2.1 SEDIMENTATION PROCESS

2.1.1 UNIT OPERATIONS AND PROCESSES

Unit operations are the physical operations to remove the impurities present in the water and waste water where as the unit processes are the chemical and biological conversion on the status of the impurities that they will be converted to a form that can be easily separated. Both are applied especially to make the fine colloidal particles to coalesce and grow in size to be removed from the water or waste water. There is no impurity that can be categorized as inorganic, it is named so for it takes time to disintegrate and had been to this hard form, free from decomposable matter with the ecological factors. We can find metal eating bacteria these days that makes the accelerated form to human use get decelerated to favor nature accommodate effectively as indigenous.

Screens are in use from the intake structure where they prevent the floating matter to enter into the pumping units, and fine and coarse screens are in use to treat waste water to prevent the entry of floating wastes and coarse solids into the treatment.

Sedimentation is simply detaining water for a sufficient time mostly in stagnant or relatively stagnant position to make the flow velocity of water less than the settling velocity of the solid particles that they without being driven by horizontal force settles down by gravity. The efficiency of the process depends on the detention time, how long the waste water remains within the sedimentation tank. When applied to individual units we need not reduce the flow velocity but make it stagnant as fill and draw type that the efficiency will be more. In the continuous flow type the flow velocity is reduced to the level of the minimum velocity which will not carry the particles with it according to stokes law that the vertical velocity, which is the settling velocity of the particle will be more than the horizontal drag velocity and the particle settles down. Mostly the tanks will be rectangular and we also have circular tanks where the flow will be from centre to periphery. Whatever may be the shape of the tank, it is the surface area which makes the travel of particles independent of others which makes the settling efficient that the depth has to be considered taking into effect the sludge accumulation and to prevent the reentry of particles back to flow.

Filtration is to the removal of fine particle sand dissolved solids where the fine sand layer and coarse sand layer below serves as the media to remove colloidal solids and the water remains completely free of solids. In trickling filters the waste water that trickles down gets oxidized that the organic matter grows in size and retained over the sand medium and bacteria assimilate on the organic matter to form layer on the surface which grows thicker and thicker to give more bacterial mass to act upon the organic solids. The bottom most layer becomes deprived of oxygen in due course of time that it sloughs and the same reaches the secondary settling tank where the same gets settled for its increased density.

Odour and colour present in water and waste water are removed by aeration and adsorption process. The odour and colour causing elements are adsorbed and aerated that the water is free from impurities for use and waste water for reuse and recycling. Toxic chemicals and metals too get adsorbed with suitable media for adsorption.

Unit processes:

Flocculation is a water treatment process where solids form larger clusters, or flocs, to be removed from water. This process can happen spontaneously, or with the help of chemical agents.

Coagulation is the chemical water treatment process used to remove solids from water, by manipulating electrostatic charges of particles suspended in water. This process introduces small, highly charged molecules into water to destabilize the charges on particles, colloids, or oily materials in suspension.

Coagulants are added to the water that the flocculent particles grow bigger in size which is by chemical reaction by rapid mixing and slow mixing and the coalescent particles which grew in size gets removed by settling. The coagulant we add changes the quality of water and the sludge volume too, and some of the coagulants add to bulking of sludge where the removal of moisture is difficult. Lime water instead of lime reduces the volume of sludge which is to all the solid coagulants. Liquid coagulants have more influence readily on coagulant particles than the solid coagulants which itself will take time to dissolve and react with the particles.

Chlorination is the process of adding chlorine or chlorine compounds such as sodium hypochlorite to water. This method is used to kill bacteria, viruses and other microbes in water. In particular, chlorination is used to prevent the spread of waterborne diseases such as cholera, dysentery, and typhoid.

The unit operations and processes can be applied in individual units of houses, colonies and industries that it gives fewer problems to the environment and handled with more efficiency. The entire process of sedimentation, filtration and hardness removal can be done at home, for removal of hardness we need not go for reverse osmosis which is much expensive on installation and maintenance but the simple lime soda process or boiling serve the purpose of both disinfection and hardness removal as the water from the top stratum of aquifer will not be saline in nature with chlorides and sulphates of calcium and magnesium as is seen common with river water discharged with domestic and industrial wastes. The lime soda solution can be sold commercially to separate salts in the tank and that can be removed very frequently. There are plant extracts that helps removing salinity too.

Construction, Operation and Maintenance Aspects of water treatmentplant:

Construction aspect:

• Must follow building code of practice when installing
• Use of materials is also need to followed as per standards
• Proper material and workmanship
• Pipe diameter, threads, wall thickness, pressure class, corrosion protection, hoop stress, buried depth, surge protection, thrust restraint, pipe bedding, and jointing should all be considered**.**

O & M aspect:

Tasks can be broken down into daily, weekly, monthly, and seasonal repeats.

Daily Tasks:

• Check water meter readings and record water use.
• Check and record water level indicators in reservoir/storage tanks.
• Check and record chlorine level in the distribution system.
• Inspect chemical feed pumps for proper operation.
• Inspect well pumps, motors, pressure gauges, and controls. Record well pump running times and pump cycle starts.
• Record and investigate customer complaints.
• Inspect heater operation during winter months.

Weekly Tasks

• Inspect chlorine testing equipment.
• Check chemical solution tanks and record use.
• Clean pump house and grounds.
• Make sure fire hydrants are accessible.
• Record pumping rate for each well or source water pump.
• Inspect pump house plumbing for leaks.
• Take bacteriological sample in for testing
(Required testing frequency may vary -- check with your local health authority).

Monthly, Seasonal, or Annual Tasks

•Take and record electrical meter readings at pump house.
•Inspect well head or intake structure.
•Inspect reservoir.

2.1.2 SEDIMENTATION TANK

It is the process in which the suspended solids are made to settle by gravity under still water conditions is called plain sedimentation.

PLAIN SEDIMENTATION

By plain sedimentation the following are the advantages.

- Plain sedimentation lightens the load on the subsequent process.
- The operation of subsequent purification process can be controlled in better way.
- The cost of cleaning the chemical coagulation basins is reduced.
- No chemical is lost with sludge discharged from the plain settling basin.
- Less quantity of chemicals is required in the subsequent treatment processes.

The amount of matter removed by sedimentation tank depends upon the factors.

- Velocity of flow
- size and shape of particles
- Viscosity of water

The particles which do not change in size, shape or mass during settling are known as the discrete particles. The velocity of discrete particles with dia less than 0.1 mm is given by

$V = 418 (S - S1) d2 (3T + 70)$ ---------- (1)

Where V → Velocity of settlement in mm/sec

S → Specific gravity of the particle

S1 → Specific gravity of water

D → dia of the particle in mm

T → Temperature in °C

If the dia of the particle is greater than 0.1mm then the velocity is measured by

$V = 418 (S - S1) d (3T + 70)$ ----------(2)

In practice settling of the particles governed by the resultant of horizontal velocity of water and the vertical downward velocity of the particle.

DESIGN ASPECTS OF SEDIMENTATION TANKS

The design aspects of sedimentary tanks are

- Velocity of flow
- Capacity of tank
- Inlet and outlet arrangements
- Shapes of tanks
- Miscellaneous considerations.

(1) Velocity of flow: The velocity of flow of water in sedimentation tanks should be sufficient enough to cause the hydraulic subsidence of suspended impurities. It should remain uniform throughout the tank and it is generally not allowed to exceed 150mm to 300mm per minute.

(2) Capacity of tank: capacity of tank is calculated by

i) Detention period

ii) Overflow rate

(i) Detention period: The theoretical time taken by a particle of water to pass between entry and exit of a settling tank is known as the known as the detention period. The capacity of tank is calculated by

C = Q x T where C → Capacity of tank

Q → Discharge or rate of flow

T → Detention period in hours

The detention period depends on the quality of suspended impurities present in water. For plain sedimentation tanks, the detention period is found to vary from 4 to 8 hours.

(ii) Overflow Rate: in this method it is assumed that the settlement of a particle at the bottom of the settlement of a particle at the bottom of the tank does not depend on the depth of tank and depends upon the surface area of the tank.

Distance of descend D

Surface overflow rate, V

C L x B x D L x B

Where L → Length of tank

B → Breadth of tank

D → Depth of tank = Side water depth = S.W.D

C → Capacity of tank

T → Detention period

U → Discharge or rate of flow

V → Velocity of descend of a particle to the bottom of tank

Surface overflow rate = S.O.R

(3) INLET AND OUTLET ARRANGEMENTS

The inlet is a device, which is provided to distribute the water inside a tank, and the outlet is a device, which is meant to collect outgoing water. These arrangements should be properly designed and located in such a way that they do not form any obstruction or cause any disturbance to the flowing water.

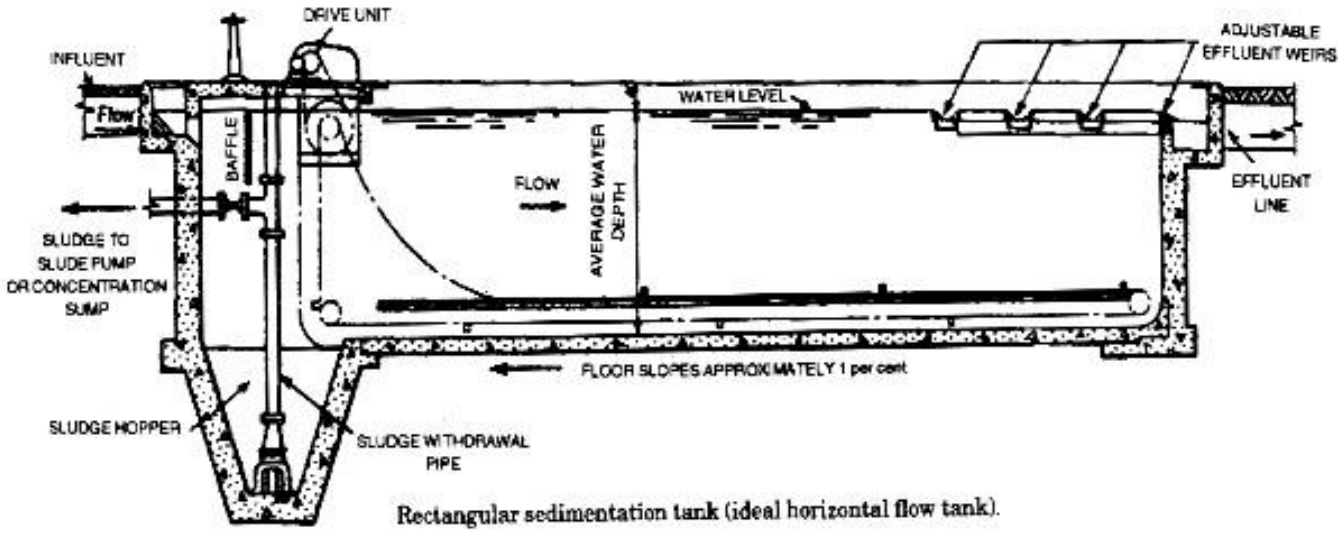
(4) SHAPES OF TANKS

Following are the three shapes of settling tank.

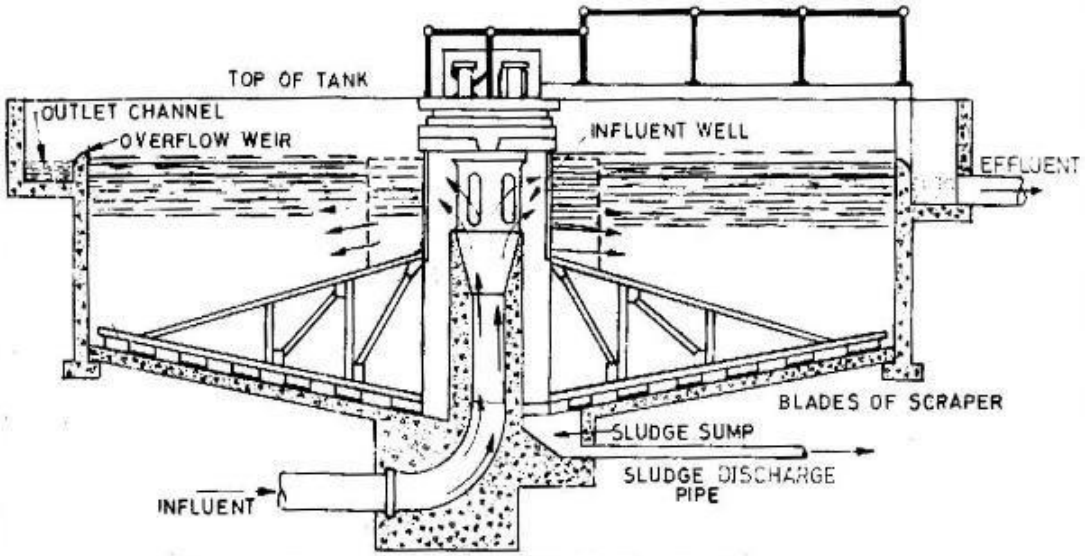
(i) Rectangular tanks with horizontal flow

(ii) Circular tanks with radial or spiral flow

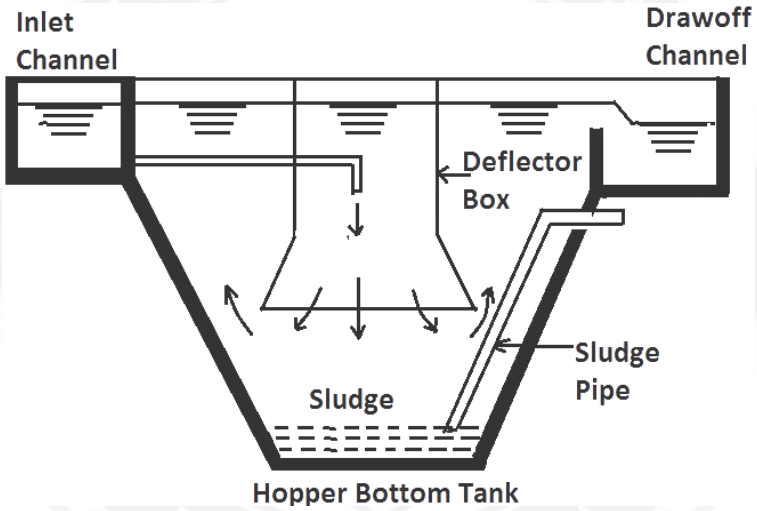
(iii) Hopper bottom tanks with vertical flow



Rectangular sedimentation tank (ideal horizontal flow tank).



Circular sedimentation tank (central feed) with radial flow.



The following are the parameters for satisfactory performance.

- Detention period ….. 3 to 4 hours for plain settling.
  2 to 21/2 hours for coagulant settling
  1 to 11/2 hours for up flow type
- Overflow rate …… 30 – 40 m3/m2/day for horizontal flow
  40-50m3/m2/day for up flow
- Velocity of flow .....0.5 to 1.0 cm/sec
- Weir loading.....300m3/m/day
- L:B .....1:3 to 1:4
- Breadth of tank…..... (10 to 12m) to 30 to 50m
- Depth of tank….....21/2 – 4m
- Diameter of circular tank…. upto 60m
- Solids removal efficiency… ..50%
- Turbidity of water after sedimentation – 15 to 20 N.T.U.
- Inlet and Outlet zones .....0.75 to 1.0m

- Free board… 0.5m
- Sludge Zone 0.5m

Settling Solid liquid separation process in which a suspension is separated into two phases:

- Clarified supernatant leaving the top of the sedimentation tank (overflow).
- Concentrated sludge leaving the bottom of the sedimentation tank

(underflow).Purpose of Settling:

- To remove coarse dispersed phase.
- To remove coagulated and flocculated impurities.
- To remove precipitated impurities after chemical treatment.
- To settle the sludge (biomass) after activated sludge process / tricking

filters.Principle of Settling:

- Suspended solids present in water having specific gravity greater than that of water tend to settle down by gravity as soon as the turbulence is retarded by offering storage.
- Basin in which the flow is retarded is called settling tank.
- Theoretical average time for which the water is detained in the settling tank is called the detention period.

Types of Settling:

Type I: Discrete particle settling - Particles settle individually without interaction with neighboring particles.

Type II: Flocculent Particles – Flocculation causes the particles to increase in mass and settle at a faster rate.

Type III: Hindered or Zone settling –The mass of particles tends to settle as a unit with individual particles remaining in fixed positions with respect to each other.

Type IV: Compression – The concentration of particles is so high that sedimentation can only occur through compaction of the structure.