IAT 03 SOLUTION

MIWWE 17CV71_ CIVIL 7TH SEMESTER 2020-21

Internal Assessment Test 3 – Dec. 2020

Sub:	Municipal & Industrial waste water Engineering					Sub Code:	17CV71	Branch:	CIVIL
Date:	14/12/20	Duration:	90 min's	Max Marks:	50	Sem/Sec	VII A & B		OBE

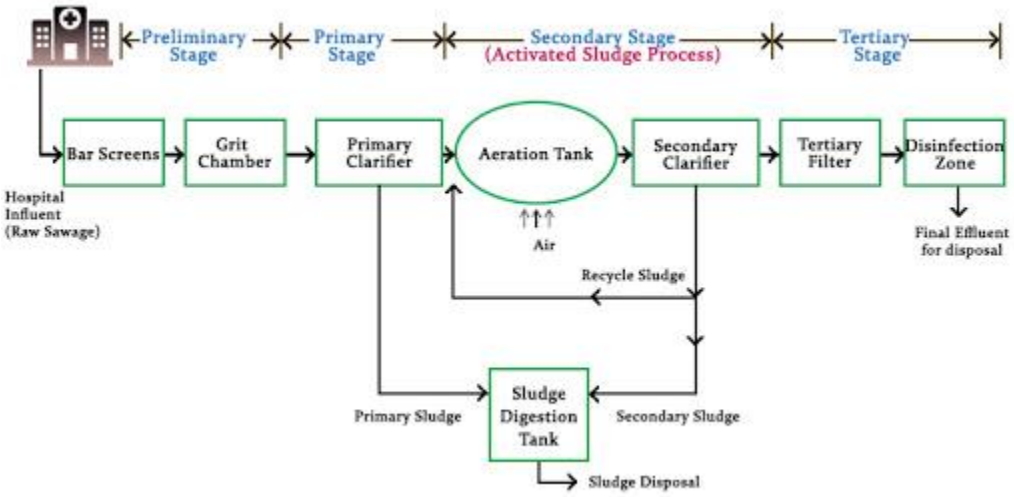
	Answer for any 50 marks	MARKS	CO	RBT
1	Explain with a flow diagram of conventional sewage treatment plant; discuss the function of each component.	[08]	CO3	L2
2	Explain F/M ratio and sludge volume index with significance in ASP.	[04]	CO3	L2
3	Rectangular sedimentation tank is used to treat 2MLD of sewage for a design period off 2.5 hours velocity of flow of 0.2 m/minute and effective depth of 3 meter. Determine: i) The length of the tank required ii) Width of the tank iii) Overflow rate of tank in $m^3/m^2/day$.	[08]	CO4	L2
4	What is meant by modification of ASP and list any four modifications explain anyone briefly	[04]	CO2	L2
5	With sketch explain grit chamber and skimming tank.	[04]	CO2	L2
6	Explain with flow diagram the working principle of conventional Trickling filter in sewerage treatment plant.	[08]	CO3	L2
7	Explain the problems associated with trickling filter operations and what are the remedial treatment for it.	[04]	CO3	L2
8	Define following terms with formulae: in ASP: i) Hydraulic Retention Time ii) Solid Retention Time(Mean Cell Residence Time) iii) Organic loading based on F/M ratio iv) Volumetric BOD5 loading.	[10]	CO4	L2

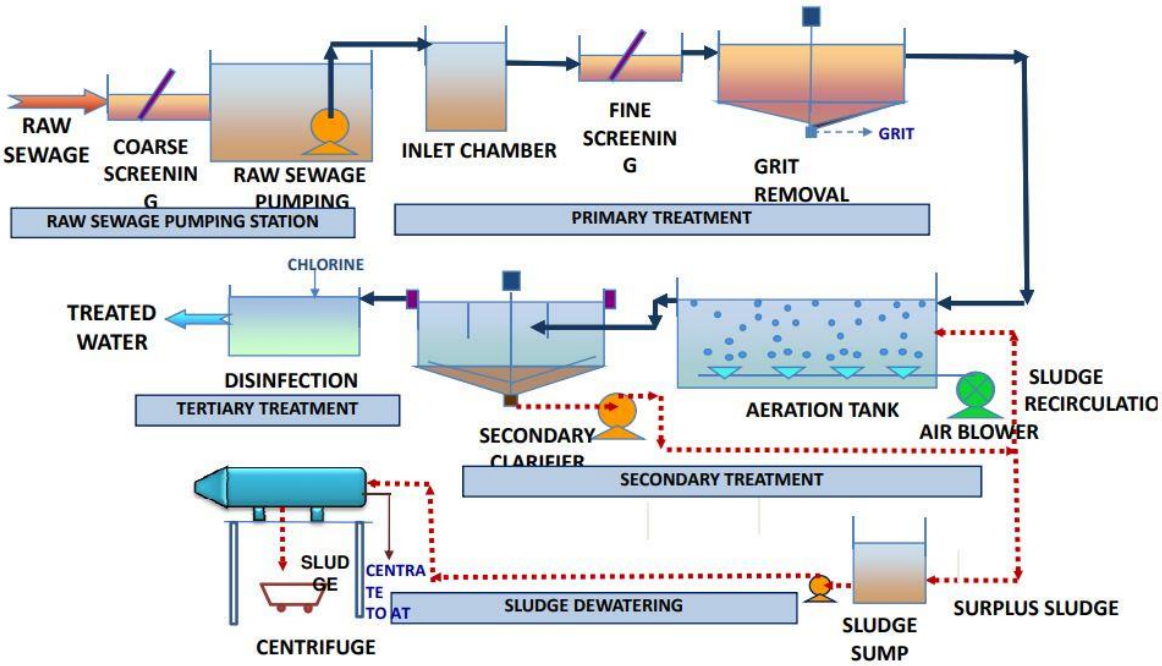
C I CCI

Solution Q.1

Sewage is 99 % water carrying domestic wastes originating in kitchen, bathing, laundry, urine and night soil. A portion of these goes into solution. The remaining goes into colloidal or suspended stages. It also contains salts used in cooking, sweat, bathing, laundry and urine. It also contains waterborne pathogenic organisms from the night soil of already infected persons.

Components of Sewage Treatment Plants • Pumping of Sewage • Primary Treatment • Secondary treatment . Tertiary treatment.





Pumping Station • Receiving Chamber • Coarse Screening • Wet Well (Raw Sewage Sump) • Pump House • Raw Sewage Pumps.

Primary Treatment • Fine Screening • Grit Removal • Primary Clarification.

The basic function of **wastewater treatment** is to speed up the natural processes by which **water** is purified. ... In the primary stage, solids are allowed to settle and removed from **wastewater**. The secondary stage uses biological processes to further purify **wastewater**. Sometimes, these stages are combined into one operation.

Sewage treatment is a multi-stage process designed to treat sewage and protect natural water bodies. Municipal sewage contains various wastes. If improperly collected and improperly treated, this sewage and its related solids could hurt human health and the environment. A treatment plant's primary objectives are to clean the sewage and meet the plant's discharge standards The treatment plant personnel do this by reducing the concentrations of solids, organic matter, nutrients, pathogens and other pollutants in sewage. The plant must also help protect the receiving water body, which can only absorb a certain level of pollutants before it begins to degrade, as well as the human health and environment of its employees and neighbours.

Q.2 SOLUTION: F/ M ratio: The **F/M ratio** is a process control number that helps you to determine the proper number of microorganisms for your system. ... Influent Flow into your activated **sludge** system (Flow MGD) Influent CBOD (mg/l) concentration into your aeration tank.

F:M ratio is a great tool for wastewater operators to make sure their bacteria population is being given the conditions needed for success. However many plants struggle with a low F:M Ratio. Having a low F:M ratio, means you have too many bacteria in your wastewater system relative to the incoming Biochemical Oxygen Demand (BOD). This causes starvation of healthy floc forming bacteria, and issues such as bulking, or high effluent Total Suspended Solids (TSS). Low F:M conditions also favor the growth of filamentous bacteria.

- Influent Flow into your activated sludge system (Flow MGD)
- Influent CBOD (mg/l) concentration into your aeration tank.
- Mixed Liquor Volatile Suspended Solids Concentration (mg/l)
- Volume (in gallons) of your aeration system

The term Food to Microorganism Ratio (F/M) is actually a measurement of the amount of incoming food (Lbs of Influent CBOD) divided by the Lbs of Microorganisms in your system. Some calculations also include the volume of activated sludge in your clarifiers, the one demonstrated here does not. If you have an activated sludge system, you should determine your F/M ratio regularly.

F= Influent Flow (MGD) X Influent CBOD Concentration (mg/l) X 8.34

M= Aeration System Volume (in Millions of Gallons) X MLVSS X 8.34

Sludge volume index: **Sludge Volume Index** (**SVI**) is used to describe the settling characteristics of **sludge** in the aeration tank in Activated **Sludge** Process. ... It is **defined** as 'the **volume** (in mL) occupied by 1 gram of activated **sludge** after settling the aerated liquid for 30 minutes'.

Sludge Volume Index, also known as SVI, describes how well the sludge from the aeration tank settles and compacts. It's a common test question on the operator exam, so be sure to absorb this information before your next test, Sludge volume index (SVI) is fairly easy and quick to perform, and can be obtained using data from laboratory tests and a simple math formula. Once you've solved a few problems, you'll get the hang of it.
In order to calculate sludge volume index (SVI), you will need two numbers. The first number comes from a 30-minute settleability test, where 1 liter of the mixed liquor sample from the aeration tank is poured into a container called a settleometer. The sludge is allowed to settle for 30 minutes, and the volume of the settled sludge is measured in mL/L.
The other number used in the sludge volume index (SVI) calculation comes from a MLSS test. It simply determines the suspended solids concentration of the sample from the aeration tank, in mg/L.

Q.3. SOLUTION:

Rectangular sedimentation tank is used to treat 2MLD of sewage for a design period off 2.5 hours velocity of flow of 0.2 m/minute and effective depth of 3 meter. Determine:
The length of the tank required ii) Width of the tank iii) Overflow rate of tank in $m^3/m^2/day$.

M3/day= sewage flow rate x population= 80% of water supply x pop.

CAPACITY REQUIRED: = detention period= 2 hours capacity= total sewage flowx 2/24= m3

Surface ares= sewage flow / over flow rate

Effective depth= capacity/ surface area

B XL = AREA m2.

L= 4X B

BX 4B= SURFACE AREA. B= AND L= can be calculated.

Q4 solution:

Modifications in **ASP** • In conventional **ASP** many **modifications** can be made both with respect to basin configuration, asrespect to basin configuration, as well as aeration techniques. 4. Tapered Aeration The tapered aeration **system** is similar to the conventional **activated sludge process.**

1. Modifications in ASP • In conventional ASP many modifications can be made both with respect to basin configuration, asrespect to basin configuration, as well as aeration techniques.
2. 3. Conventional ASP
3. 4. Tapered Aeration • The tapered aeration system is similar to the conventional activated sludge process. The major difference is in the arrangement of the diffusers. • The diffusers are close

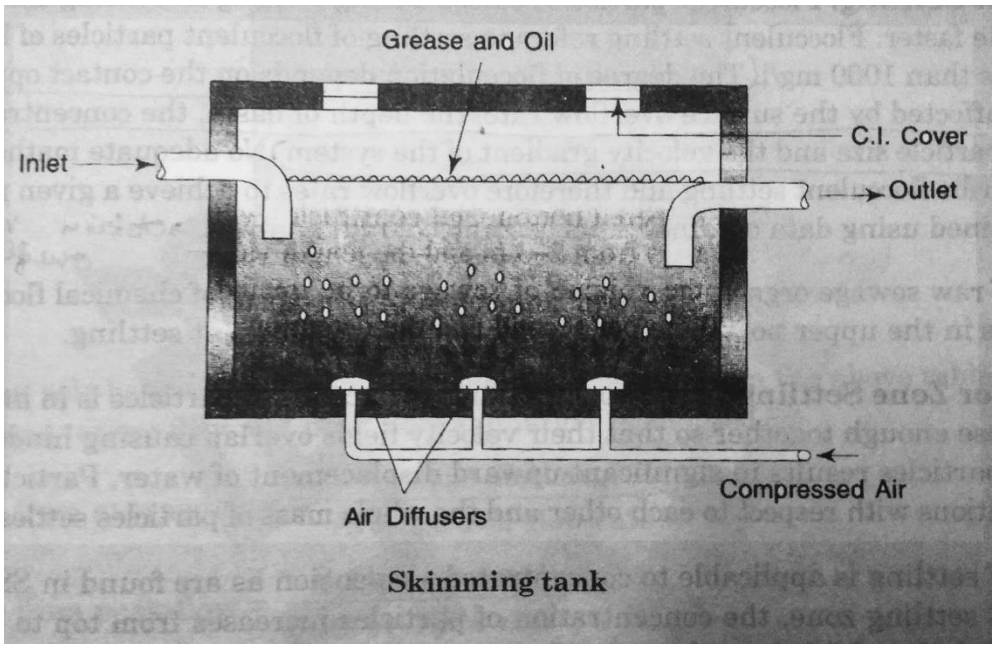
together at the• The diffusers are close together at the influent end where more oxygen is needed. • Toward the other end of the aeration basin, the spacing of the diffusers is increased.

4. 5. Step Aeration • In step aeration, the returned sludge is applied at several points in the aeration basin. • Generally, the tank is subdivided into three or more parallel channels with around-the-end baffles, and the sludge is applied at separate channels or steps. • The oxygen demand is uniformly distributed.

Aeration in an activated **sludge** process is based on pumping air into a tank, which promotes the microbial growth in the wastewater. The microbes feed on the organic material, forming flocks which can easily settle out. Aeration is the most critical component of a treatment system using the activated sludge process. A well designed aeration system has a direct impact on the level of wastewater treatment it achieves. An ample and evenly distributed oxygen supply in an aeration system is the key to rapid, economically-viable, and effective wastewater treatment**.**

The Membrane Aerated Biofilm Reactor is a game changer for wastewater treatment. Understand how to apply the MABR to reduce OPEX intensive biological treatment with smarter aeration.

Q 5. **skimming tank** is a chamber so arranged that the floating matter like oil, fat, grease etc., rise and remain on the surface of the waste water (Sewage) until removed, while the liquid flows out continuously under partitions or baffles.



Skimming tank

A skimming tank is a chamber so arranged that the floating matter like oil, fat, grease etc., rise and remain on the surface of the waste water (Sewage) until removed, while the liquid flows out continuously under partitions or baffles.

It is necessary to remove the floating matter from sewage otherwise it may appear in the form of unsightly scum on the surface of the settling tanks or interfere with the activated sludge process of sewage treatment. It is mostly present in the industrial sewage. In ordinary sanitary sewage, its amount is usually too small.

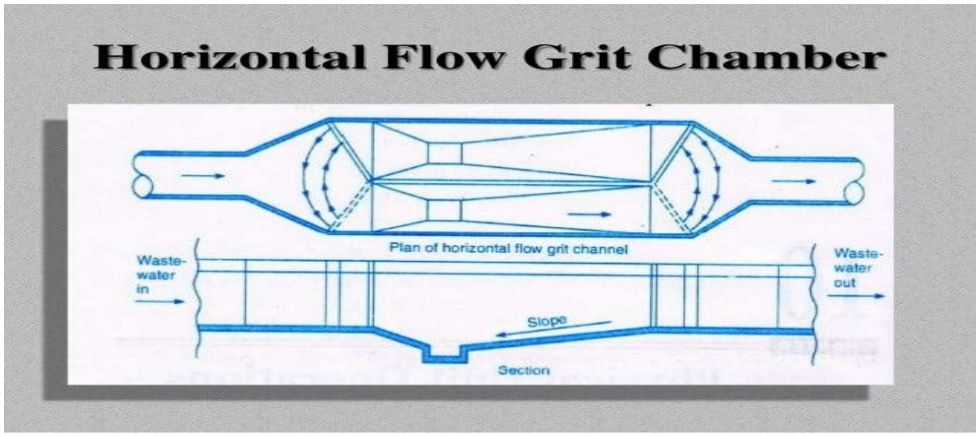
The chamber is a long trough shaped structure divided up into two or three lateral compartments by vertical baffle walls having slots for a short distance below the sewage surface and permitting oil and grease to escape into stilling compartments.

The rise of floating matter is brought about the blowing air into the sewage from diffusers placed in the bottom. Sewage enters the tank from one end, flows longitudinally and leaves out through a narrow inclined duct. A theoretical detention period of 3 minutes is enough. The floating matter can be either hand or mechanically removed.

Grease traps are in reality small skimming tanks designed with submerged inlet and bottom outlet (Fig. 5.12). The traps must have sufficient capacity to permit the sewage to cool and grease to separate. Frequent cleaning through removable covers is essential for satisfactory operation. Grease traps are commonly employed in case of industries, garages, hotels and hospitals.

GRIT CHAMBER DESIGN: OPERATIONS

Grit chamber is a long narrow or circular tank in the primary sewage treatment plant that is designed to reduce the velocity of the flow of sewage to eliminate the girt materials such as sand, ash and clinkers, eggshells, bone chips and many inert materials inorganic in nature.



Types of Grit Chambers

Major classification of grit chambers is made into 3 types-

1. Velocity controlled V-shaped long grit channels
2. Square shaped chambers with entry and exit on opposite sides and mild hopper
3. Vortex type cone and the centrifugal action plummets the grit to the bottom

Further depending upon the several factors such as the quantity and quality of grit to be handled, head loss requirements, space requirements, topography and economic considerations with respect to both capital and operating costs are divided into-

1. Mechanically Cleaned
2. Manually Cleaned.

Q.6 Solutions: Conventional Trickling Filters:

Trickling filter is an ***attached growth process*** i.e. process in which microorganisms responsible for treatment are attached to an inert packing material. Packing material used in attached growth processes include rock, gravel, slag, sand, redwood, and a wide range of plastic and other synthetic materials.

Process Description

- The wastewater in trickling filter is distributed over the top area of a vessel containing non-submerged packing material.
- Air circulation in the void space, by either natural draft or blowers, provides oxygen for the microorganisms growing as an attached biofilm.
- During operation, the organic material present in the wastewater is metabolised by the biomass attached to the medium. The biological slime grows in thickness as the organic matter abstracted from the flowing wastewater is synthesized into new cellular material.
- The thickness of the aerobic layer is limited by the depth of penetration of oxygen into the microbial layer.
- The micro-organisms near the medium face enter the endogenous phase as the substrate is metabolised before it can reach the micro-organisms near the medium face as a result of increased

thickness of the slime layer and loose their ability to cling to the media surface. The liquid then washes the slime off the medium and a new slime layer starts to grow. This phenomenon of losing the slime layer is called ***sloughing***.

- The sloughed off film and treated wastewater are collected by an underdrainage which also allows circulation of air through filter. The collected liquid is passed to a settling tank used for solid- liquid separation.

Types of Filters

https://nptel.ac.in/content/storage2/courses/105104102/images/images/flow-dia-TF_01.gif

Generally trickling filter design is based on empirical relationships to find the required filter volume for a designed degree of wastewater treatment. Types of equations:

1. NRC equations (National Research Council of USA)
2. Rankins equation
3. Eckenfilder equation
4. Galler and Gotaas equation

NRC and Rankin's equations are commonly used. NRC equations give satisfactory values when there is no re-circulation, the seasonal variations in temperature are not large and fluctuations with high organic loading. Rankin's equation is used for high rate filters.

Q.7 Solutions:Common operating problems

1. Filter Ponding

If the voids in the media get plugged, flow can collect on the surface in ponds. Excessive sloughing, excessive organic loading, non-uniformity in size of media and improper functioning of primary treatment units are its chief causes.Remedies

- Wash the filter surface with a stream of water under high pressure.
- Dose the filter with heavy applications of chlorine.
- Take the filter out of service for a period of one day or longer to allow it to dry out.

2. Filter Flies

primary nuisance insect- tiny, gnat-size filter fly, or Psychoda. Filter flies develop most frequently in an alternately wet and dry environment. remedies:

- Dose filter continuously, not intermittently.
- keep orifice openings clear
- apply insecticides to filter walls
- dose filter with chlorine
- keep weeds and tall grass cut around filter

3. Odours

The presence of “rotten egg” odour is an indication of anaerobic condition.Remedies

- Maintain aerobic conditions in all units, including settling tanks and waste water system.
- Recirculate to filters.

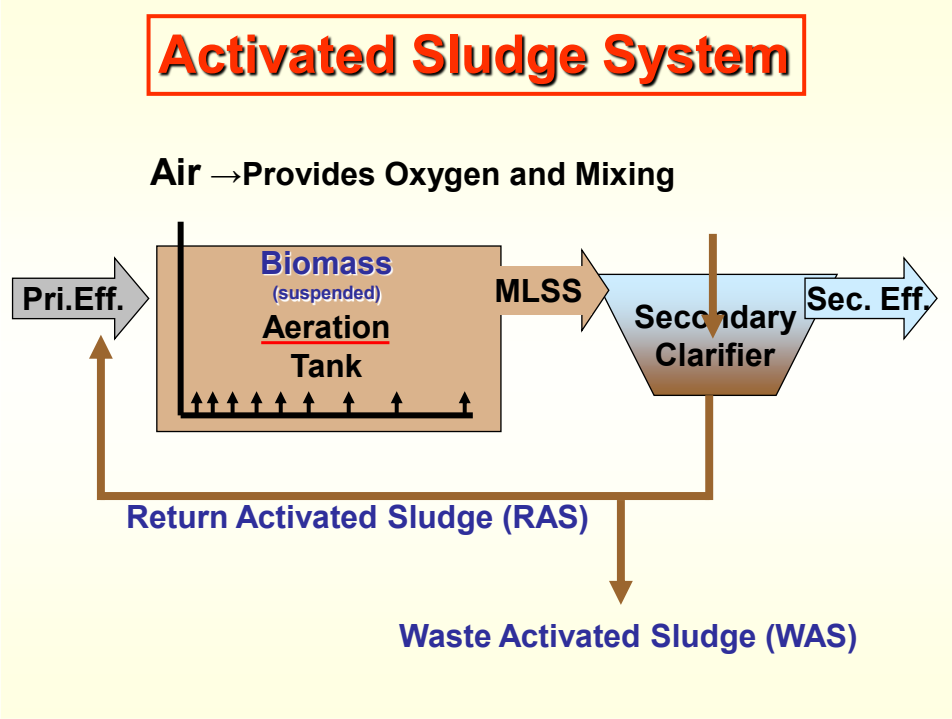
4. Icing for Filter Surface

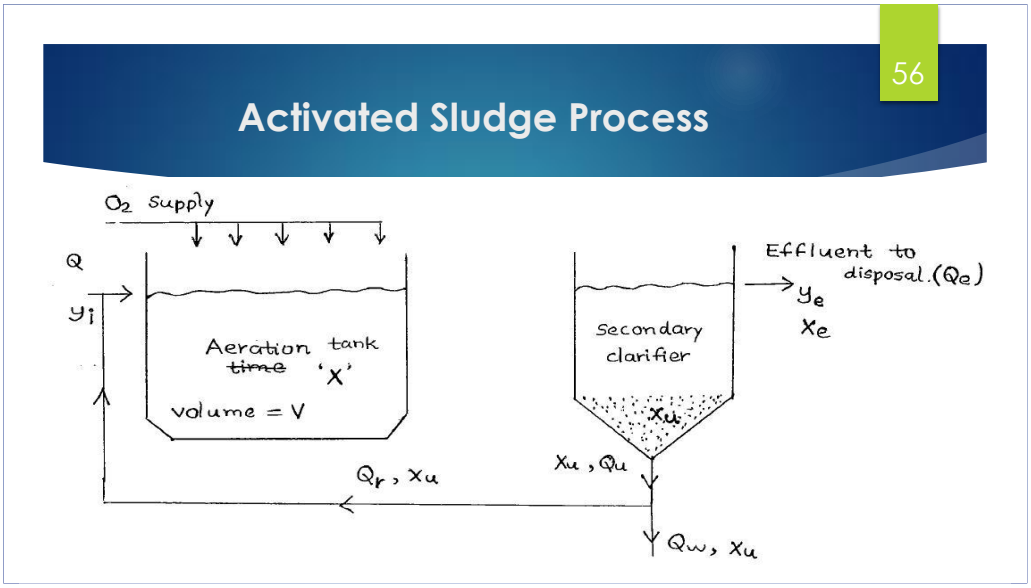
Cold weather not only reduces the efficiency of trickling filters by decreasing the activity of the microorganisms, but in severe cases actually can cause the wastewater to freeze on the medium surface.Remedies

- decrease recirculation to the filter (influent is usually warmer than recycled flows)
- construct wind screens
- operate two-stage filters in parallel rather than in series

Q.8 Define following terms with formulae: in ASP:
i) Hydraulic Retention Time ii) Solid Retention Time(Mean Cell Residence Time)
iii) Organic loading based on F/M ratio iv) Volumetric BOD5 loading.

Solutions:





≡ Let Q- waste wtaer flow rate, yi--- influent BOD (Si), V- volume of aeration tank (LBH) X- MLSS (Mixed Liquor Volatile Suspended Solids) or MLVS mixed liquor volatile suspended solids.

≡ Qe- flow rate effluent, Xe- MLSS in effluent Xe=0 If not given) ye- Effluent BOD (ye= 0 if not given) Qu=under flow rate (flow rate of sludge) Xu=MLSS under flow (MLSS in sludge) Qw- flow rate of waste sludge taken to treatment. Qr= flow rate of recycling sludge.

≡ **Design parameters of ASP:**

≡ **F/M ratio: F/M= mass of food applied per day/Mass of Microorganism**

≡ **F/M= Q. yi/V.xi : F/M : 0.2 per day to 0.4 per day.**

≡ **Sometimes F/M considered as the ratio of mass of food consumed to mass of micro organism: F/M= Q.(yi-ye)/V.x (10% change may be there in values)**

≡ **Aeration tank loading criteria: Four criteria's:**

≡ **1. HRT 2. Volumetric BOD loading 3. Organic loading based on food to MCOs ration (F/M) 4. Solid Retention Time (SRT)**

≡ **Hydraulic Retention Time: HRT (hours) = (V/QX1000) * 24.**

≡ **V= volume of aeration tank m3. Q-sewage inflow MLD (excluding sludge recycle)**

≡ **2. Volumetric BOD5 loading: BOD5 applied per unit volume of aeration tank. Expressed as under: (Volumetric load Kg BOD5/m3) = Q * La/V. Here La= influent BOD5 to aeration tank (mg/l)**

≡ **3. Organic Loading based on F/M ratio: microbial mass M. The organic loading rate is defined as the ratio of kg BOD5 applied per day to kg MLSS in aeration tank expressed as: F/M = Q . La/V/1000) Xt. Xt= Mixed liquor SS. (MLSS) Lower the F/M ratio=>higher BOD removal:**

End of the solution