Sewage Treatment - Physical & Physicochemical Treatments

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1. Introduction: Sewage, Sewage treatment & Need of Sewage treatment

Sewage is the liquid waste generated from cities. It includes kitchen & bathroom waste, discharges from latrines, urinals, floors & street washings, lawn watering and liquid wastes generated from commercial establishments. Sewage is extremely putrescible. It's decomposition leads to production of large amount of foul gases and growth of microbial mass, specially of pathogenic nature.

Contaminants present in sewage may be classified in different categories. These are large floating, suspended and dissolved solids of organic or inorganic nature. Organic solids are of particular importance as their decomposition leads to evolution of foul smells, growth of micro-organisms, anaesthetic look to rivers or water bodies and many more environmental implications. Besides the solids, sewage may contain other impurities like oil and greasy material, chemicals, heavy metals (particularly, if industrial effluents are also disposed off in public saver system), chlorides, sulphates, phosphates and nitrogen compounds etc.

If the sewage is disposed off in water bodies such as rivers and lakes or discharged on to land, it leads to many environmental implications such as formation of sludge banks in the river at the point of confluence of sewage drain with river, ugly look to river water, reduction in dissolved oxygen of river water, growth of disease causing microorganisms, direct deletrous effect of chemicals on aquatic culture, corrosion of river structures such as, bridge piers, water intake structures etc., and over all change in flora and fauna of the water body.

The proper treatment is to be given to sewage prior to its disposal in any of the receiving systems (rivers, lakes, land). Bureau of Indian Standards (BIS) has specified the permissible standards of disposal of treated wastes in different disposal systems in form of IS codes. These are:

a) IS 4764-1973: specifies permissible standards of disposal for treated domestic waste i.e. sewage in surface water.

b) IS 2490-1974 specifies permissible standards for disposal of treated industrial wastes in surface waters
c) IS 3307-1965 gives the permissible standards for disposal of treated waste waters on to the land
d) IS 3306-1974 gives permissible standards for disposal of industrial effluents in public sewers.

These permissible standards are supposed to be national guidelines for guiding the various State Pollution Control Boards for prescribing their legal enforceable standards, depending upon the water quality and dilution available in their respective surface water sources and the type of effluents produced by the different industries.

1.2 Treatment of sewage: Physical, Physico Chemical & Biological Treatment

Sewage it normally treated for larger floating substances, inorganic silt or grit, oil and greasy material and for removal of organic solids of suspended and dissolve forms. Certain industrial effluents however are treated for specific type of pollutants present in effluent. For example, Electroplating industry effluents are treated for heavy metals such as Zinc, Nickel, Copper, Cadmium, Silver, Cyanides and acids. Chemical industry effluents are treated for chemicals. Fertilizer effluents are principally treated for N, P, K and Paper industry effluents are treated for chemicals, BOD and fibrous solids etc.
All effluents, domestic or industrial can be treated in broad three categories of treatment processes. These are:

a) Physical Treatment - Screens, Grit removal, oil & Grease removal
b) Physico Chemical - Co-agulation and flocculation, chemical treatment, neutralization etc.
c) Biological Treatment - Aerobic and anaerobic processes such as ASP, Trickling filters, oxidation ponds, Aerobic filters, SAFF, UASBR, etc.

2. Processes for treatment of Sewage

The sewage conventionally is not treated by physico-chemical processes. It is treated by physical and biological treatment processes. The treatment further can be classified in three categories. These are;

a. Preliminary treatment (Physical treatment)

The units involved are: Screens or Screening chamber, Grit chamber, Skimming tank.

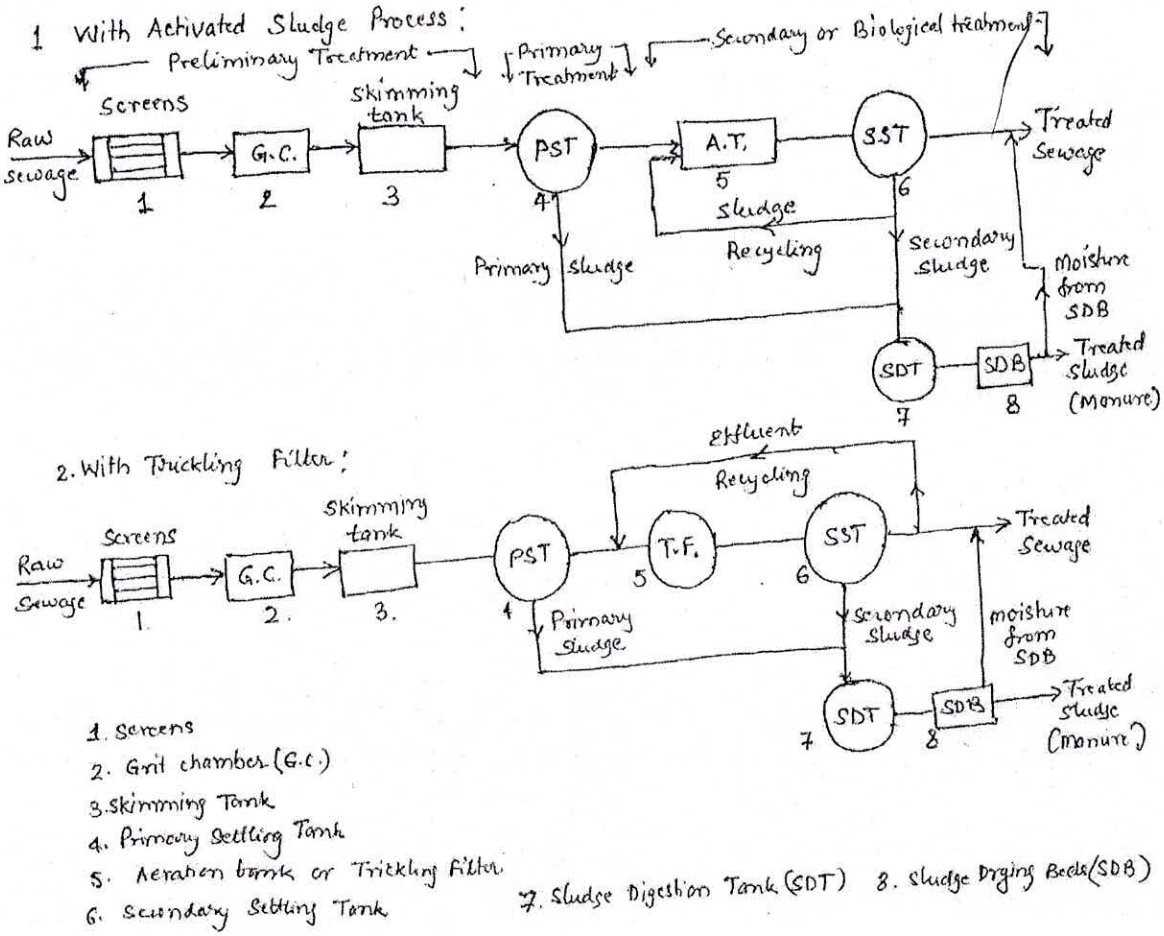
b. Primary Treatment (Physical Treatment)

The unit provided is Primary Settling Tank (Primary Sedimentation Tank)

c. Secondary Treatment (Biological Treatment)

The units provided are Activated Sludge Process or Trickling Filter followed by Secondary Settling Tank, Sludge Digestion Tank, Sludge Drying Beds (Physical treatment).

3. Process flow chart of a conventional waste water/sewage treatment plant



4. Description of Treatment Units

a) Screens or Screening chamber: Screens are provided for removing larger floating substances such as vegetable debris, wood or paper pieces, dead animal parts, plastic or polythene etc. from the waste. Screens are provided in form of inclined parallel bars across the flow in a chamber. The flow velocity through the screens is reduced to design velocity of .8 to 1.0 m/sec. Screens are coarse, medium or fine type. Usually medium screens of spacing between 30-50 mm are provided at an inclination

of 40-60°. The screens are cleaned manually or mechanically. The material retained on screens is disposed off by dumping or incineration.

b) **Grit Chamber:** Grit chamber is provided for removing suspended inorganic silt or grit of size .2 mm or more. Grit chamber is a rectangular channel provided with some velocity control device, where the flow velocity is reduced. This reduces turbulence in the flow and helps in easy sedimentation of grit. Settled grit is removed from the bottom of Grit Chamber and is disposed off by dumping or land filling. Grit Chambers are designed for 40 to 60 sec of detention time and .3 m/sec of horizontal velocity. The outlet of the chamber is usually provided with proportional flow weir as a velocity control device. Parshal flume is another type of velocity control device provided in Grit chamber.

c) **Skimming Tanks:** Oil & Greasy material present in sewage is removed in skimming tank. These tanks work on the principle of air floatation or dissolved air floatation. In air floatation process the sewage is detained in a rectangular tank for a period of approximately 3 minutes. The oil and greasy material, being lighter than sewage floats on surface and forms a layer which is called 'scum'. The scum is skimmed off from the top and treated sewage outflows from the bottom of tank.

Dissolved air floatation process is an improvement over simple floatation process in which compressed air is diffused in the skimming tank from the bottom. The air bubbles rise up in the tank, absorbing the oil and greasy material on their surfaces and carry the oil and greasy material to the surface, resulting in increased efficiency of process.

d) **Primary Treatment:** This process is provided for removing finer suspended inorganic matter and larger suspended organic matter from the sewage. The process works on the principle of sedimentation given by stokes law, which gives settling velocity of spherical particles in the form

i. $$V_s = \frac{\gamma_s - \gamma_w}{18\mu} \cdot d^2$$ ii.

where, V_s is the setting velocity in m/sec.
γ_s is the specific weight of solid particles
γ_w is the specific weight of water
and d is the diameter of settling particles in m. The settling is effective when larger detention time (2-4 hrs) is provided in the tank and horizontal velocity is reduced significantly to .3 m/minute.

The Primary treatment unit provided is called Primary Settling Tank or Primary Sedimentation Tank. Primary settling tanks are provided either in rectangular plan or

circular in plan shapes. In rectangular in plan shap the sewage is fed at inlet end of the tanks and outflows from the outlet end. Length to breadth ratio in the tank is generally kept between 2:1 to 4:1 and depth of tank is kept between 3-4.5 m. To avoid short circuiting of contents of sewage in Primary settling tank, inlet is provided with a inlet baffle wall and outlet is provided with weir.

In circular in plan Primary settling tank in the tank, the sewage is centrally fed through a central column or shaft. The sewage outflows radically from the tank. The circular periphery of tank is provided with weir to collect the effluent for further treatment. The diameter of circular tank is kept less than 60 m. If diameter required for the tank is larger than 60 m, two circular tanks in parallel are provided.

The sludge produced in primary treatment is obnoxious and therefore is further treated in anaerobic sludge digestion tank in combination with the sludge produced from secondary settling tank of biological treatment system.

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