Unit-2

SEWER DESIGN

1. What are the Demerits of chemical precipitation?

1. High cost of chemicals
2. Large quantity of sludge which offers difficulty of its removal
3. Skilled attendance
4. Putrescible efficient

2. What do you mean by chemical precipitation?

When certain chemicals are added to, sewage they produce a precipitate known as flow which in insoluble or slightly soluble in water. The flow attracts small particles to form large size and thus size goes on increasing during the process of settlement.

3. Write the expression for finding out the settling velocity?

Vs Ss 1 d^2

18

For particle < 0.1 mm

Where

Vs → Settling velocity in m/s

→ Unit t of water in leg / m^3

→ Absolute or dynamic velocity on kg sec / m^2 d → die of particle in m

4. Write the hazen formula for determining the velocity?

Vs 418 Ss 1 d 3T 100 70

Where

Vs → Velocity in m/s d → dia of particle in m T → Temperature in C

(For particles between 0.1 mm and 1mm)

5. What is do you mean by transitional setting zone?

Grit particles however, generally lie between 0.1mm and 1 mm, and hence undergo settling which lies in between streamline settling and turbulent settling. This settling zone is called the transitional settling zone

6. What are the users of Baffle?

1) Baffler are required to prevent the movement of organic matter and its escape along with the efficient
2) Distribute the sewage uniformly through the cross section of the tank.
3) It is used to avoid short circuiting

7. Write the equation for finding out the critical scour velocity?

$$V_H = 3 \text{ to } 4.5 \sqrt{g d (S_s - 1)}$$

V_H → critical scour velocity

8. What are the classifications of biological process?

a) Aerobic processes
b) Anaerobic processes
c) Aerobic – anaerobic processes

9. List out the aerobic processes?

1. Activated sludge processes
2. Trickling filters
3. Aerobic stabilization pond
4. Aerated lagoon

10. List out the anaerobic process?

1. Anaerobic sludge digestion,
2. Anaerobic contact processes
3. Anaerobic filters
4. Anaerobic lagoons or ponds

11. What are the sources of waste water?

1. Domestic waste water (i.e sewage)
2. Agricultural return waste water
3. ndustrial waste water

12. What are the methods involved in the treatment of waste water?Mainly classified into

1. Conventional treatment methods
2. Advanced waste waster treatment

Conventional treatment methods

i. Preliminary processes
ii. Primary treatment iii. Secondary treatment

Advanced waste water treatment

i. Tertiary treatment

13. What are the functions involved in the chemical unit processes

1. Chemical precipitation
2. Gas transfer
3. Adsorption
4. Disinfection
5. Combustion
6. loss exchange
7. Electro dialysis

14. What do you understand by waste water treatment?

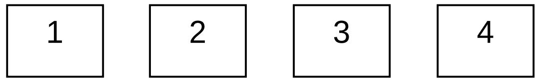
The waste water treatment or sewage treatment is a broad term that applies to any process/operation or combination of processes and operations that can reduce the objectionable properties of water carried waste and render it less dangerous with the following.

1. Removal of suspended and floatable material
2. Treatment of biodegraslable organics
3. Elimination of pallogenic organisms

15. What is the detention periods range for sedimentation?

The detention periods range 45 to 120 min

16. Draw a general layout for sewage treatment process?



1 → Screening
2 → Sedimentation
3 → Oxidation
4 → Disinfection

17. Give example for single & Double storied sedimentation tank?

Single stored tanks → septic tank
Double stored tank → Inhofe tank

18. What is the detention period for detritus tank?

For detritus tanks, the detention period is 3 -5 minutes.

PART-B

1. What do you understand by unit operations and processes? What is its importance in water and waste water treatment? Elaborate various types of unit operations used for waste water treatment.

The waste water treatment is a bread term that applies to any operation / process or combinations of operations and processes that can reduce the objectionable properties of water-carried waste that render it less dangerous and repulsive to man. Waste water treatment is a combination of physical chemical, biological processes

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

Following are the important operations which constitute the physical, chemical, biological unit operations/processes, employed in water and waste water treatment.

1. Gas transfer : Aeration
2. Ion transfer
   a. Chemical coagulation
   b. chemical precipitation
   c. Ion exchange
   d. Adsortpion
3. Solute stabilization.
   a. cj;promatopm b. Liming

   c. Re carbonation
   d. Super-chlorination
4. Solid transfer
   a. Straining
   b. Sedimentation
   c. Floatation
   d. Futration.
5. Nutrient or molecular transfer
6. Interglacial contact.
7. Miscellaneous operations
   a. Disinfection
   b. Copper sulphating
   c. Fluoridation
   d. Thermal desalination.
8. Solid concentration and stabilization
   a. Thickening
   b. Centrifuging
   c. Chemical conditioning
   d. Elutriation
   e. Biological floatation
   f. Vacuum filtration
   g. Air drying
   h. Heat drying
   i. Sludge digestion
   j. Incineration
   k. Wet combustion

The unit operation approach in water anal waste water treatment has the following advantages

1. It gives better understanding of the processes inherent in the treatment and of the capabilities of there processes in a chaining the objectives.
2. It helps in the development of mathematical and physical models of treatment mechanisms and the consequent design of treatment plants.
3. It helps in the coordination of effective treatment procedure to attain desired plant performance and efficient quality.

2. What do you understand by physical unit operations? Write a noteon application of various physical unit operation employed in waste water treatment.

The physical unit operation in which application of physical forces predominate consist of the following

1. Screening
2. Communication
3. Flow equalization
4. Mixing
5. Foliation
6. sedimentation
7. Flotation
8. Estuation
9. Vacuum filtration
10. Micro screening 11. Air drying

Because the physical unit operations were deprival originally from observations of the physical work, they were the first treatment methods to be used. They form the basis of most process flow sheets in table gives the applications of physical unit operating on waste water treatment

	Operation		**Application**
1.	Screening	→	Removal of coarse and settle able solids by surface spraining
2.	Communication	→	Girding of coarse solids
3.	Flow equalization	→	Equalization of flow and mass loadings of BOD and suspended solids.
4.	Mixing	→	Mixing of chemicals and gases with waste water and maintaining solids in suspension.
5.	Flocculation	→	Promotion of the aggregation of small particle into larges particles
6.	Sedimentation	→	Removal of settle able solids and thickening of sludge
7.	Floatation	→	Removal of finally divided suspended solids and particulars with pensioner close to that of water also thickness biological sludge.

8. Filtration → Removal of fine residual suspended solids removing after biological or chemical treatment
9. Micro screening → Same of filtration, also removal of algal from stabilization pond efficient.

3. What is meant by chemical unit processes? Enlist the applicationsof various chemical unit processes employed in waste water treatment.

Chemical unit processes are those in which removal of continents are brought about by chemical activity in the field of waste water treatment, chemical unit operations are usually used in conjunction with physical unit operation and biological unit processes. The following chemical unit processes are commonly used for waste water treatment.

1. Chemical precipitation
2. Gas transfer
3. Adsorption
4. Disinfection
5. Combustion
6. Ton exchange
7. Electro dialysis

It should be clearly noted that chemical unit processes are additive processes whereas physical unit operations and biological unit processes are subtractive processes. This is an inherent disadvantage of chemical unit operations because there is usually is net increase in the dissolved constitution in the waste water because of the chemical unit processes. In most of the caser, we add something else. Another disadvantage of chemical unit processes is that they are all intensive in local operating cost. Table gives the summary of the applications of chemical unit processes in waste waster treatment.

Process	Application
1. Chemical →	Removal of phosphoresces precipitation and enhancement of suspended solids removal in primary sedimentation.
2. Gas transfer →	Addition and removal of gases
3. Adsorption →	Removal of organics

4. Disinfection → Disinfection of disease – causing organism.
5. De chlorination → Removal of total combined chlorine residuals
6. Misillaneous → Achievement of specific objectives in waste water treatment

4. Design a detritus tank for a DWF of 350 ips in a separate sewage system. Make suitable assumptions wherever required.

Solution:

Let is assume the following Detention

time: 3m; Flow velocity: 0.2 m/s

Maxi flow : 3 times DWF

Hence Q max : 3 x 350 lit/s

Let us provide 3 tanks attached and running parallel to each other. Hence design discharge for each tank is Q = 350 l/s = 0.35 m^3/s

Cross – section area required Qv

$$0.35/0.2 = 1.75m^2$$

Let as provide a water depth of 1.2m, in the rectangular portion

Width of tank =

$$\text{Area}/\text{depth} = 1.75/1.2 = 1.458m$$

Provide a width of 1.5m

Also, length of tank = Velocity x detention time

= 0.2 (3 x 60) = 36m

Making a provision of 6m for inlet and outlet arrangement, the total length of tank = 42m. Thus each unit of the distribute tank will be 1.5m width

and 42m length. Provide of free board of 0.3m. Also, provide a bottom depth of 1.5m for the accumulation of detritus and this depth be tapered of an angle of 45 as shown in figure.

5. Design a detritus tank if the dry weather flow of a separate system of sewage scheme is 130 l/s. Assume

(i) The maximum flow to be three time to average
(ii) The definition period as 45 seconds
(iii) The velocity as 30 cm/s The length of the tank = 45 x

30 = 1350cm

If the depth is 90cm taking actual velocity as 22.5 cm/s Width

of tank for average flow

$$= \frac{130 \times 1000}{22.5 \times 90}$$

= 64cm = 65m ray

The detritus tank is there 13.5 m x 0.65 x 0.90 m. At the top, a free board of 30 cm and at the bottom, 45cm. Storage of grit etc should be provided. The tank may be 65 cm wide up to the depth of 120 cm and thenthe sides will slope down to form an elongated through of 13.5m length and 90 cm width at the bottom with rounded corners. The total depth of the tank

= 90 + 30 + 45 = 165 cm

For maximum flow three tanks of above dimensions will be required but normally one will be in use

6. Design in a preliminary treatment unit the screen and the detritus tanks for 50,000 people. The dry weather flow is 110 lit / h / day. Assume the maximum flow as 3 times the DWF. Assume suitably the data not given

Screens

Total flow

= 50000 110 / litday

63.65 ls

Maximum flow = 3 x 63.65 = 190.95 l/s ray 190 l/s

Using one screen with openings of 25mm, at the rate of 1160 cm^2 per thousand people

Submerged area required = 50 x 1160 cm^2
= 5.8 m^2

Alternatively, the area of the rack may be @ 1.0 cm^2 per 100 lit of DWF

i.e $\frac{50,000}{100}$ 5.5m^2

How assuming that 15 lit screenings per ML of flow are separated.

Total screenings= $\frac{15}{10^6}$ 50,000 110 □ 82.5lit if the

velocity in the screen chamber is 45 cm/s C/s area of

screen chamber

$$\square \frac{190 \times 1000}{45}$$

$\square$ 4220cm^2

Detritus tank:

Assuming the maximum capacity of tank as 0.8% of DWF, it is equal to $\frac{0.8}{100}$ 50,000 110 □ 44000lit maximum quantity that flows through the tank = 190 l/s

If the limiting velocity is 30 cm/s

c/s area = $\frac{190 \times 1000}{30}$ 6334cm^2 If the

detention period is 45 sec

Length of the tank = 45 x 30 = 1350 cm

Providing 5 tanks of 13.5 length each Total capacity

of the tank

42755lit

Quantity of grit at the rate of 151/ML/day

= 82.5 lit/day If the

cleaning period is 2 weeks

Storage for 2 weeks = 82.5 x 14 = 1155lit Total

capacity of 5 tanks

= 42755 + 1155 = 43910 = 44000 lit say

Which is equal to maximum capacity required, Depth

of tank = $\frac{1350}{16} \approx 85$cm, say

Width = $\frac{6334}{85} \approx 80$cm, say

7. Design of circular settling tank unit for a primary treatment of sewage at 12 million lit per day. Assume suitable values of detention period (Presuming that trickling filters are to follow the sedimentation tank) and surface loading.

Solution:

Assuming the normal detention period for such cases as 2 hr and surface loading as 40,000 lit / m^2 /day

The quantity of sewage to be treated per 2 hours

$\Box 12 M.lit \Box 2 / 24$

$\Box 1 M.lit \Box 1000 m^3$

$\Box$

$\Box$ Capacity of tank = 1000 m^3 Now,

surface loading

$$\Box \frac{Q}{\text{surface area of tank}} \Box \frac{Q}{\Box / 4\, d^2}$$

$$40{,}000 = \frac{12 \times 10^6}{\frac{\pi}{4} d^2}$$ where

d is the dice of the tank

$$d^2 = \frac{4 \times 12 \times 10^6}{\pi \times 40{,}000}$$

$$d = \sqrt{\frac{300 \times 4}{\pi}} = 19.55\text{m say } 19.6\text{m}$$

Now, effective depth of tank

$$= \frac{\text{Capacity}}{\text{Area of X - section}}$$

$$= \frac{1000}{\frac{\pi}{4} \times (19.6)^2}$$

$$= \frac{1000}{302}$$

= 3.2m say

Hence, use a settling tank with 19.6 m dia and 3.2m water depth with free board of 0.3 m extra depth.

8. Design a suitable rectangular sedimentation tank provided with mechanical cleaning equipment for treating the sewage from a city, provided with an assured public water supply system, with a max daily demand of 12 million lit/day. Assume suitable values of detention period and velocity of flow in the tank. Make any other assumptions, wherever needed.

Solution:

Assuming that 80% of water supplied to the city becomes sewage, we have the quantity of sewage required to be treated per day i.e (max daily)

= 0.8 x 12 million lit
= 9.6 M. lit

Now assuming the detention period in the sewage sedimentation tank as 2 hrs, we have

$$Q = \frac{9.6}{24} \times 2 \text{M.lit}$$

$= 0.8 \text{M.lit}$

$= 800 \text{cu.m}$

Now assuming that the flow velocity through the tank is maintained at 0.3 m/min, we have

The length of the tank required

= velocity of flow x detention period

= 0.3 x (2 x 60)

= 36 m

C/s area pf the tank required

$$= \frac{\text{Capacity of the tank}}{\text{length of the tank}}$$

$$= \frac{800}{36} = 22.2 m^2$$

Assuming the water depth in the tank (i.e effective depth of tank) as 3 m The

width of the tank required

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

$$= \frac{22.2}{3} = 7.4 m$$

Since the tank is provided with mechanical cleaning arrangement no extra space at bottom is required for sludge zone.

No, assuming a free – board of 0.5 m, we have The overall

depth of the tank = 3 + 0.5= 3. 5 m

In overall size of 36m x 7.4 m x 3.5 m can be used.