Sewage Treatment - Biological Treatment

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1. **Introduction**: Primary treatment of sewage removes 60 to 65% of suspended solids and 30-35% of BOD*. Though some fraction of Solids and BOD is also removed in preliminary treatment units, that is not accounted for in the design of further treatment units (Primary or secondary units). Primary treatment removes most of suspended inorganic solids and part of organic suspended solids. The remaining organic solids (finer suspended and dissolved) are removed in secondary or biological treatment unit.

   The objective of biological treatment is to coagulate the fine and dissolved organic matter by the biological action of micro-organisms (principally the bacteria). Bacteria metabolizes the organic substance and stabilizes it by oxidation or reduction and cellular synthesis. In fact about half of the organic matter is oxidized reduced by bacteria for release of energy for their survival. This oxidation or reduction of organic matter loads to its final conversion in form of stable end products. Rest half of the organic matter is utilized in formation of new cell mass (Cellular synthesis). This cell mass is separated from the sewage in secondary settling tank in the treatment plant. Biological treatments are classified in two classes; Aerobic and Anaerobic. In aerobic treatment, the treatment occurs in the presence of air. The stable and products formed in this process are Carbondioxide, water, nitrates, sulphates and phosphates. In case of anaerobic treatment oxygen is absent and the products methane, carbondioxide, ammonia and water are formed.

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*BOD: Organic matter concentration in sewage or wastewater is best expressed by BOD (Biochemical Oxygen Demand) though other parameters such as COD (Chemical Oxygen Demand), TOC (Total Organic Carbon), and ThOD (Theoritical Oxygen Demand) are also used for expressing organic solid concentration. Organic matter present in sewage is of two categories: biodegradable and non biodegradable. Biodegradable organic matter is of more concern because of it not removed, it undergoes decomposition resulting in production of foul gases and growth of micro-organisms in water thus polluting water bodies. Non-biodegradable fraction is not so important as it is not attacked by micro-organisms and hence does not decompose. The non biodegradable fraction of sewage may be left untreated.
BOD reflects the concentration of bio-degradable organic substance. It is defined as the oxygen required by micro-organism (bacteria) for decomposition of organic matter under aerobic conditions. Usually 5 day BOD at 20°C temperature is the standard BOD value taken for sewage.

2. Aerobic Biological Treatment Processes

Aerobic treatment processes occur in the presence of oxygen. The oxygen can be fed in the process by compressed air diffusion or by absorption of atmospheric oxygen by agitation of the sewage mass. The agitation is provided by mechanical aeration systems or also known as surface aeration systems.

Following are the Aerobic treatment units which are employed in treatment of sewage:

- Activated Sludge Process or its modifications
- Trickling filters
- Biotowers
- Rotating Bed Contactors (RBC)
- Submersed Aerated Fixed Film (SAFF) reactors
- Fluidized Bed Reactors (FBR)
- Oxidation/Stabilization ponds
- Aerobic Lagoons

3. Anaerobic Biological Treatment Processes

The stabilization of organic substance present in sewage can also be achieved by anaerobic treatment of sewage. These processes occur in absence of oxygen. The following anaerobic treatment units are commonly used:

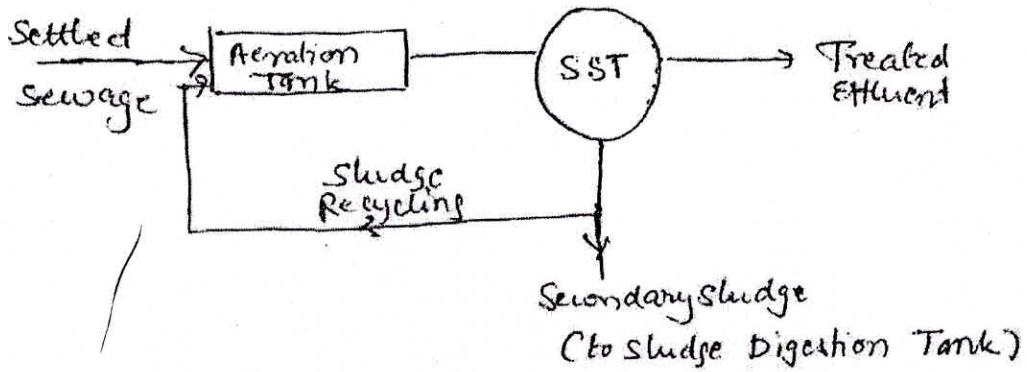
- Anaerobic ponds / Lagoons
- Anaerobic filters
- Upflow anaerobic sludge blanket reactors (UASBR)
- Sludge digestion tanks

4. Biological Treatment Processes adopted in Conventional Sewage Treatment

In a conventional sewage treatment activated sludge process or trickling filters are the most common processes adopted. These are aerobic biological treatment units. However, anaerobic treatments units such as UASBR is also being adopted in recent past.

a) Activated sludge Process (Aerobic Suspend Growth System)

The hydraulic flow chart of an ASP is shown below:



In activated sludge process, the settled sewage from primary settling is fed in to aeration tank, where it is kept in contact with bacteria recycled from secondary sludge. Atmospheric air or compressed air is introduced in the tank by mechanical agitation at the surface or by diffusion at the bottom. The bacterial mass stabilizes organic matter. The stabilized mass which is mostly the bacterial cells, is separated in secondary settling tank. Certain factors such as MLSS (mixed liquor suspended solid) concentration, hydraulic retention time (HRT), Food to microorganism ratio (F/m ratio), Mean cell residence time or Solid Retention Time (SRT) effect the efficiency of treatment in activated sludge process.

Some modified forms of activated sludge process are also in common use. These are:

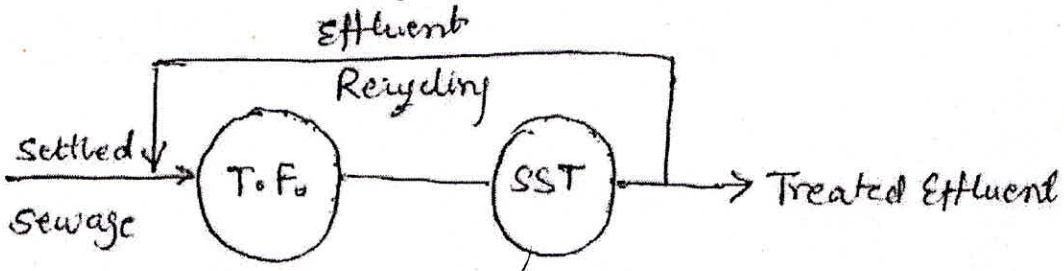
- Tapered Aeration ASP
- Step Aeration ASP
- Complete mix ASP
- Contact Stabilization ASP
- Extended Aeration ASP

Extended aeration ASP, which is mostly used, differs from conventional ASP in respect of extended hydraulic retention time, higher solid retention time, lower food to micro organism ratio and lager MLSS concentration.

b) Trickling filters (Aerobic attached growth systems)

Sewage filteration is another option for aerobic biological treatment of sewage where the settled sewage is filtered through a bed of granular medium. Trickling filters are used for this purpose. Sewage is applied over the granular surface of filter through sewage distribution arms. The organic matter of percolating sewage is caught (adsorbed) by bacterial mass growing on the surface of the granular medium, and is stabilized (oxidized). The bacterial mass later on gets detached from the granular surfaces and flows down to the under drainage system provided

for collection of effluent. The effluent is taken to secondary settling tank, where cell mass is removed from the sewage in form of secondary sludge from filter. Hydraulic flow chart of Trickling filters is shown below:



A distinguishing feature of trickling filter from ASP is, that a part of treated effluent from secondary settling tank is recycled back into the filter whereas, a part of secondary sludge is recycled back in aeration tank in ASP.

c) Upflow Anaerobic Sludge Blanket Reactor (UASBR) (Anaerobic Suspended Growth System)

Anaerobic treatments are more commonly used in industrial effluent treatment. In UASBR the sewage upflows in a closed tank after being fed at bottom through a system of pipe laterals for homogenous feeding. Bacterial mass produced by anaerobic decomposition forms a blanket of sludge (thicker zone of cell mass) which absorbs the organic mass of incoming sewage more effectively and stabilizes it. Anaerobic treatment units usually give lesser efficiency of treatment in comparison to aerobic treatment systems but increased hydraulic retention time (HRT) reduces the size of anaerobic treatment unit. However for meeting the desired standards of treated sewage disposal, aerobic treatment follows anaerobic treatment in most of the cases.

Sludge Digestion Tank (Anaerobic Biological Treatment)

The sludge generated in primary and secondary setting tank is again of foul nature. This is further given biological treatment, more commonly in anaerobic sludge digestion tank. These tanks are circular in shape provided with a cap at the top for collecting biogas (Methane) generated in the process. Sludge fed in digestion tank is decomposed by anaerobic bacteria and result in formation of digested sludge. The digested sludge is further sent to sludge drying beds (SDBS) for removing the moisture content of digested sludge. Supernatant from the tank is recycled back is to the treatment system with raw sludge.

REFERENCES:

1. 'MANUAL ON WASTEWATER TREATMENT' published by Ministry of Urban Development.
2. 'WASTEWATER ENGINEERING: TREATMENT DISPOSAL AND REUSE' by 'Metcalf & Eddy Inc., Tata McGraw-Hill, publication.