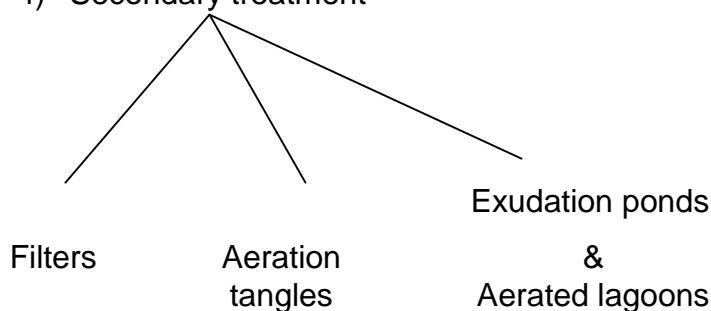


## **UNIT – I**

### **Planning for Sewerage Systems** **PART – A**

#### **1. What are the types of treatment processes?**

- 1) Preliminary treatment
- 2) Primary treatment
- 3) Complete final treatment
- 4) Secondary treatment



#### **2. What are the various sources of wastewater generation?**

- I. Industrial Wastes
- II. Domestic wastes
- III. Agricultural Wastes

#### **3. List out the types of anaerobic biological units?**

- 1) Anaerobic lagoons
- 2) Septic tank
- 3) Inhofe tank

#### **4. What is means by screening?**

Screening is the very first operation carried out at a sewage treatment plant and consists of passing the sewage through different types of screens so as to trap and remove the floating matter such as process of cloth, paper, wood, cork, hair, fiber etc.

#### **5. What is the purpose of providing screen?**

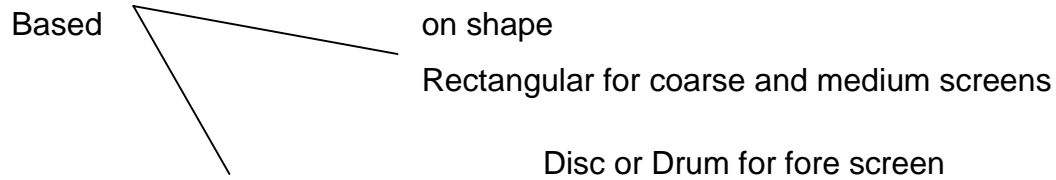
The main idea of providing screens is to protect the pumps and other equipments from the possible damages due to the floating matter of the sewage.

It should be used for removing the floating matters.

#### **6. What are the types of screen?**

Classification based on size of the opening

- 1) Coarse screens
- 2) Medium screens
- 3) Fore screens



### 7. Define bar screen?

Rectangular shaped coarse and medium screens are made of steel bars fixed parallel to one another at desired spacing on a rectangular frame and are called bar screen.

### 8. What is meant by movable screen?

Movable screens are stationary during their operating periods. But they can be lifted up bodily and removed from their partitions for the purpose of cleaning.

A common movable bar medium screen is a 3 – sided cage with a bottom of perforated plates. It is mainly used in deep pits ahead of pumps.

### 9. Define Communicators?

Comminutes or shredders are the patented devices, which break the larger sewage solids to about 6 mm in size. When the sewage is screened through them such devices are used only in developed countries like USA.

### 10. What is meant by Screening?

The material separated by screens is called the screenings. It contains 85 to 90% of mixture and other floating matter. It may also contain some organic load which may putrefy, lacing bad smells and nuisance.

### 11. What are the methods adopted for disposal of screenings?

- 1) Burning
- 2) Burial
- 3) Dumping

**Burning** of the screenings is done in the incinerators

**Burial:** The process is technically called composting

Another method of disposing of the screening is by dumping them in low lying areas (away from the residential areas) or in large bodies of water such as sea.

### 12. Define Grit Chamber?

Grit chambers, also called or grit channels or grit basins, are intended to remove the inorganic particles (specific gravity about 2.65) such as sand, gravel, grit, egg, shells, bones etc of size 2 mm or larger to prevent damage to the pumps and to prevent their accumulation in sludge digesters.

**13. Define unit process?**

Methods of treatment in which the application of physical forces predominate are known as unit operations while methods of treatment in which chemical or biological activities are involved are known as unit process.

**14. What are the types of unit operations & processes?**

- 1) Physical unit operations
- 2) Chemical unit process
- 3) Biological unit process

**15. Give any two advantages of unit operations/ process?**

- 1) It gives better understanding of the process as inherent in the treatment and of the capabilities of these processes in attaining the objectives.
- 2) It helps in the development of mathematical and physical models of treatment mechanisms and the consequent design of treatment plants.

**16. Define phase transfer?**

Most waste water treatment process bring about changes on concentration of a specific substances by moving the substance either into or out of the waste water itself. This is called phase transfer.

**17. Define detention time?**

The detention time (t) of a settling tank may be defined as the average theoretical time required for the sewage to flow through the tank. Otherwise known as detention period or retention period

**18. Define the term Displacement efficiency?**

The ratio of the "Flowing through period" to the "detention period" is called the displacement efficiency.

**19. What is meant by principle of sedimentation?**

The turbulence is retarded by offering storage to sewage these impurities tend to settle down at the bottom of the tank offering such storage. This is the principle of sedimentation.

**20. Define the term "Sedimentation Basin"?**

The basin in which the flow of sewage is retarded is called the settling tank or the sedimentation Tank or the sedimentation Basin. **21. Define the term "Detention Period"?**

The theoretical average time for which the water is detained is called the detention period.

**22. Give any two advantages of chemical coagulation process in sewage treatment?**

- i) Sedimentation aided with coagulation produces better efficient with lesser BOD and suspended solids, as compared to plain sedimentation.
- ii) Coagulated settling tank requires less space than that required by an ordinary plain settling tank.

**23. What are the Demerits of coagulation in sewage treatment?**

- i) Cost of chemicals is added to the cost of sedimentation, without much use, and thereby making the treatment costlier.
- ii) The process of coagulation requires skilled supervision and handling of chemicals.

**24. What are the types of sedimentation tank?**

Based on flow

1. Vertical flow tank
2. Horizontal flow tank
3. Radial flow tank

According to use

1. Primary
2. Secondary
3. Intermediate

**25. What are the chemicals used for precipitation of sediment?**

1. Alum
2. Ferrous sulphate
3. Ferric sulphate
4. Ferric chlorides
5. Sodium aluminate
6. Sulphuric acid
7. lime
8. copperas

**26. What are the factors that affect the precipitations?**

1. Kind of chemical
2. Quality of chemical
3. character and concentration of sewage
4. Ph values of sewage
5. time of mixing and flow rates

6. Temperature
7. Violence of agitation

**27. What are the merits of chemical precipitation?**

- i) More rapid and through clarification
- ii) Removal of higher percentage of suspended solids.
- iii) Simplicity of operation
- iv) Small size tank is enough

**PART – B****1. Explain classification of Treatment processes?**

Sewage before being disposed of either in river streams or on land has generally to be treated. So as to make it safe

Sewage can be treated in difference ways  
treatment process are often classified as

- 1) Preliminary treatment
- 2) Primary treatment
- 3) Secondary or (biological) treatment
- 4) Complete final treatment

**Preliminary treatment:**

Preliminary treatment consists solely in separating the floating materials (Like dead animals, tree branches, papers, pieces of rags, wood etc) and also the heavy settle able inorganic solids.

It also helps in removing the oils and greases etc. From the sewage this treatment reduces the BOD of the waste water, by about 15 to 30%.

The process used are screening for removing floating papers, rags, clothes etc.

Grit chambers or detritus tanks: For removing grit and sand

Slimming tanks: For removing oils and greases.

**Primary Treatment**

Primary treatment consists in removing large suspended organic solids. This is usually this is usually accomplished by sedimentation on settling basins.

The liquid effluent from primary treatment often contains a large amount of suspended organic material and has a high BOD about (60% of original).

The original solids which are separated out in the sedimentation tanks (in primary treatment) are often stabilized by an anaerobic decomposition in a digestion tanks or are incinerated.

Sometimes the preliminary as well as primary treatments are classified to gather under primary treatment.

**Secondary treatment**

Secondary treatment involves further treatment of the effluent, coming from the primary sedimentation tank. This is generally accomplished through biological decomposition of organic matter, which can be carried out either under aerobic or anaerobic conditions.

In these biological units, bacteria will decompose the fine organic matter, to produce cleaner effluent.

The treatment reactors, in which the organic matter is decomposed (oxidized) by aerobic bacteria are known as aerobic biological units; and may consists of

- (i) Filters (intermittent sand filters as well as trick long filters).
- (ii) Aeration tanks with the feed of recycled activated sludge (i.e., the sludge which I settled in secondary sedimentation tank, receiving effluents from the aeration tank)
- (iii) Exudation ponds and Aerated legions. Since the there aerobic units, generally make use of primary settled sewage, they are early classified as secondary units.

The effluent from the secondary biological treatment will usually contain a little BOD (5 to 10% of the original). The organic solids sledge separated out in the primary as wells as in the secondary settling tank will be disposed of by stabilizing them under anaerobic process in a sludge digestion tank.

### **The final or advanced Treatment**

Thus treatment is sometimes called tertiary treatment, and consists in removing the organic local left after the secondary treatment, and particularly to kill the pathogence bacteria. Thus treatment, which is normally carried out by chlorination

Shows diagrammatic sketches of some standard types of sewage treatment plants

## **2. Describe the types of screens with need sketch.**

Screening is the very first operation carried out at a sewage treatment plant, so as to trap and remove the floating matter, such as pieces of cloth, paper, wood cork, hair, fiber, kitchen refuge, fecal solids etc present in sewage.

Thus, the main idea of providing screens it to protect the pumps and other equipments from the possible damages due to the floating matter of the sewage.

Types of screens depending upon the size of the openings and screens may be classified as

- 1) Coarse screen
- 2) Medium screens
- 3) Fine screens **Coarse Screen:**

It is also known as racks and the spacing between the bars (i.e., opening size) is about 50 mm or more. These screens do help in removing large floating objects from sewage. The material separated by coarse screens, usually consists of rags, wood, paper etc.

**Medium Screen:**

The spacing between bars is about 6 to 40 mm. These screens will ordinarily collect 30 to 90 lit of material per million liter of sewage. The screenings usually contain some quantity of organic material may be dispersed of by incineration or burial.

Rectangular Shaped coarse and medium screens are now – a – days widely used at sewage treatment plants.

Now – a – days these screens are generally kept inclined at about 30 to 60° to the direction of flow, so as to increase the opening area and to reduce the flow velocity and thereby making the screening more effective.

**Fine Screens:**

Have perforations of 1.5mm to 3mm in size. The installation of these screens prove very effective and they remove as much as 20% of the suspended solids from sewage. These screens, however, get clogged very often, and need frequent cleaning. They are, therefore, used only for treating the industrial waste waters or for treating those municipal waste waters, which are associated with heavy amounts of industrial wastewaters.

These screens will considerably reduce the load on further treatment units.

Brasses or Bronze plates or wire mesh are generally used for constructing fine screens. The metal used to should be resistant to rust and corrosion.

Fine screens may be disc or drum type, and are operated continuously by electric motor (Figure S.K.G Fig no 277)

**3. Estimate the screen requirement for a plant treating a peak flow of 60 million liters/day of sewage.****Solution:**

Peak flow = 60 ML/day

$$= \frac{60 \times 10^6 \text{ L}}{1000} \text{ cu.m/day}$$

$$= \frac{60,000}{24 \times 60 \times 60} = 0.694 \text{ m}^3/\text{sec}$$

Assuming that the velocity through the screen (at peak flow) is not allowed to exceed 0.8 m/sec we have the net area of screen openings required

$$\approx \frac{0.694 \times 0.87}{0.8} \text{m}^2$$

Using Rectangular steel bars in the screen, having 1 cm width and placed at 5 m clear spacing The gross area of the screen required

$$\frac{1 \times 0.876}{5} \approx 0.175 \text{m}^2$$

Assuming that the screen bars are placed at 60° to the horizontal  
The gross area of the screen needed

$$\approx \frac{1.04}{\frac{\sqrt{3}}{2}} \approx \frac{1.04 \times 2}{\sqrt{3}} \approx 1.2 \text{m}^2$$

Hence a coarse screen of 1.2m<sup>2</sup> area is required while designing the screen, we have also to design its cleaning.

### Frequency:

The cleaning frequency is governed by the head loss through the screen. The more the screen opening are clogged, more will be the head loss through the screen generally not more than half the screen clogging is allowed to know whether the screen has been clogged and needs cleaning.

The h<sub>L</sub> through the cleaning screen and half cleaned screen, can be completed as follows Velocity through the screen = 0.8 m/sec

$$\begin{aligned} \text{Velocity above the screen} &= \frac{0.8 \times 5}{6} \text{ m/sec} \\ &= 0.67 \text{ m/sec} \end{aligned}$$

$$\begin{aligned} \text{Head loss through the screen} &= 0.7929(V^2 - u^2) \\ &= 0.7929(0.8^2 - 0.67^2) \\ &= 0.0134 \text{ ray } 0.013 \text{ m} \end{aligned}$$

When the screen openings get half clogged then the velocity through the screen

$$\begin{aligned} V &= 0.8 \times 2 = 1.6 \text{ m/sec} \\ \text{Head loss} &= 0.7929(1.6^2 - 0.67^2) \\ &= 0.1538 \text{ say } 0.15 \text{m} \end{aligned}$$

This shows that when the screens are totally clean, the head loss is negligible is about 1.3cm only where as, the h<sub>L</sub> shoots up to about 15 cm at half the clogging. The screens should therefore be cleaned frequently as to keep the head loss within the allowable range.



4. A grit chamber is designed to remove particles with a diameter of 0.2mm, specific gravity 2.65. Settling velocity for these particles has been found to range from 0.016 to 0.22 m/sec, depending on the shape factor, A flow through velocity of 0.3 m/s. Will be maintained by proportioning weir determine the channel dimensions for a maximum waste water flow of 10,000 cum/day.

**Solution:**

Let us provide a rectangular channel section, since a proportional flow weir is provided for controlling velocity of flow

Now,

Horizontal velocity of flow =  $V_h = 0.3 \text{ m/s}$

Settling velocity is b/w 0.016 to 0.022 m/s and hence let it be 0.020 m/s

Now

$$Q = \text{Velocity} \times \text{cross-section} = V_h \times A$$

$$\frac{10000}{24 \times 60 \times 60} = 0.116 \text{ m}^3/\text{sec}$$

$$0.116 = 0.3A$$

$$A = \frac{0.116}{0.3} = 0.385 \text{ m}^2$$

Assuming a depth of 1m, we have the width (B) of the basin

$$1 \times B = 0.385 \quad B = 0.385 \text{ m}$$

say 0.4m

Now settling velocity  $V_s = 0.02 \text{ m/s}$

Detention time = Depth of the basin / settling velocity

$$= \frac{1}{0.02} = 50 \text{ sec}$$

Length of the tank =  $V_h \times \text{detention time}$

$$= 0.3 \times 50$$

$$= 15 \text{ m}$$

Hence, use a rectangular tank with dimensions

$$\text{Length (L)} = 15 \text{ m}$$

$$\text{Width (B)} = 0.4 \text{ m}$$

$$\text{Depth (b)} = 1.0 \text{ m}$$

5. Design a suitable grit chamber cum dewatering tank for a sewage treatment plant getting a dry weather flow from a separate sewerage system @ 400 l/s. Assume the flow velocity through the tank as 0.2 m/s and detention period of 2 minutes the maximum flow may be assumed to be three times of dry weather flow.

**Solution:**

$$\begin{aligned}
 \text{The length of the tank} \\
 &= \text{Velocity} \times \text{Detention time} \\
 &= 0.2 \times (2 \times 60) = 24 \text{ m}
 \end{aligned}$$

Now assuming that each detritus tank is designed for passing D.W.F, we have

$$\begin{aligned}
 \text{The discharge passing through each tank} \\
 &= 400 \text{ l/s} = 0.4 \text{ m}^3/\text{sec}
 \end{aligned}$$

$$\text{Cross-sectional Area required} \propto \frac{\text{Discharge}}{\text{Velocity}}$$

$$\begin{aligned}
 &\propto \frac{0.4}{0.2} \\
 &= 2 \text{ m}^2
 \end{aligned}$$

Assuming the water depth in the tank to be 1.2 m, we have the width of the tank

$$\frac{\text{Area of X section}}{\text{Depth}}$$

$$\begin{aligned}
 &\frac{2}{1.2} \\
 &= 1.67 \text{ m} \\
 &\text{Say } 1.7 \text{ m}
 \end{aligned}$$

Hence, use a nitrites tank with 24 m X 1.7 m X 1.2 m size At the top, a free-board of 0.3 m may be provided, and at the bottom a dead space depth of 0.45 m for collection of detritus may be provided.

$$\begin{aligned}
 \text{Thus, the overall depth of the tank} &= 1.2 + 0.3 + 0.45 \\
 &= 1.95 \text{ m}
 \end{aligned}$$

The tank will be 1.7 wide up to 1.5 m depth, and then the sides will slope down to form an elongated trough of 24 m length and 0.8 m width at the bottom with rounded corners, as shown in figure.

### **Detritus tanks:**

Detritus tanks are nothing but grit chambers designed to flow with a smaller flow velocity (of about 0.09 m/s) and longer detention periods (about 3 to 4 mini) so as to separate out not only the larger grit etc., but also to separate out the very fine sand particles etc.

**6. Design a grit chamber for a horizontal velocity of 25 cm/sec and a flow which ranges from a minimum of 25000 cu-m/day to a maximum of 1,00,000 cu-m /day. Average flow is 62500 cu-m/days. Using Bernoulli's theorem**

Total energy at U/s point in channel  
= Total energy at critical point in control section

$$E_1 = E_c = 1.5 \frac{V_c^2}{2g}$$

but  $E_1 = D$

$$D = 1.55 \frac{V_c^2}{g}$$

Using the value of  $D_{max}$ , as equal to 1.16 at maximum discharge we have

$$V_c \text{ at } Q_{max} = \sqrt{16 \times 9.81 \times 1.55}$$

$$= 2.71 \text{ m/s}$$

$$\text{Also } y_c \text{ at } Q_{max} = \frac{V \text{ at } Q_{max}}{g} = \frac{2.71}{9.81} = 0.274 \text{ m}$$

The discharge through the control section is

$$Q = (W \cdot y_c) \cdot V_c$$

Where  $W$  is the throat width &  $W \cdot y_c$

is the flow area of the throat

$$W = \frac{Q}{y_c \cdot V_c}$$

$$W = \frac{Q_{max}}{y_c \cdot V_c}$$

$$y \cdot V \text{ both at } Q_c = Q_{max}$$

$$= \frac{0.289}{0.74 \times 2.71}$$

$$= 0.144 \text{ m say } 0.15 \text{ m}$$

Let us use throat width  $2 = 0.15 \text{ m}$  For other flow conditions:

Using the above used two formulas we have  $y_c = \frac{V_c^2}{g}$

$$W \cdot y_c \cdot V_c = Q$$

$$V_c = \frac{Q}{W \cdot y_c}$$

$$y_c \propto \sqrt[3]{\frac{QW}{g}}$$

$$g \cdot y_c \cdot y_c^2 w^2 = Q^2$$

$$y_c^2 \propto \frac{Q^2}{g \cdot w^2}$$

$$y_c \propto \sqrt[3]{\frac{Q^2}{g \cdot w^2}}$$

Knowing Q and w, we can find  $y_c$  at different discharges

$$D \propto 1.55 \sqrt[3]{\frac{Q^2}{g}}$$

$$D = 1.55 y_c$$

Knowing  $y_c$  at different discharges, we can find D at different discharges

Then finally we have for a parabolic section

$$\frac{2}{3} \times B \times D = A$$

$$B = \frac{1.5A}{D}$$

knowing A at various discharges,

## 7. Describe the skimming tanks with neat sketch?

Skimming tanks are sometimes employed for removing oil and grease from the sewage and placed before the sedimentation tanks. They are, therefore used where sewage contains too much of grease or oils which include fats, waxes, soaps, fatty acids.

If such greasy and oily matter is not removed from the sewage before it enters further treatment units, it may form unsightly and odourous scums on the surface of the settling tanks or interfere with the activated sludge treatment process.

These oil and greasy materials may be removed in a skimming tank, in which air is blown by an aerating device through the bottom the rising air tends to coagulate and congeal (solidify) the grease and cause it to rise to the surface (being pushed in separate compartments) from where it is removed.

The typical details of a skimming tank as shown

It consists of a long trough shaped structures divided into two or three lateral compartments by means of vertical baffle walls (having slots in them) for a short distance below the sewage surface as shown. The baffle walls help in pushing the rising coagulated greasy material into side compartments (called stilling compartments) the rise of oils and grease is brought above by blowing compressed air into the sewage from diffusers placed at the bottom of the tank.

The collected greasy materials are removed (i.e. skimmed off) either by hand or by some mechanical equipment. It may then be disposed of either by burning or burial.

A detention period of about 3 to 5 min is usually sufficient, and the amount of compressed air required is about 300 to 6000 m<sup>3</sup> per million lit of sewage.

$$\text{Surface Area} = 0.00622 \frac{Q}{V_r g}$$

$V_r g$  Rate of flow of sewage in m<sup>3</sup>/day  $V_r$

Minimum rising velocity of greasy material to be

removed in m/min - 0.25 m/minute in most cases.

The efficiency of a skimming tank can be increased considerably (3 to 4 times) by passing chlorine gas (2 mg / lit of sewage) along with the compressed air.