5.1 SEWAGE TREATMENT METHODS

PRIMARY SEDIMENTATION TANK

After grit removal in grit chamber, the wastewater containing mainly lightweight organic matter is settled in the primary sedimentation tank (PST). Due to involvement of many unknown parameters under settling of light weight, sticky, and non regular shaped particles, the classical laws of sedimentation as applicable in grit removal are not valid and this settling is called as flocculant settling. The primary sedimentation tank generally removes 30 to 40% of the total BOD and 50 to 70% of suspended solids from the raw sewage.

The flow through velocity of 1 cm/sec at average flow is used for design with detention period in the range of 90 to 150 minutes. This horizontal velocity will be generally effective for removal of organic

suspended solids of size above 0.1 mm. Effluent weirs are provided at the effluent end of the rectangular tanks, and around the periphery in the circular tanks. Weir loading less than 185m3/m.d is used for designing effluent weir length (125 to 500 m3/m.d). Where primary treatment follows secondary treatment, higher weir loading rates can be used. The sludge collection hopper is provided near the centre in circular tank and near the influent end in rectangular tanks. A baffle is provided ahead of the effluent weir for removal of floating matter. This scum formed on the surface is periodically removed from the tank mechanically or manually.

The efficiency of the sedimentation tank, with respect to suspended solids and BOD removal, is affected by the following:

- Eddy currents formed by the inertia of incoming fluid,
- Wind induced turbulence created at the water surface of the uncovered tanks,
- Thermal convection currents,
- Cold or warm water causing the formation of density currents that moves along the bottom of the basin, and Thermal stratification in hot climates.

Because of the above reasons the removal efficiency of the tank and detention time has correlation R = t/(a+b.t), where ‘a’ and ‘b’ are empirical constants, ‘R’ is expected removal efficiency, and ‘t’ is nominal detention time.

To account for the non optimum conditions encountered in the field, due to continuously wastewater coming in and going out of the sedimentation tank, due to ripples formed on the surface of the water because of wind action, etc., the settling velocity (overflow rate) obtained from the column studies are often multiplied by a factor of 0.65 to 0.85, and the detention time is multiplied by a factor of 1.25 to 1.50. This will give adequate treatment efficiency in the field conditions as obtained under laboratory test.

Recommendation for Design of Primary Sedimentation Tank

Primary sedimentation tanks can be circular or rectangular tanks designed using average dry weather flow and checked for peak flow condition. The numbers of tanks are determined by limitation of tank size. Two tanks in parallel are normally used to facilitate maintenance of any tank. The diameter of circular tank may range from 3 to 60 m (up to 45 m typical) and it is governed by structural requirements of the trusses which supports scrapper in case of mechanically cleaned tank. Rectangular tank with length 90 m are in use, but usually length more than 40 m is not preferred. Width of the tank is governed by the size of the scrappers available for mechanically cleaned tank. The depth of mechanically cleaned tank should be as shallow as possible, with minimum 2.15 m. The average depth of the tank used in practice is about 3.5 m. In addition, 0.25 m for sludge zone and 0.3 to 0.5 m free board is provided. The floor of the tank is provided with slope 6 to 16 % (8 to 12 % typical) for circular tank and 2 to 8% for rectangular tanks. The scrappers are attached to rotating arms in case of circular tanks and to endless chain in case of rectangular tanks. These scrappers collect the solids in a central sump and the solids are withdrawn regularly in circular tanks. In rectangular tanks, the solids are collected in the sludge hoppers at the influent end, and are withdrawn at fixed time intervals.

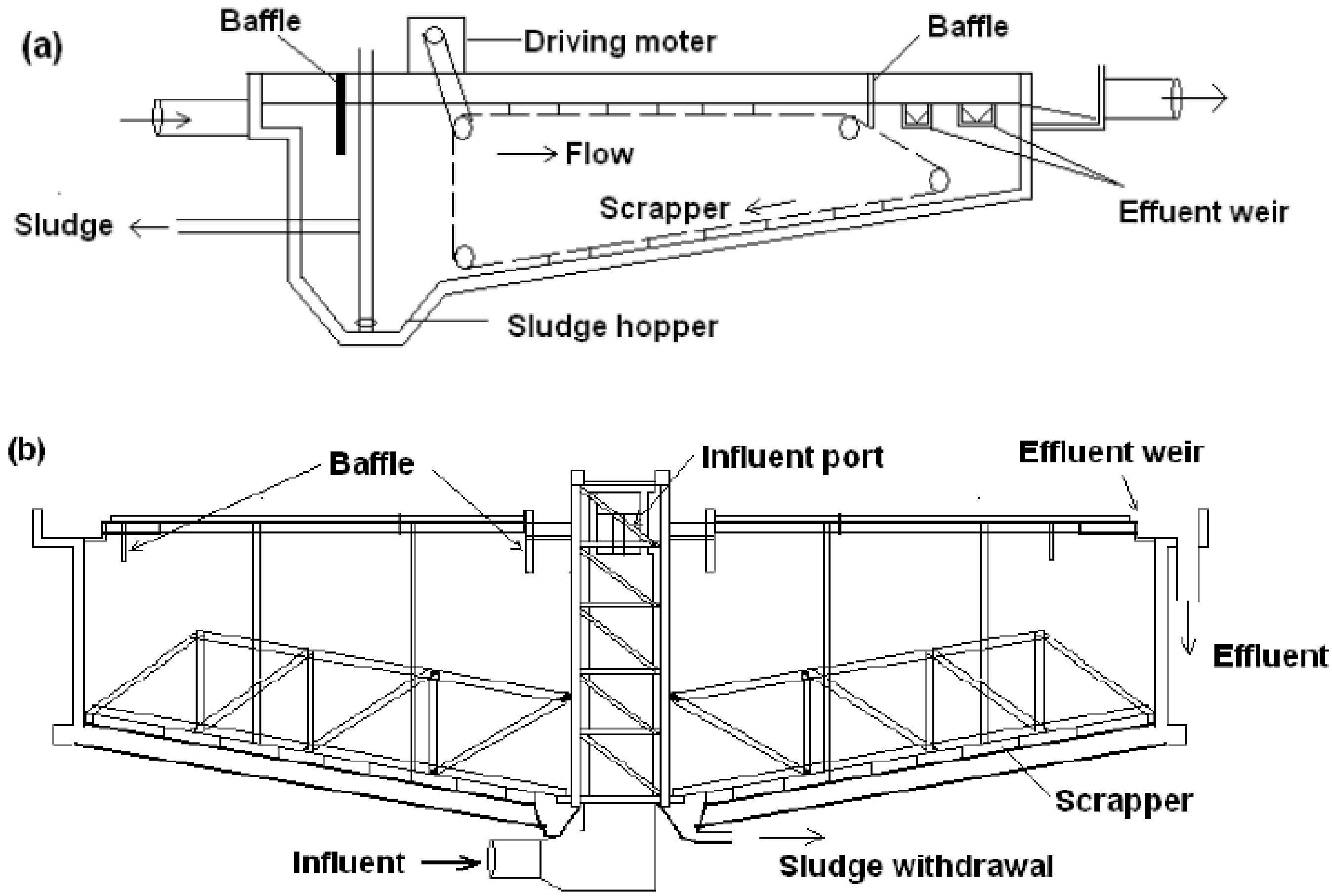


Figure (a) Rectangular and (b) Circular primary sedimentation tank

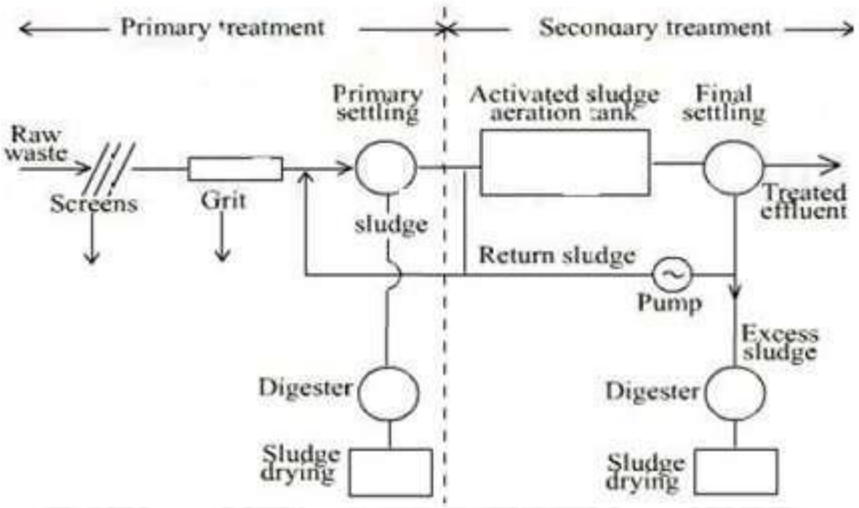
The scrapper velocity of 0.6 to 1.2 m/min (0.9 m/min typical) is used in rectangular tank and flight speed of 0.02 to 0.05 rpm (0.03 typical) is used in circular tank.

The detention time in PST could be as low as 1 h to maximum of 2.5 h. providing detention time of 1.5 to 2.5 h at average flow is a common practice. To avoid resuspension (scouring) of settled particles, horizontal velocities through the PST should be kept sufficiently low.

5.1.1 ACTIVATED SLUDGE PROCESS

The most common suspended growth process used for municipal wastewater treatment is the activated sludge process as shown in figure

Flow sheet of an activated sludge system



Activated sludge plant involves:

1. Wastewater aeration in the presence of a microbial suspension,
2. Solid-liquid separation following aeration,
3. Discharge of clarified effluent,
4. Wasting of excess biomass, and return of remaining biomass to the aeration tank.

In activated sludge process wastewater containing organic matter is aerated in an aeration basin in which micro-organisms metabolize the suspended and soluble organic matter. Part of organic matter is synthesized into new cells and Part is oxidized to CO_2 and water to derive energy. In activated sludge systems the new cells formed in the reaction are removed from the liquid stream in t he form of a flocculent sludge i n settling tanks. A part of this settled biomass, described as activated sludge is returned to the aeration tank and the remaining forms waste or excess sludge.

Activated Sludge Process Variables

The main variables of activated sludge process are the mixing regime, loading rate, and the flow scheme.

Mixing Regime

Generally two types of mixing regimes are of major interest in activated sludge process: plug flow and complete mixing.

In the first one, the regime is characterized by orderly flow of mixed liquor through the aeration tank with no element of mixed liquor overtaking or mixing with any other element. There may be lateral mixing of mixed liquor but there must be no mixing along the path of flow.

In complete mixing, the contents of aeration tank are well stirred and uniform throughout. Thus, at steady state the effluent from the aeration tank has the same composition as the aeration tank contents.

The type of mixing regime is very important as it affects

1. Oxygen transfer requirements in the aeration tank,
2. Susceptibility of biomass to shock loads,
3. Local environmental conditions in the aeration tank, and
4. The kinetics governing the treatment process.

Flow Scheme

The f low scheme involves:

1. The pattern of sewage addition
2. The pattern of sludge return to the aeration tank and
3. The pattern of aeration.

Sewage addition may be at a single point at the inlet end or it may be at several points along the aeration tank. The sludge return may be directly from the settling tank to the aeration tank or through a sludge reaeration tank. Aeration may be at a uniform rate or it may be varied from the head of the aeration tank to its end.

Sludge characteristics

By analyzing the different characteristics of the activated sludge or the sludge quality, plant operators are able to monitor how effective the treatment plant's process is. Efficient operation is ensured by keeping accurate, up-to-date records; routinely evaluating operating and laboratory data; and troubleshooting, to solve problems before they become serious.

5.1.2 EXTENDED AERATION SYSTEM

It is an innovative activated sludge process using extended retention of biological solids to create an extremely stable, easily operated system. The capabilities of this unique technology far exceed ordinary extended aeration treatment. The process maximizes the stability of the operating environment and provides high efficiency treatment. The design ensures the lowest cost construction and guarantees operational simplicity. The system utilizes a longer sludge age than other aerobic systems. Sludge age, also known as SRT (Solids Retention Time) or MCRT (Mean Cell Residence Time), defines the operating characteristics of any aerobic biological treatment system. A longer sludge age dramatically lowers effluent BOD and ammonia levels, especially in colder climates.

The systems long sludge age process produces BOD levels of less than 10 mg/L and complete nitrification (less than 1 mg/L ammonia). Minor modifications to the system will extend its capabilities to denitrification and biological phosphorus removal.

System Construction

A major advantage of this system is its low installed cost. Most systems require costly in-ground concrete basins for the activated sludge portion of the process. This system can be installed in earthen basins, either lined or unlined. The fine bubble diffusers require no mounting to basin floors or associated anchors and leveling. These diffusers are suspended from the Bio-Flex floating aeration chains. The only concrete structural work required is for the simple internal clarifier(s) and blower/control buildings.

Aeration System Components

The ability to mix large basin volumes using minimal energy is a function of the uniqueBioFlex moving aeration chains and the attached BioFuser fine bubble diffuser assemblies. The gentle, controlled, back and forth motion of the chains and diffusers distributes the oxygen transfer and mixing energy evenly throughout the basin area. No additional airflow is required to maintain mixing.