AI 3010 WASTE AND BY PRODUCT UTILIZATION

UNIT I NOTES

Effluent treatment

The effluent treatment facility is installed for biological treatment of the effluents. The effluent bears large amounts of organic matter. The direct discharge of the effluent into the water bodies causes depletion of DO of the water. Hence, in order to meet the recommended standards of quality of the effluent, it is necessary to treat the effluent before it is finally disposed off. This treatment facility provides for removal of major pollutants from the effluent.

Treatment process

Process Concept

The raw effluent, bears large amount of suspended solids and oxygen consuming organic matter. The conceptual approach of the treatment includes the removal of suspended particles, dissolved organic matters and handling of sludge for disposal.

The heart of this treatment scheme is the aerobic biological reactor, which are designed on the basis of activated sludge process. The activated sludge treatment process basically involves the stabilization of organic matter by the action of various microorganisms as depicted in the following equation.

Organic + Microorganisms + Oxygen + Nutrients = New cells + Carbon dioxide + Ammonia + Energy

This could be restated in engineering term as- Waste + Sludge + Air – Surplus Sludge + End products

In this biological process, a part of the newly synthesized sludge undergoes oxidation called, Endogenous respiration.

Cells + oxygen – End products + Less cells

The preformed biological flocks (MLSS) come in contact with the incoming waste in the aeration tank under highly aerobic environment and oxidize the organic matter to more stable materials. The efficiency of the system mainly depends upon the concentration of active microorganism present to perform the assimilation of organic matter. The activated sludge, in general, consists bacteria and protozoan, rotifers etc in the presence of DO. The desirable environmental condition like sufficient DO, substrate and nutrients are required for cell growth and energy for various metabolic functions. It is essential that the biological flock should readily separate from the treated wastewater in the final clarifier.

The oxygen supply is required for the following:

- Oxidation of organic matter (substrate removal)
- Endogenous respiration of microorganisms.
- Nitrification - Nitrification generally begins after carbonaceous demand is satisfied.

Excess or deficient quantity of food (incoming BOD) adversely affects the physical quality of biological sludge. The activated sludge system is designed on the basis of a particular food to microorganism ratio. This ratio is in practice indicated by the quantity of BOD in influent per unit quantity of mixed liquor suspended solids per unit time. This may be expressed as kg, BOD/kg, MLSS/day. The volatile suspended solid, which repression is between 60 – 70% of MLSS is used as a measure of active cells in the system. The optimal pH for an active biological aeration system is between 6.5 – 9.0.
In the aeration tank required MLSS concentration is maintained by recirculating the biological solids separated in the final clarifier. The surplus biological sludge (and the sludge from the secondary clarifier) needs further dewatering, which is achieved in sludge drying beds. The final effluent is suitable for discharging into the inland surface water.

Process Units

This effluent treatment facility consists of the following units:

1. Storage tank
2. Equalization tank
3. Neutralization tank
4. Primary clarifier
5. Anaerobic Hybrid Reactor
6. Aeration tanks – 1 & 2
7. Final clarifier
8. Sludge drying beds

Unit Description And Operation

1) Storage Tank- The function of storage tank is to collect and store the raw effluent from different parts of factory.

Process: The raw effluent is collected from the different part of the factory and stored. From the storage tank the raw effluent is passed to the equalization tank with the help of pump. The pH of the raw effluent in the storage tank is 5.5 – 6.5.

2) Equalization Tank - The function of equalization tank is to equalize the raw effluent emanating from different processing units.

Process: The effluent is collected in an existing combined effluent from where it is pumped to the existing aeration tank, which serves as an equalization tank. The floating aerator is operated to homogenize effluent which is then pumped to the neutralization tank.

3) Neutralization Tank- The function of the neutralization tank is to neutralize the raw effluent, which is generally acidic in nature.

Process: The raw effluent, which is usually acidic (pH-5.5 to 6.5) in nature is neutralized by adding the saturated solution of NaOH, So, the final pH of the neutralization tank is adjusted to pH- 8.0 to 9.0. Then the raw effluent after has been treated in neutralization tank is allowed to pass in the primary clarifier through gravity.

4) Primary Clarifier - The function of PC is to remove suspended heavy particles from the raw effluent.

Process: In this tank, the heavy particles along with the sludge, which the bacteria have degraded settles down at the bottom of the tank and the water flows on top of it. A rotator is fixed in the middle of the tank, so that the heavy particle along with the sludge which has settled down does not block the outlet of the PC. In this tank, mostly the inactive heavy particles along with little amount of sludge is thrown out in the Sludge drying beds. The pH of the PC is maintained to 7.0 to 8.0.

5) Anaerobic Hybrid Reactor - This unit is provided for the anaerobic treatment of the effluent.

Process - The effluent after treatment in PC is passed to the AHR through gravity. The design of the AHR is in a way that at the bottom of this tank anaerobic bacteria's beds are made. The effluent which comes from PC react with the anaerobic bacteria and the break up of organic compounds takes place with the production of Methane gas which can be seen in the form of bubbles on the upper layer of the water in the tank. The pH of the AHR is maintained to 7.0-7.5 because the anaerobic bacteria are stable in this pH. If there is much fluctuation in the pH of this tank the anaerobic bacteria can die.

6) Aeration Tanks 1 & 2 – This unit is provided for aerobic biological treatment of the effluent for the reduction of organic matter in the effluent.

Process: The effluent from the AHR is received in the aeration tank stage-1 by pumping and is aerated by the help of mechanical surface aerators in the presence of previously developed biological sludge (Mixed Liquor Suspended Solids i.e. MLSS). The food / microorganism ratio is maintained at about 0.6 and 0.137 in the first and second stage aeration tanks respectively which correspond to about 3500 mg / ml.

Operation - The start up of the activated sludge process can be accomplished by using seed sludge available from night soil develop a suitable microorganism population expressed as MLSS.

The following method is recommended for the initial development of MLSS in the aeration tank: –

The use of seed sludge (Night soil) provides the reliable means of start up. Seed sludge may be added in the aeration tank to provide approx. 500mg/ltr. MLSS. The tank is to be filled up with fresh water prior to the addition of seed sludge. The seed sludge is to be aerated by running both the aerators and be continued for at least 24 hrs in order to make the sludge into aerobic. With the seed sludge aerated, raw

effluent into the aeration tank is to be introduced at approx. 25% of the design flow. If possible, aeration must be continued by all aerators and feeding of effluent increased in daily increments of 25%. This enables the treatment process to produce a quality effluent as the MLSS concentration is increasing. During this operation the requisite quantity of nutrients in aeration tank is also added.

Required nutrients viz. N and P are added with aeration tanks by pumping a solution of Urea and DAP. The aerators also help to keep the biological solids in suspension. The mixed liquor from the aeration tanks is subjected to gravitational settling in the hopper bottom secondary clarifier.

7) Final Clarifier- The function of final clarifier is to separate biological solids from the mixed liquor first stage aeration tank.

Process : The mixed liquor from the first stage aeration tank is received in the clarifier by gravity. The clarifier is hopper bottom type. The sedimentation of sludge is withdrawn by pumps and is recirculated back into the aeration tank stage-1 for maintaining the MLSS. Provision is given to transfer the sludge into the stage-2 aeration tank through the necessary connections given on the delivery line of the sludge recirculation pump.

Operation - The clarifier is filled up with effluent by gravity. The biological solids get settled by gravity at bottom. The suctions valves corresponding to each hopper portion of clarifier are kept opened. The settled sludge is recirculated by operating pump back into the aeration tank continuously. If the MLSS exceed the required level, or sludge needs to be wasted, the sludge is diverted into aerobic.

Discharge Through V-Notch : The raw effluent, which has been treated through different process, lastly clarified, is now discharged into the water bodies through the V-Notch. This is a pipeline made which has a V shape ending and having a scale mark from which height and discharge of the effluent can be calculated. The following table shows the discharge through V- Notch.

8) Sludge Drying Beds- This unit is meant for dewatering and drying the excess biological sludge.

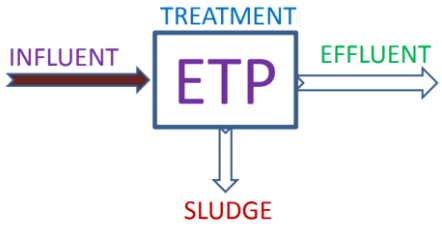
Process: The excess biological sludge from the stage-1 aeration tank after aerobic digestor is conveyed to the sludge drying beds by gravity. The excess sludge from the stage-2 aeration tanks is withdrawn to the sludge drying beds by pumping. Each bed comprises of coarse sand, broken stone. The dewatering of sludge is affected by percolation of associated water through the filter media while the sludge is retained on the media surface. The sludge over the media gets dried up by natural drying and removed manually for disposal as landfill. The percolated water is pumped to the aeration tank-2.

Operation - Allow the sludge to flow to the drying beds. Once the sludge thickness comes to about 300 mm charging of sludge is to be stop and the bed is isolated to dry up by natural evaporation. This takes about 10 days.

What is the difference between effluent and wastewater?

Effluent is sewage that has been treated in a septic tank or sewage treatment plant. It is also referred to as "trade effluent" or "wastewater." Effluent is waste other than waste from kitchens or toilets, surface water or domestic sewage. It can be produced and discharged by any industrial or commercial premise.

ETP (Effluent Treatment Plant) is a process design for treating the industrial waste water for its reuse or safe disposal to the environment. • Influent: Untreated industrial waste water. • Effluent: Treated industrial waste water. • Sludge: Solid part separated from waste water by ETP.



Treatment Levels & Mechanisms of ETP

• Treatment levels: ¬ Preliminary ¬ Primary ¬ Secondary ¬ Tertiary (or advanced)

• Treatment mechanisms: ¬ Physical ¬ Chemical ¬ Biological

Preliminary Treatment level Purpose:

Physical separation of big sized impurities like cloth, plastics, wood logs, paper, etc. Common physical unit operations at Preliminary level are:

Screening: A screen with openings of uniform size is used to remove large solids such as plastics, cloth etc. Generally maximum 10mm is used.

Sedimentation: Physical water treatment process using gravity to remove suspended solids from water.

Clarification: Used for separation of solids from fluids.

Primary Treatment Level Purpose:

Removal of floating and settleable materials such as suspended solids and organic matter.

• Methods: Both physical and chemical methods are used in this treatment level.

• Chemical unit processes: Chemical unit processes are always used with physical operations and may also be used with biological treatment processes. Chemical processes use the addition of chemicals to the wastewater to bring about changes in its quality. Example: pH control, coagulation, chemical precipitation and oxidation.

Chemical coagulation and Flocculation:

• Coagulation refers to collecting the minute solid particles dispersed in a liquid into a larger mass.

• Chemical coagulants like Al2 (SO4)3 {also called alum} or Fe2 (SO4)3 are added to wastewater to improve the attraction among fine particles so that they come together and form larger particles called flocs.

• A chemical flocculent (usually a polyelectrolyte) enhances the flocculation process by bringing together particles to form larger flocs , which settle out more quickly.

• Flocculation is aided by gentle mixing which causes the particles to collide.

Secondary Treatment Level Methods:

Biological and chemical processes are involved in this level. Biological unit process

To remove, or reduce the concentration of organic and inorganic compounds.

Biological treatment process can take many forms but all are based around microorganisms, mainly bacteria.

Aerobic Processes : Aerobic treatment processes take place in the presence of air (oxygen). Utilizes those microorganisms (aerobes), which use molecular/free oxygen to assimilate organic impurities i.e. convert them in to carbon dioxide, water and biomass.

Anaerobic Processes The anaerobic treatment processes take place in the absence of air (oxygen). Utilizes microorganisms (anaerobes) which do not require air (molecular/free oxygen) to assimilate organic impurities. The final products are methane and biomass.

Flowchart of ETP