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Internal Assesment Test -II–Dec-2021

Sub:	Municipal Waste Water Engineering					Sub Code:	18CV55	Branch:	CIVIL
Date:	20/12 / 2021	Duration:	90 min's	Max Marks:	50	Sem/Sec:	V		OBE

	Answer All Questions	MARKS	CO	RBT
1	Calculate the diameter and discharge in a sewer of circular sewer laid at a gradient of 1 in 500 when running half full. With the velocity of 2 m/sec. Use Mannings formula taking N=0.012	[10]	CO2	L3
2	Define BOD and Explain with a neat sketch, the salient features of oxygen sag curve	[10]	CO2	L2
3	Draw and explain briefly the flow Diagram of Municipal waste water treatment plant with their operation units	[10]	CO2	L2
4	Draw a neat diagram and explain grit chamber and skimming tank		CO3	L2
5	a. Define Deoxygenation constant b. Determine the 1 day BOD and ultimate first stage BOD for a wastewater whose 5 day 20^{o} C BOD is 200 mg/L. The reaction rate constant k (base e) = 0.23 per day		CO2	L3

1 Calculate the diameter and discharge in a sewer of circular sewer laid at a gradient of 1 in 500 when running half full. With the velocity of 2 m/sec. Use Mannings formula taking N=0.012

$$d = 0.5\,D \text{ and } \theta = 180^\circ$$

$$\therefore \quad a = \frac{1}{2} \times \frac{\pi}{4} D^2 = \frac{\pi}{8} D^2$$

$$p = \pi D \frac{\theta}{360^\circ} = \pi D \frac{180}{360} = \frac{\pi D}{2}$$

and $$r = \frac{\pi}{8} D^2 \times \frac{2}{\pi D} = \frac{D}{4}$$

Now $$v = \frac{1}{N} r^{2/3} s^{1/2}$$

$$\therefore \quad 2 = \frac{1}{0.012} \left(\frac{D}{4}\right)^{2/3} \left(\frac{1}{500}\right)^{1/2} = 1.4789\, D^{2/3}$$

From which $D = 1.573$ m

Hence $$Q = a \times v = \frac{\pi}{8} (1.573)^2 \times 2$$

$$= 1.942 \text{ cumecs}$$

2. Define BOD and Explain with a neat sketch, the salient features of oxygen sag curve

Biochemical oxygen demand or B.O.D. is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water or wastewater sample to break down organic material present in a given water or wastewater sample at certain temperature (200C) over a specific time period (5 days).

Oxygen Sag Curve:

The oxygen sag or oxygen deficit in the stream at any point of time during self purification process is the difference between the saturation DO content and actual DO content at that time.

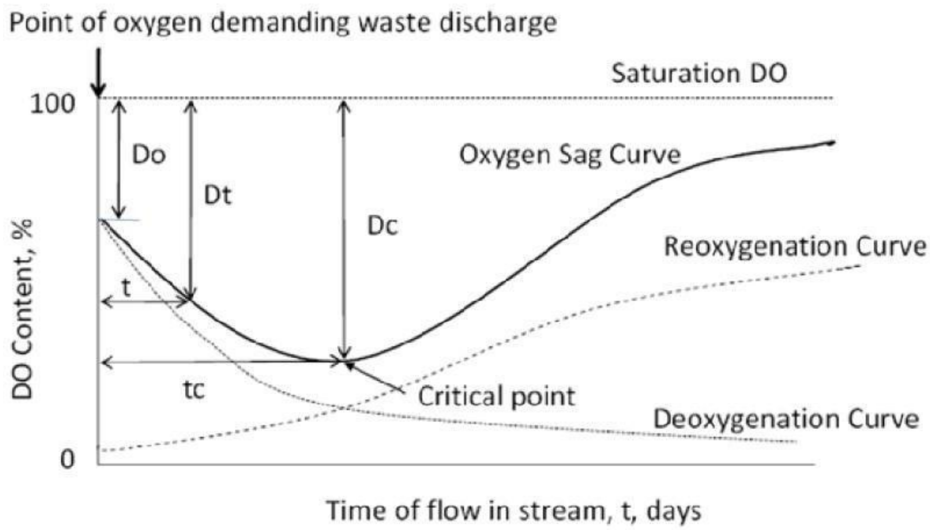
OR

The amount of resultant oxygen deflect can be obtained by algebraically adding the de - oxygenation and re -oxygenation curves. The resultant curve so obtained is called oxygen sag curve

Oxygen Deficit, D = Saturation DO – Actual DO

The saturation DO value for fresh water depends upon the temperature and total dissolved salts present in it and its value varies from 14.62 mg/L at 0oC to 7.63 mg/L at 30ºC, and lower DO at higher temperatures.

The DO in the stream may not be at saturation level and there may be initial oxygen deficit (D). At this stage, when the effluent with initial BOD load Lo, is discharged in to stream, the DO content of the stream starts depleting and the oxygen deficit (D) increases. The variation of oxygen deficit (D) with the distance along the stream, and hence with the time of flow from the point of pollution is depicted by the Oxygen Sag Curve. The major point in sag analysis is point of minimum DO, i.e., maximum deficit. The maximum or critical deficit (Dc) occurs at the inflexion points (as shown in fig) of the oxygen sag curve.



Deoxygenation, reoxygenation and oxygen sag curve

De-oxygenation curve: The curve which represents (or) showing the depletion of D.O with time at the given temperature

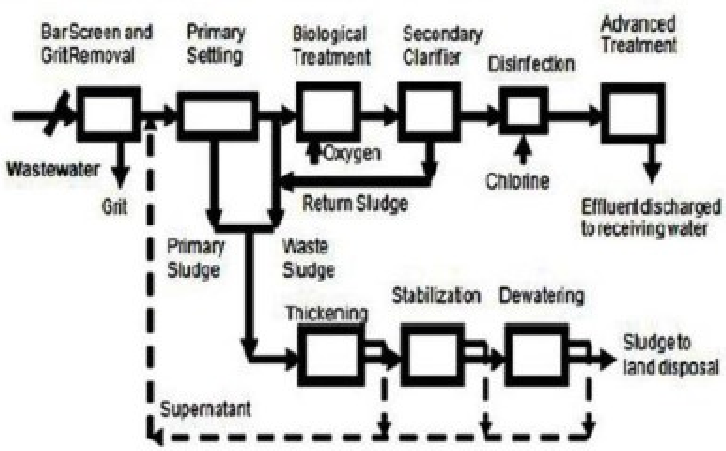
Re-oxygenation Curve: In order to counter balance the consumption of D.O due to the de – oxygenation, atmosphere supplies oxygen to the water and the process is called the re – oxygenation.

When wastewater is discharged in to the stream, the DO level in the stream goes on depleting. This depletion of DO content is known as de-oxygenation. The rate of de- oxygenation depends upon the amount of organic matter remaining (Lt), to be oxidized at any time t, as well as temperature (T) at which reaction occurs. The variation of depletion of DO content of the stream with time is depicted by the de-oxygenation curve in the absence of aeration. The ordinates below the de-oxygenation curve indicate the oxygen remaining in the natural stream after satisfying the bio-chemical demand of oxygen. When the DO content of the stream is gradually consumed due to BOD load, atmosphere supplies oxygen continuously to the water, through the process of re-aeration or re-oxygenation, i.e., along with de-oxygenation, re-aeration is continuous process.

3. Draw and explain briefly the flow Diagram of Municipal waste water treatment plant with their operation units

Flow diagram of Municipal wastewater treatment plant

The influent or wastewater collected from residences or industries are first subjected to **Screening** process to remove the floating matters present in the sewage. The water which comes out of screening tanks is passed through the **Grit chambers** or **Detritus tanks** to remove the grits or sand particles. Then effluent which comes out of grit chamber is subjected to **Primary Sedimentation tanks** in order to remove the large suspended organic solids which is achieved by settling process where water is allowed to flow in slower rate, then heavy denser particles settles down at the bottom of the tank. The settled organic particles at the bottom of the primary sedimentation tanks is called **primary sludge.** The effluent which comes out of the primary settling tank is subjected to **Biological treatment or Secondary treatment** where, decomposition of organic matter takes place by aerobic bacteria with the supply of oxygen. Then stabilized organic particles along with the water is passed through the **Secondary clarifier** where the stabilized organic particles settles at the bottom of the tank. The sludge which is settled at the bottom of the tank is again recirculated back and mixed with effluent which comes of primary sedimentation tank which is part of **Activated Sludge Process** and remaining sludge is mixed with primary sludge and then subjected to **Sludge digestion process**. In sludge digestion process, wastewater is first subjected to **Thickening**, where number of solid sludge particles are increased by separating from liquid. The liquid which rests over the solid sludge particles are removed out is called as supernatant. The solid sludge which consists of moisture content is removed out in



Dewatering process. The dry form of sludge is used as manure for improving the fertility of soil. The effluent which comes out of secondary clarifier is fed into disinfection tank where chlorine is added to the wastewater to kill germs and pathogenic bacteria's present in the water. Then water which comes out of disinfection tank containing germs are removed out in final or advanced or tertiary treatment process after that, the water can be directly discharged to nearby water courses.

Treatment process as a whole classified into 4 types

1) Priliminary treatment process
2) Primary treatment process
3) Secondary or Biological treatment process
4) Tertiary or final or advanced treatment process

Preliminary treatment process:

This treatment process consists of separating the floating materials like dead animals, tree branches, papers, pieces of rags or wood etc., present in the sewage and also to remove heavy settable inorganic solids. This process also helps in removing oil and grease particles present in the sewage. This process reduces the BOD of wastewater by about 15 to 30%.

The units used in preliminary process are

a) **Screening -** For removal of floating matters like papers, rags, pieces of clothes etc.
b) **Grit chambers or Detritus tank** – For removal of grits and sand particles.
c) **Skimming tanks –** For removal of oil and grease particles present in the sewage.

Primary treatment process: This treatment process consists of removing large suspended organic solids. This is usually achieved by **sedimentation process**. The liquid effluent from primary treatment process consists of large amount of suspended organic matters having BOD of 60% of original. The organic solids which are separated out in the sedimentation tank are often stabilized by anaerobic decomposition in a digestion tank. This residue is used for landfills or soil conditioners.

Secondary treatment process: This treatment process further treats the effluent which is coming out from primary sedimentation tanks. This treatment process is achieved by biological decomposition of organic matter which can be carried out either under aerobic or anaerobic condition.

Treatment process in which organic matter is decomposed by aerobic bacteria is called aerobic decomposition. Units which are used in this treatment process are

Filters – Interment sand filters as well as trickling filters. Intermittent sand filters are used for treatment of wastewater by attaching microorganisms to the filter medium and treated water is collected in the underdrains at the bottom of sand filter and is transported to a line for further treatment or disposal. Trickling filters are used to remove organic matter from wastewater. Trickling filter is an aerobic treatment system that utilizes microorganisms attached to the medium to remove organic matter from wastewater.

Aeration tanks – Wastewater is is mixed with microbes in the aeration tank and oxygen is supplied. Microbes consume that supplied oxygen and decomposes the organic matter present in the wastewater and thus water is cleaned.

Oxidation ponds – Oxidation ponds are also known as stabilization ponds or lagoons. Within an oxidation pond heterotropic bacteria degrade organic matter in the sewage which results in production of cellular material and minerals. The production of these supports the growth of algae in the oxidation pond.

Aerated lagoons: Aerated lagoons or aerated basins is a holding and treatment pond provided with artificial aeration to promote the biological decomposition of wastewater. Treatment process in which organic matter is decomposed anaerobic bacteria is called **anaerobic decomposition**. Units which are used in this treatment process are,

a) **Anaerobic lagoons**: These are also called as manure lagoon which are manmade earthen basins filled with animal waste that undergoes anaerobic decomposition and it will be converted into excellent manures.

b) **Septic tanks**: These are water-tight box made of concrete or fiber glass to separate solids and liquids by settling process. Tanks are used for reception and processing of sewage which is achieved by sedimentation along with anaerobic sludge digestion. The effluent from the secondary biological treatment will usually contain a little BOD of 5 to 10% of original

Final or Advanced or Tertiary treatment process: This process removes remaining organic load after secondary treatment and to kill pathogenic bacteria present in the sewage and this achieved by chlorination

Tertiary Treatment

Tertiary treatment or advanced waste water treatment includes operation and process used to remove organic load left after the secondary treatment and in particular to kill the pathogenic bacteria. It is normally carried out by chlorination.

Tertiary treatment may be aimed at the reuse of wastewater. The common processes that are used in this treatment are:

i. Removal of refractory organisms through adsorption.

ii. Removal of dissolved inorganic substances through chemical precipitation, ion recharge, reverses osmosis, electro dialysis, membrane filtration process and distillation, nutrient removal such as nitrogen and phosphorus etc

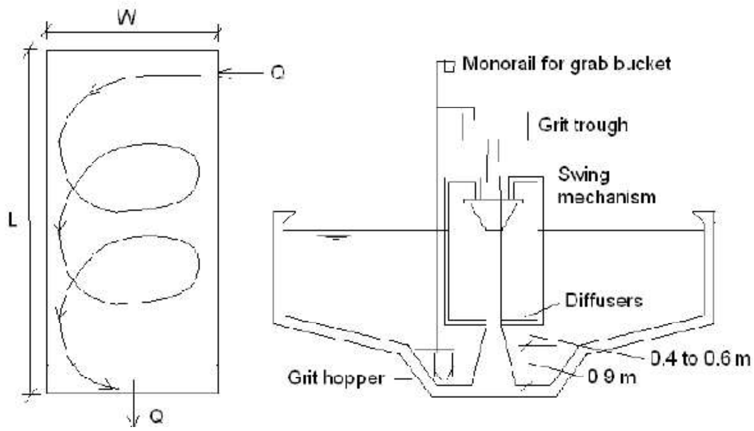
4. Draw a neat diagram and explain grit chamber and skimming tank

Grit chambers: Grit includes sand and other heavy matters which are inert inorganic such as metal fragments, rags etc. If not removed in preliminary treatments, grit in primary settling tank can cause abnormal abrasive wear and tear on mechanical equipment and sludge pumps, can clog by deposition and can accumulate in sludge holding tanks and digesters. Therefore grit removal is necessary to protect the moving mechanical equipment and pump elements from abrasion. Grit removal devices depends upon the differences in specific gravity between organic and inorganic solids to affect their separation.

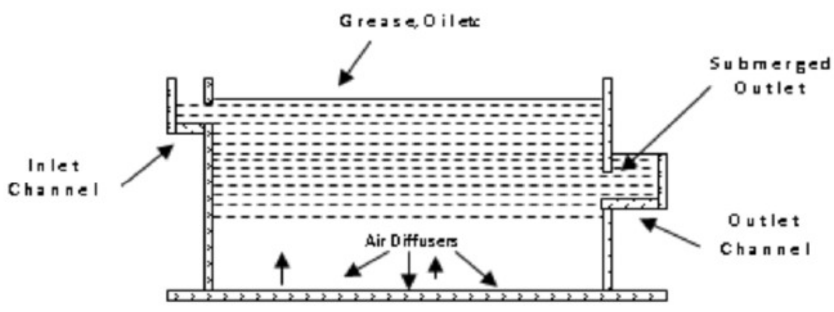
Types of Grit chambers:

Grit chambers are of two types, mechanically cleaned and manually cleaned. Mechanically cleaned grit chambers are provided with mechanical equipment for collection and washing of grit chambers, which are operated either on a continuous or intermittent basis. Manually operated grit chambers should have sufficient capacity for storage of grits between the intervals of cleaning.

Aerated Grit chambers: An aerated grit chamber is a special form of grit chamber consisting of a standard spiral flow aeration tank provided with air diffusion tubes placed at one end of the tank at about 0.6 to 1m from the bottom. The heavier grit particles with their higher settling velocities drop down to the floor, where as lighter organic particles will remain in suspension and carried with the roll of spiral motion due to the diffused air and eventually carried out of the tank.



Skimming tank: Skimming tanks are narrow rectangular tanks having at least two longitudinal baffle walls interconnected. They are used to remove grease and fatty oils from sewage. Air diffusors are provided at the bottom of the tank. Compressed air applied at the rate varying from 300 to 6000m3/million liters of sewage agitates the sewage, which prevents settling of solids. Air tends to change the oil and grease to a soapy mixture. This mixture is carried to the surface by the air bubbles, sum of which are entrained in it and may be skimmed off.



Skimming Tank

5. Define Deoxygenation constant. Determine the 1 day BOD and ultimate first stage BOD for a wastewater whose 5 day 20° C BOD is 200 mg/L. The reaction rate constant k (base e) = 0.23 per day

When wastewater is discharged in to the stream, the DO level in the stream goes on depleting. This depletion of DO content is known as de-oxygenation

5b) Sol:- Given :- $t = 5$ days

$T = 20°C$.

$BOD = 200$ mg/l

$K(e) = 0.23$/day.

$BOD_5 = y_5 = L_0 - L_5$

$y_5 = L_0(1 - e^{-kt})$.

$\therefore 200 = L_0(1 - e^{-0.23 \times 5})$

$$L_0 = \frac{200}{1 - e^{-0.23 \times 5}}$$

$\Rightarrow L_0 = 292.67$ mg/l

for a 1 day BOD, Here $K = 0.23$, $t = 1$.

$y_t = L_0 - L_t$, $y_t = L_0(1 - e^{-kt})$

$y_1 = L_0(1 - e^{-0.23 \times 1})$

$y_1 = 292.67(1 - e^{-0.23})$

$y_1 = 60.13$ mg/l

Here, 1 Day BOD i.e $y_1 = 60.13$ mg/l

The ultimate first stage BOD $= L_0 = 292.67$ mg/l