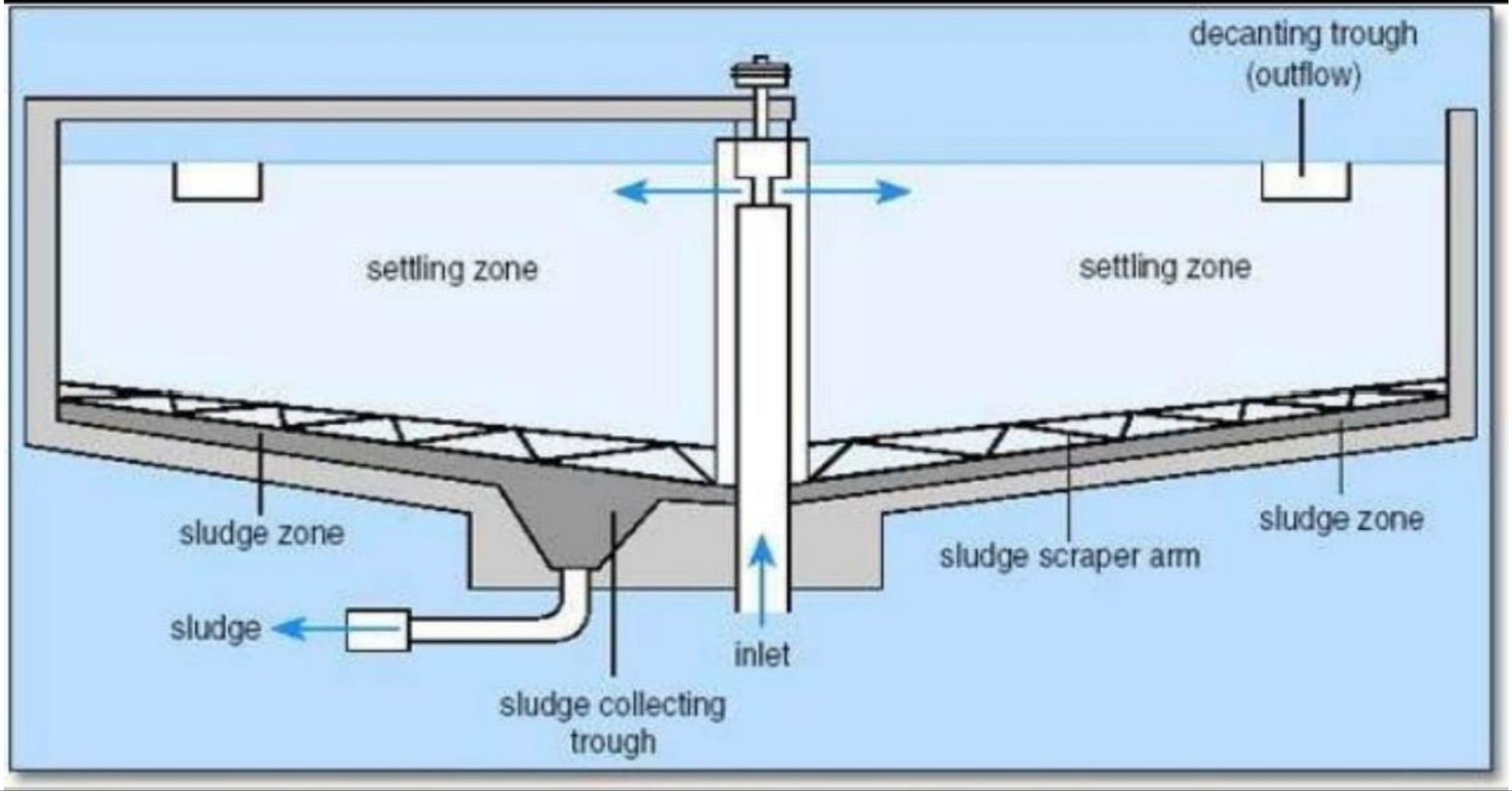
- coagulants when thoroughly mixed with water form a precipitate called floc.



Sedimentation :-

- **Sedimentation:-**
  Sedimentation is the process removes suspended particle form the water which could not be removes in the screening process.

Primary sedimentation tank for sludge removal



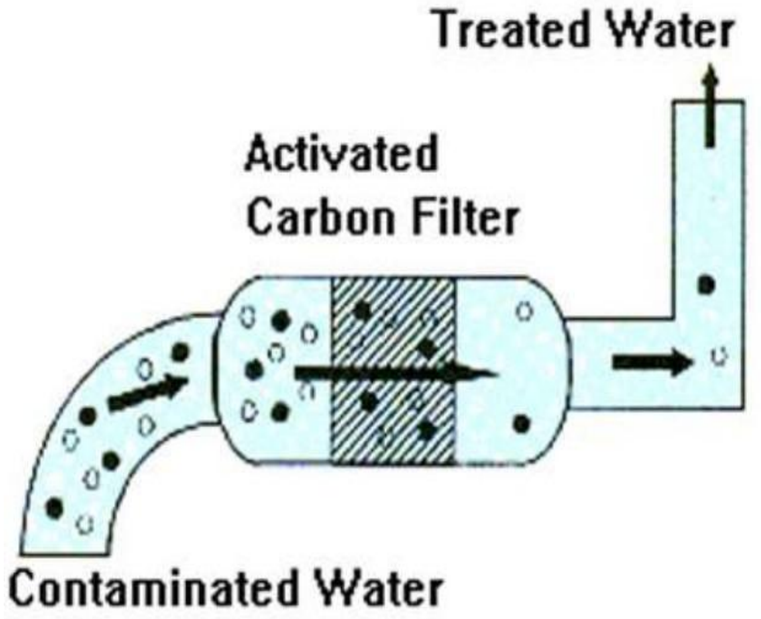
FILTERATION

- It is carry out for the removes of fine suspended particles and flow from the water.

- Filtration also remove organic matter. Micro organism , minerals form the water

ACTIVATED CARBON FILTER

- Activated Carbon Filtration is an established technology that works through absorption of the problematic compounds, primarily to remove taste and odour and also remove some harmful contaminants and organic compounds.



ULTRAVIOLET (UV) WATER FILTERS

- UV Filters are able to kill the majority of bacteria and viruses in the water which passes through them, However, they won't remove chemical pollutants from the water. Since the treatment is ineffective outside the treatment area, water should be used immediately after it is treated.

❑ SAND FILTERS

Sand based water filters have been used for over 100 years to treat wastewater; they are generally used on a larger scale to treat a water supply for a whole community. Most units require a constant flow of water to work correctly and so wouldn't be suitable for well water treatment

❑ RAPID SAND GRAVITY FILTER

Rapid sand gravity filter is a type of filter commonly used for large municipal supplies.

Sand, which is cheap, inert, durable and widely available, makes a highly desirable filter medium for the treatment or pre treatment of potable water and is used in many rural settings because they are relatively simple to built and operate.

Such filters consist of 60 to 70 cm deep column of fine sand to permit a filtration rate of not more than 200 WmLl hour of water

DISINFECTION

Minor methods of disinfection are:

- **Boiling of water**
- **Treatment with excess lime Treatment with ozone**
- **Treatment with iodine and bromine**
- **Treatment with ultra violet rays**
- **Treatment with potassium permanganate**

These methods are applied only for small water supplies

SOFTENING

- Softening is done in order to carry out the remove of the hardness form the water.

- The reduction or removal of hardness from water is known as iron softening. If bicarbonates of calcium and magnesium are present in water such hardness is called temporary hardness or carbonate hardness and this can be easily removed by boiling or by the addition of lime.

- If sulphates, chlorates and nitrates of calcium and magnesium are present in water they requires special treatment such as lime soda process, zeolite process and demineralization process.

❑ In **lime soda process** lime and soda ash are added to the hard water. which reacts with calcium and magnesium salts so as to form insoluble precipitates of calcium carbonate and magnesium hydroxide.

❑ In **zeolite process** hard water is passed through a bed of zeolite sand (complex silicates of aluminium and sodium) whereby it exchanges its calcium and magnesium for the sodium in the zeolite until sodium becomes exhausted.

❑ In **demineralization** removal of minerals present in water can be carried out by first passing the water through a bed of cation exchange resins and then through a bed of anion exchange resins.

THANKS

WASTEWATER TREATMENT PLANT

Waste water Treatment

Purpose:

-To manage water discharged from homes, businesses, and industries to reduce the threat of water pollution.

-Water discharged from homes, businesses, and industry enters sanitary sewers.

-Water from rainwater on streets enters storm water sewers.

-Combined sewers carry both sanitary wastes and storm water

Wastewater Treatment

Pre-treatment

- Preliminary treatment
- Primary treatment
- Secondary treatment
- Tertiary Treatment

Wastewater Treatment

Pre-Treatment:

-Occurs in business or industry prior to discharge

-Prevention of toxic chemicals or excess nutrients being discharged in wastewater.

-Water moves toward the wastewater plant primarily by gravity flow.

-Lift stations pump water from low lying areas over hills

Preliminary Treatment:

- removes large objects and non-degradable materials
- protects pumps and equipment from damage
- bar screen and grit chamber

Wastewater Treatment

- Measurement and sampling at the inlet structure

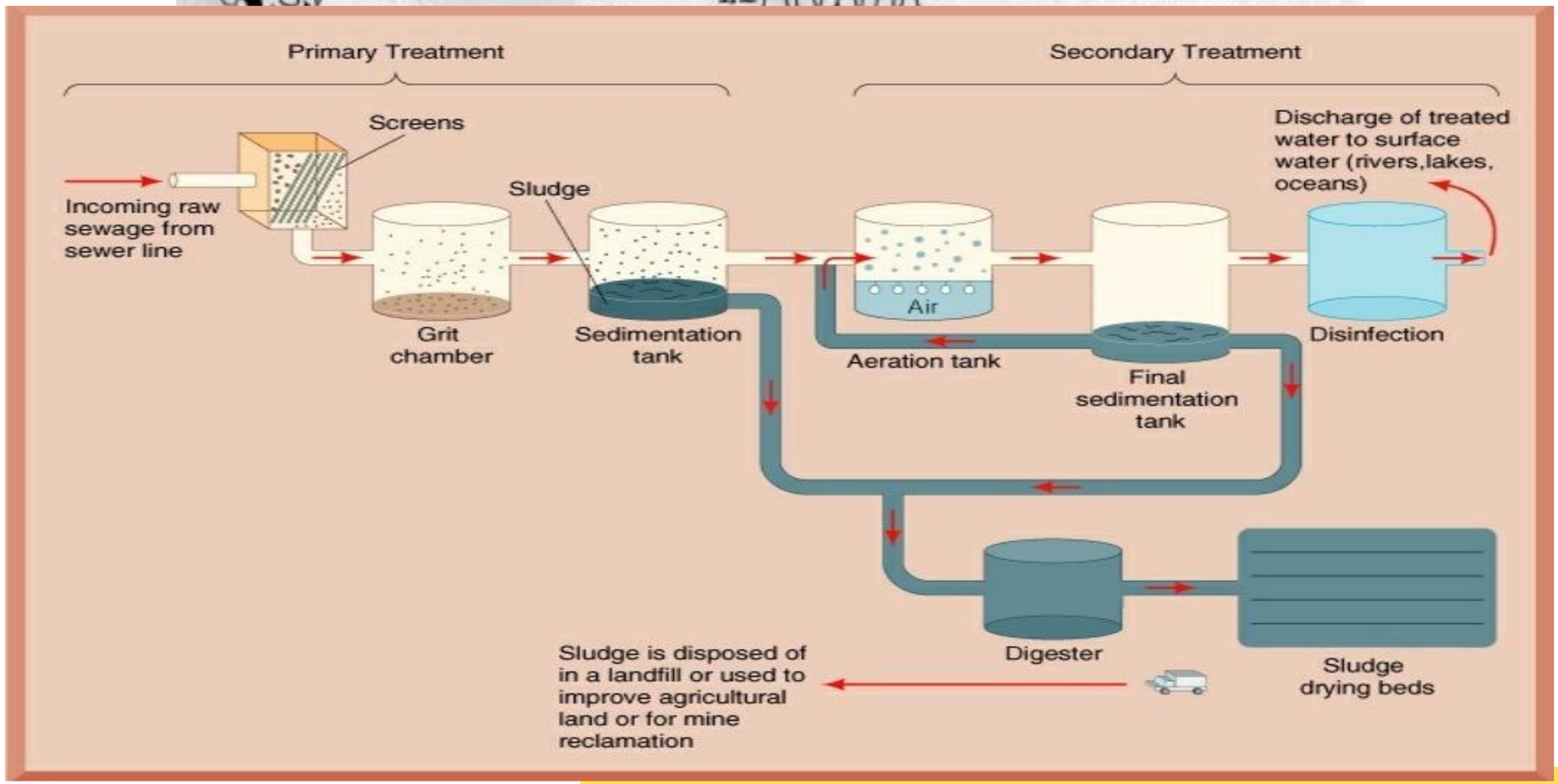
  - a flow meter continuously records the volume of water entering the treatment plant

- - water samples are taken for determination of suspended solids and B.O.D.

- Measurements of Suspended Solids and B.O.D. indicate the effectiveness of treatment processes

- Both Suspended Solids and B.O.D. decrease as water moves through the wastewater treatment processes

Wastewater Treatment



PRE-LIMINARY TREATMENT

Bar Screen

- catches large objects that have gotten into sewer system such as bricks, bottles, pieces of wood, etc.

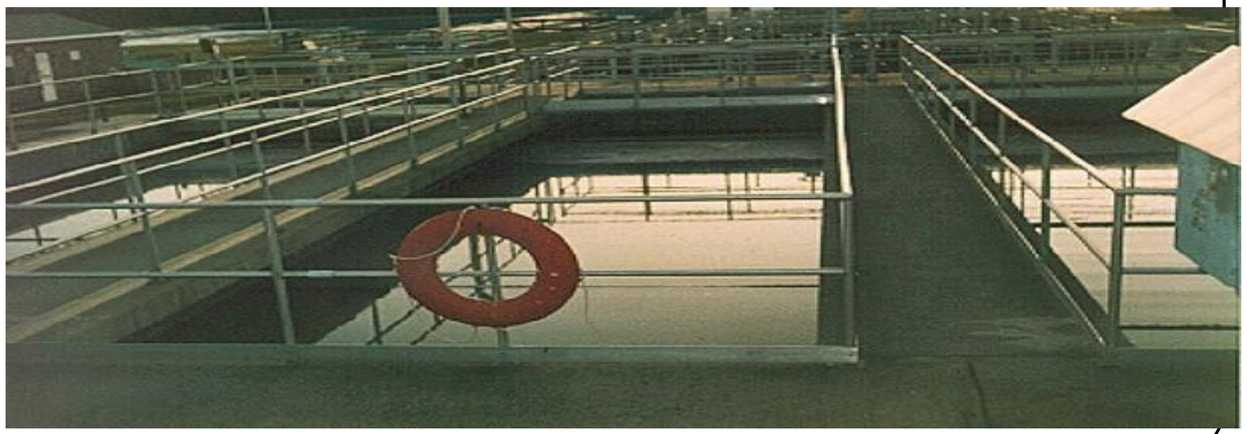
Preliminary Treatment

Grit Chamber

- removes rocks, gravel, broken glass, etc.

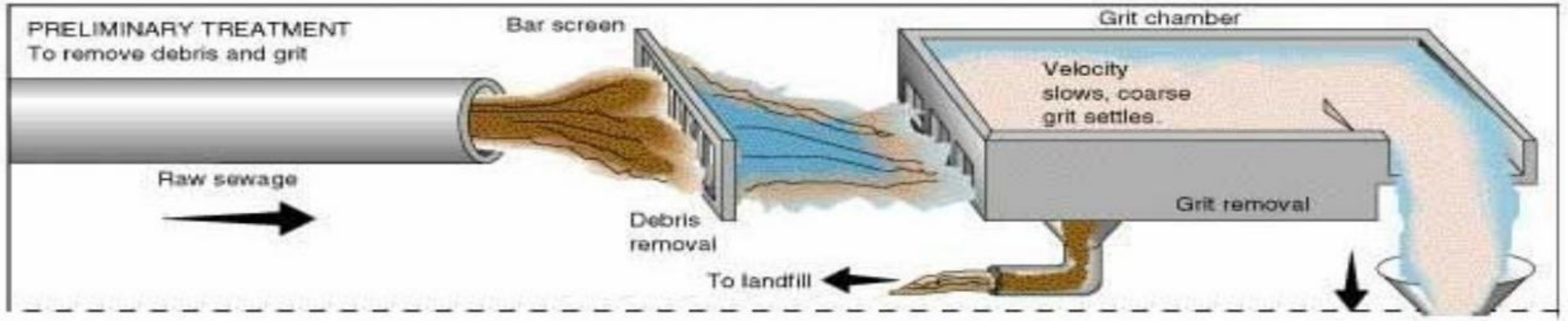
Mesh Screen

- removes diapers, combs, towels, plastic bags, syringes, etc.



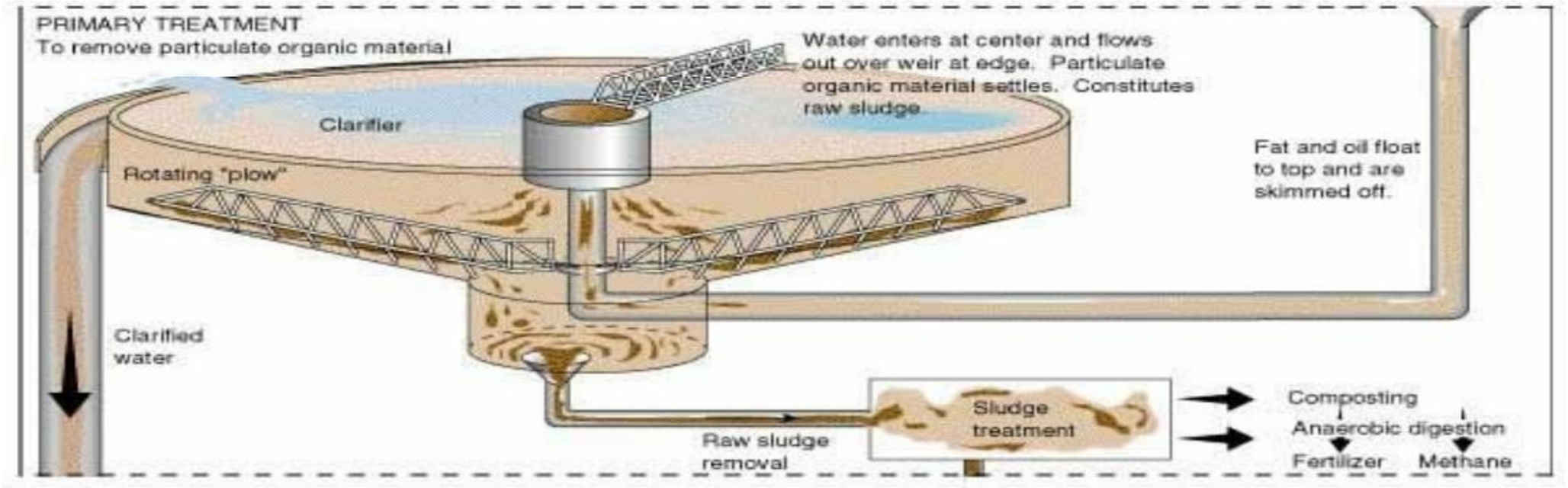
Wastewater Treatment

- Preliminary Treatment



Wastewater Treatment

Primary Treatment



PRIMARY TREATMENT

- Primary treatment reduces the suspended solids and the B.O.D. of the wastewater.
- From the primary treatment tanks water is pumped to the trickling filter for secondary treatment.
- Sludge from the primary sedimentation tanks is pumped to the sludge thickener.

  - more settling occurs to concentrate the sludge prior to disposal
- Secondary treatment will further reduce the suspended solids and B.O.D. of the wastewater.

SECONDARY TREATMENT

Secondary treatment is a biological process

Utilizes bacteria and algae to metabolize organic matter in the wastewater

Secondary treatment systems are classified as Aerobic suspended –growth treatment and Anaerobic suspended-growth treatment.

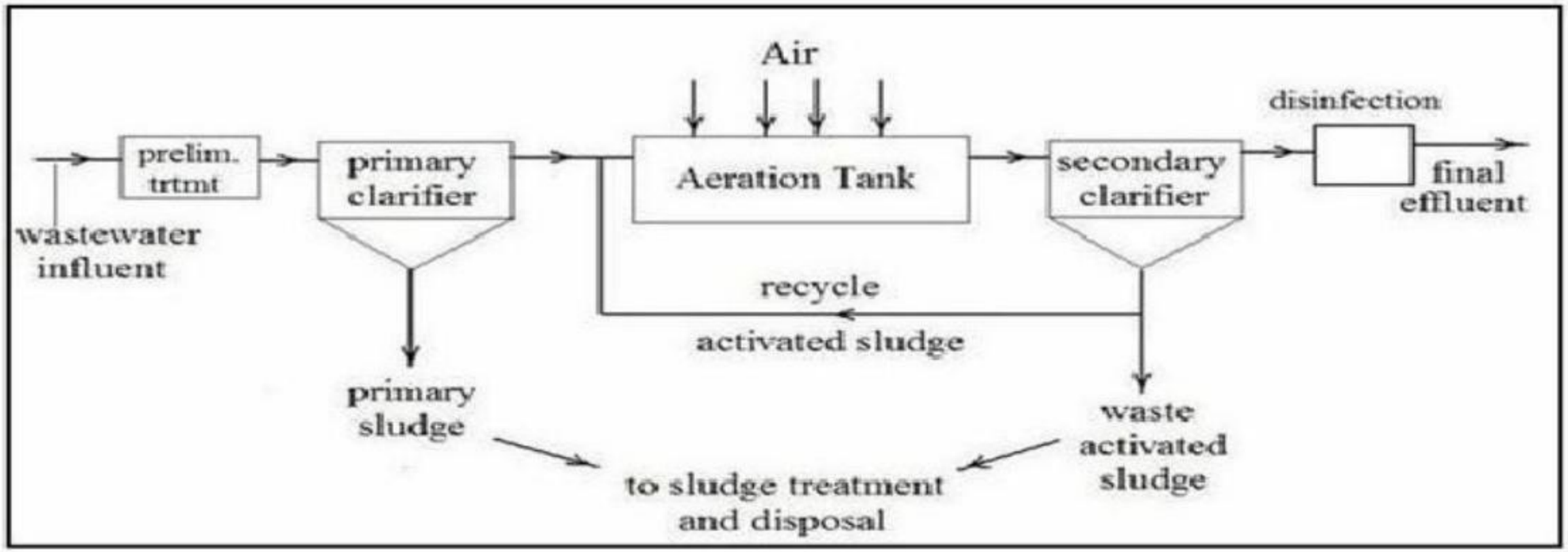
SECONDARY TREATMENT

❑ AEROBIC SUSPENDED –GROWTH TREATMENT

- ✓ Activated sludge process
- ✓ Aerated lagoons
- ✓ Trickling Filter
- ✓ Aerobic digestion

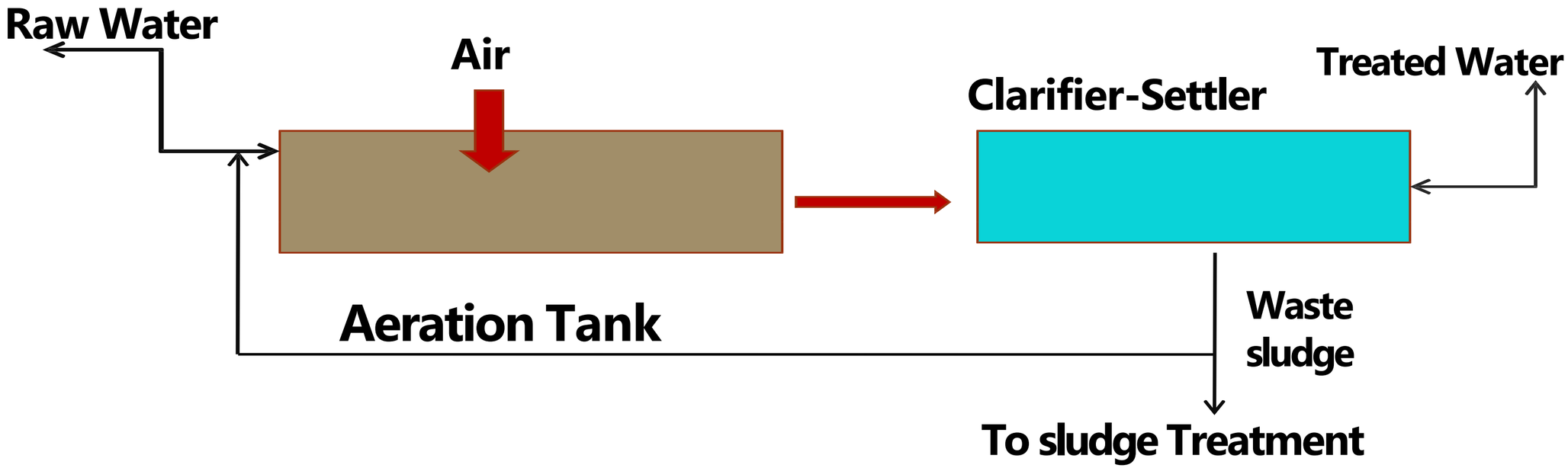
❑ ANAEROBIC SUSPENDED-GROWTH TREATMENT

Anaerobic filters or fixed-film consists of column filled with solid media for the treatment of organic matter in sewage.



Activated Sludge Wastewater Treatment Flow Diagram

ACTIVATED SLUDGE PROCESS



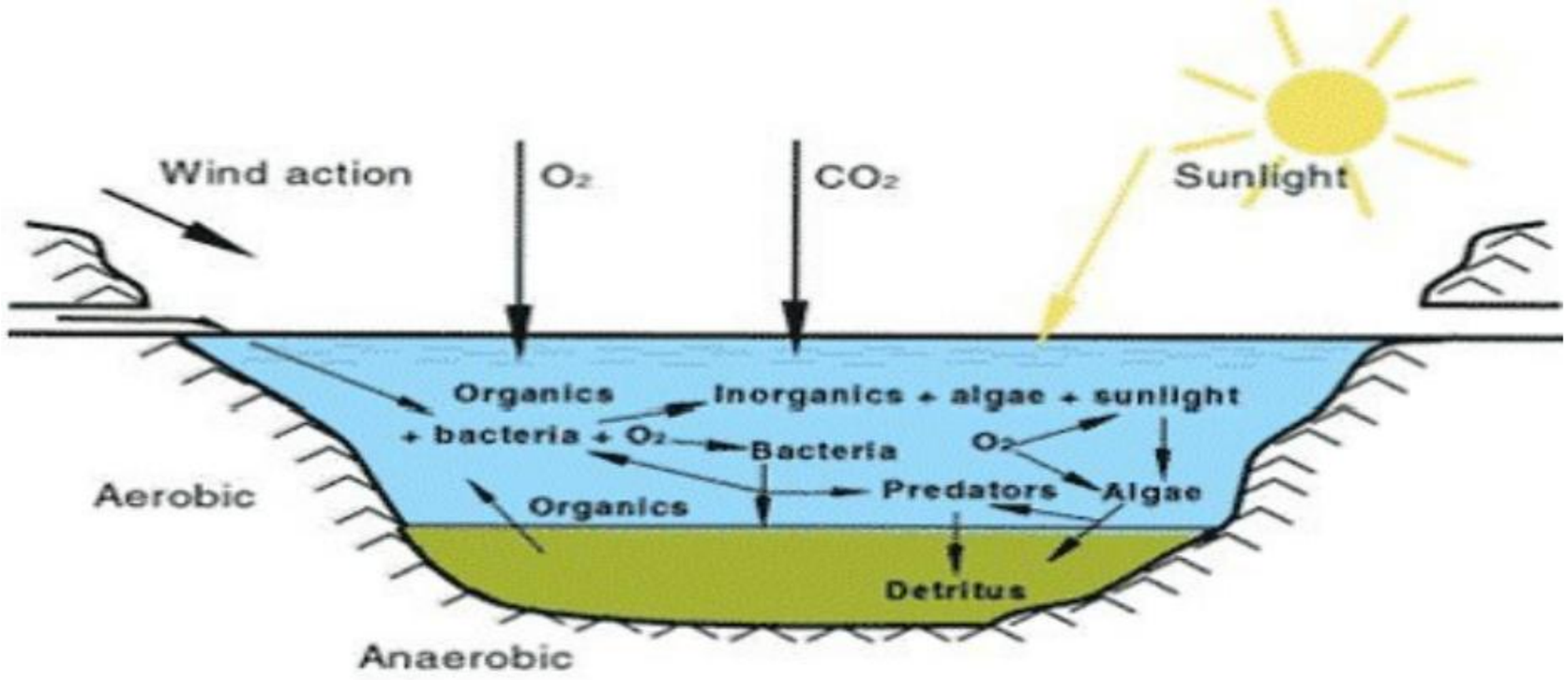
Activated sludge process

- The effluent from the primary clarifier goes to aeration tank.
- Aeration tank also receives microorganisms from the secondary settling tank known as activated sludge.
- Oxygen is pumped into aeration tank for maintaining aerobic conditions.
- After few hours of agitation, the waste water goes to secondary settling tank where solids settle at the bottom .
- The sludge is produced, dewatered and disposed off.
- Sludge can be used for landfills or disposed off in ocean or used in croplands, pastures, etc.,

AERATED LAGOONS

- Lagooning describes the process of placing effluents in a shallow impermeable water basin to allow degradation to take place. This type of containment is used for wastewater with low organic contents. The cleaning of the effluents takes place as a result of bacterial action, algae or aquatic vegetation.

- Oxygenation for bacterial oxidation of organics comes from photosynthesis by algae and a bit from wind. CO_2 released by bacteria is used by the algae. Excess biomass and other settlables are treated by anaerobic bacteria at the bottom.


Wind action
O2
CO2
Sunlight
Organics
+ bacteria + O2
Bacteria
Inorganics + algae + sunlight
O2
Predators
Algae
Organics
Aerobic
Detritus
Anaerobic

AEROBIC DIGESTION

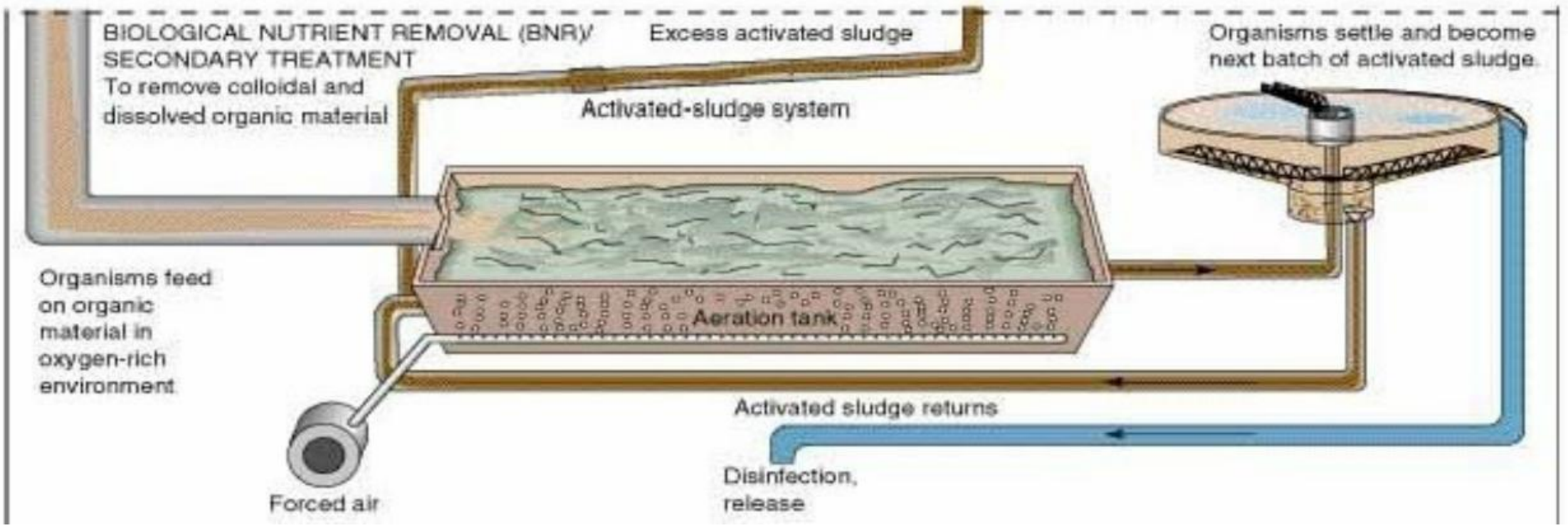
- Aerobic digestion is an extension of the activated sludge aeration process whereby waste primary and secondary sludges are continually aerated for long periods of time.
- In aerobic digestion the microorganisms extend into the endogenous respiration phase, which is a phase where materials previously stored by the cell are oxidized, with a reduction in the biologically degradable organic matter. This organic matter, from the sludge cells is oxidized to carbon dioxide, water and ammonia.
- The ammonia is further converted to nitrates as the digestion process proceed.

- The oxygen uptake rate levels off and the sludge matter is reduced to inorganic matter and relatively stable volatile solids.

- The major advantage of aerobic digestion is that it produces a biologically stable end product suitable for subsequent treatment in a variety of processes. Volatile solids reductions similar to anaerobic digestion are possible.

Wastewater Treatment

Secondary Treatment



SECONDARY TREATMENT-TRICKLING FILTER

- **The trickling filter does not "filter" the water.**

- **Water runs over a plastic media and organisms clinging to the media remove organic matter from the water.**

- **It consist of a bed of crushed stones/pebbles covered with slime which consists of aerobic bacteria, algae, fungi, protozoa, worms & insect larvae.**

Sewage is degraded by the aerobic bacteria when it passes through the bed and is collected at the bottom of the filter.

It helps in better removal of organic matter and also keeps the filter moist when the flow rate is slow

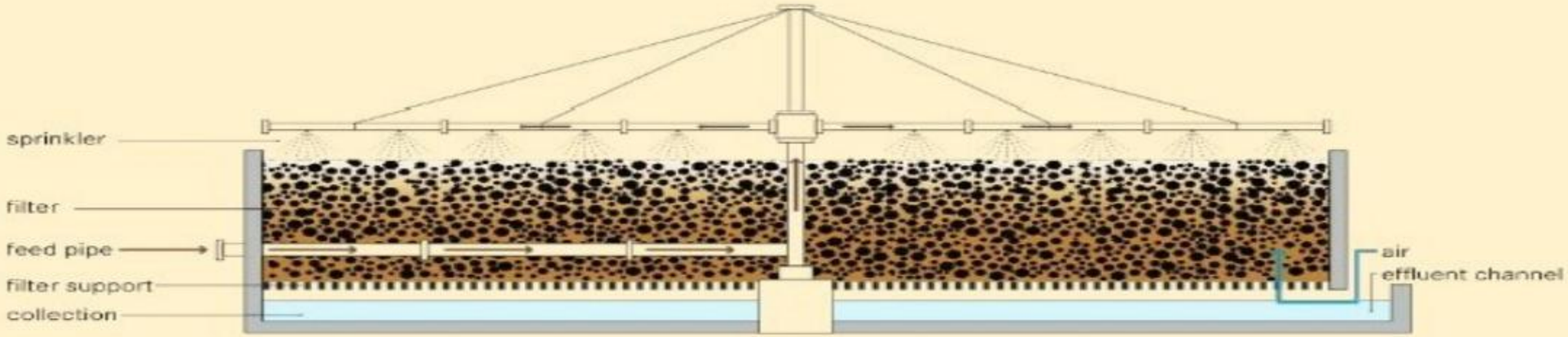
TRICKLING FILTER

The final clarifiers remove additional sludge and further reduce suspended solids and B.O.D.

SECONDARY TREATMENT

TRICKLING FILTER OPERATION

Type of Attached Growth System



The wastewater is distributed over "media" upon which a biological film growth develops containing living organisms that break down organic material.

TERTIARY TREATMENT

- To provide final treatment stage to further improve the effluent quality before it is discharged to the receiving environment (Sea, river, lake etc).
- Sand filtration removes residual suspended matter.
- Filtration over activated carbon remove residual matter.

IMPORTANCE OF TERTIARY TREATMENT

- To remove total suspended solids and organic matter those are present in effluents after secondary treatment.
- To remove specific organic and inorganic constituents from industrial effluent to make it suitable for reuse.
- To make treated wastewater suitable for land application purpose or directly discharge it into the water bodies like rivers, lakes, etc.
- To remove residual nutrients beyond what can be accomplished by earlier treatment methods.
- To remove pathogens from the secondary treated effluents.
- To reduce total dissolved solids (TDS) from the secondary treated effluent to meet reuse quality standards.

TERTIARY TREATMENT

- Nutrient removal (ammonia and phosphorus)
- Nitrification/ Dinitrification
- Ion exchange
- Membrane Process

- anaerobic microbiological process with a different microbe where O_2 is toxic (more sludge)

$$NO_3^- \rightarrow N_2 \text{ (escapes to atmosphere)}$$

$$PO_4^{-3} + Al^{+3} \rightarrow AlPO_4\,(s) \text{ (into sludge)}$$

- PO_4^{-3} if not removed in sludge in secondary process
- aeration to strip N_2 and re-oxygenate (add DO).

Phosphorus Removal

A) Physical:

a) filtration for particulate phosphorus

b) membrane technologies

A) Chemical:

a) precipitation

C) Biological: •

a) enhanced biological phosphorus removal (EBPR)

BIOLOGICAL NITRIFICATION

Conversion of Ammonia to Nitrite (Nitrosomonas)

$$NH_4^+ + 2\,O_2 \longrightarrow NO_2^- + 2\,H^+ + H_2O$$

Conversion of Nitrite to Nitrate (Nitrobacter)

$$NO_2^- + 0.5\,O_2 \longrightarrow NO_3^-$$

Denitrification :

Denitrifying bacteria obtain energy from the conversion of NO_3^- to N_2 gas.

$$NO_3^- + CH_3OH + H_2CO_3 \longrightarrow C_5H_7O_2N + N_2 + H_2O + HCO_3^-$$

Organic matter — Cell mass

AMMONIA REMOVAL

- The most common processes for removal of ammonia from wastewater are

i) Air stripping

ii) Biological nitrification and denitrification.

Air Stripping

iii) It consists of converting ammonium to gaseous phase and then dispersing the liquid in air, thus allowing transfer of the ammonia from wastewater to the air.

iv) The most important and efficient reactor for air stripping is counter current spray tower.

DISINFECTION

1) **Uv radiaton** :- killing bacteria , virus and other pathogens . by damaging their genetic structure . • No chemical are used • More Rapid

2) **Ozonation** :- Disinfection achieved by formation of free radicals as oxidizing agents • more effective against viruses and bacteria then chlorination .

3) **Chlorination** :- chlorine is used in 2 forms – Cl_2 gas form or hypochlorite tablets.

• Chlorine react with water to form HOCL , which rapidly dissociate to form hypochlorite ion.

• Chlorine effective against bacteria..

❑ **Ion- exchange** - Ion exchange can be used in waste water treatment plants to swap one ion for another for the purpose of demineralization . The widest application of this process is in domestic water softening.

❑ **Membrane process**

1) **Microfiltration** –

✓ Pore sizes 0.01 – 12 um

✓ Capable of removing bacteria , macromolecules .

2) **Ultra filtration-** Remove organic molecules, virus, bacteria or a molecules weight above about 800 daltons

✓ Pore size 0.002 -0.03um

3) **Nanofiltration**:- Allow monlovalent ions such as sodium or potassium to pass but reject a high proportion of divalent ions such calcium and magnesium .

✓ Pore sizes are typically 0.001 – 0.01um

✓ Effective for removal of colour – forming organic compounds.

4) **Reverse osmosis** :- Rejects monovalent ions and organics of molecular weight > 50 dalton • Pore sizes <0.002um • Used for desalination of sea water.

❑ SAND FILTER

✓ Sand ,either fine or coarse is generally used as filter media.

They consist of fine sand supported by gravel are used in water treatment process of water purification.

✓ sand filter is an environmental friendly waste water treatment process.

Simple to use and inexpensive.

ADVANCED TERTIARY TREATMENT

- Disposal of Sludge or Bio-solids

- The sludge undergoes lime stabilization (pH is raised by addition of lime) to kill potential pathogens.

- The stabilized sludge is land applied by injection into agricultural fields

THANK YOU