Water & Wastewater Treatment

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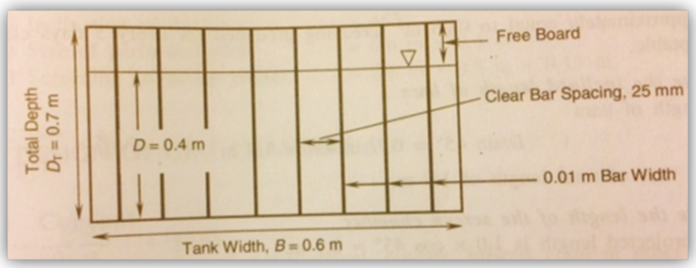
Water Treatment Plant

1. What are the main factors that must be considered when developing a treatment process train?
2. What are the water treatment systems consists of?
3. What are the main units in Preliminary?

Screen

4. According what the screens classified? And what are the types of screen?
5. On what the head loss through screen mainly depends?
6. Assuming suitable criteria, design a screen chamber to treat a maximum flow (Qmax) of 0.15m^3/s of domestic wastewater in a channel. Providing the dimensions of the screen chamber Length, L= 2.0m, Width (breadth), B= 0.6m and the depth, D= 0.4m. Providing bars dimensions 10mm x 50mm with a clear opening of 25mm. Compute approach velocity (flow through velocity). Compute the number of bars. Compute flow velocity through the screen bars. Compute head loss through the bar rack. Compute the quantity of screening. Compute the inclined length of bars. Compute the length of the screen chamber



Sedimentation Tank

7. What are the types of settling process? Show it by drawing.
8. What are the Conditions of Terminal velocity based on Newton's and Stokes' laws?
9. Find the settling velocity of spherical silica particle of specific gravity 2.67, in water at 25°C if the diameter of particles is 0.004 cm. At 25°C, μ=0.9 centistoke →0.009 cm/sec^2 , g=980 cm/sec^2
10. A sand particle has an average diameter of 1 mm and a shape factor (Ø) of 0.90 and a specific gravity of 2.1, determine the terminal velocity of the particle settling in water at 20°C (kinematic viscosity of water=1.003×10^{-6} m^2/s and water specific gravity=1, density of water=1000 kg/m^3). Drag coefficient can be computed using the following equation:

$$C_D = \frac{24}{Re} + \frac{3}{\sqrt{Re}} + 0.34$$

11. Estimate the settling velocity of sand (ρ_p = 2,650 kg/m^3) with a mean particle diameter of 0.21mm. Assume the sand is approximately spherical. The density of water at 20^{0}C is 998 kg/m^3 and the viscosity of water at 20^{0}C is (1.01×10^{-3}) N-s/m^2 (Newton = kg-m/s^2).
12. What are the sedimentation zones? Define it and show it by diagram.
13. What are the characteristics of an ideal horizontal flow settling tank? Expaline it and show it by diagram
14. Assuming the diameter of the clarifier to be 20 m and the wastewater flow rate 10 MLD, calculate the detention time, SOR and WLR of the clarifier having a wastewater depth of 2.5m.
15. A rectangular sedimentation tank has a length of 10 m and width of 5 m. for a flow rate of 1.0 MLD, calculate the Weir Loading Rate
16. Design primary settling tank to treat domestic wastewater flow of town having 500,000 population. Assume the following necessary design criteria: Average flow, Q =33.5 × 10^3 m^3/d. Surface loading rate, SOR at daily average flow = 40 m^3/m^2.d (m/d). Detention time, t = 2.0 hr. **Find:** Surface area, the diameter of the tank, the volume of the tank and the Weir loading rate.
17. A settling basin is designed to have a surface overflow rate of 32.6 m/day. Determine the overall removal obtained for a suspension with the size distribution given in the table below. The density of the particles is 1.2g/cm^3 and the water temperature is 20^o C.

Note: From appendix at 20^o C , μ =1.027 cp (mPa.sec) and ρ=0.997g/cm^3, $g = 9810\ mm/sec2$

Particle size , mm	0.1	0.08	0.07	0.06	0.04	0.02	0.01
Weight fraction greater than size, % ($1-x_s$)	10	15	40	70	93	99	100

18. From the settling curves (see Fig.) determine the theoretical efficiency of sedimentation tank with a depth equal to the test cylinder and detention time of 25 min . What surface overflow rate (SOR) should be used in a full-sized clarifier in order to achieve equivalent results? The test cylinder has a depth of 3m . *Note: The readings* → *%removal*= $(\frac{C_{initial}-C}{C_{initial}}) \times 100$. Where $C_{initial}$= Initial concentration, C=Concentration

Depth, %	Time of sampling , min							
	5	10	15	20	25	30	35	40
10	62	73	78	88	91	-	-	-
20	48	52	71	73	77	81	83	-
30	39	55	63	69	73	76	79	82

19. Given:
- Initial concentration, Co = 400 mg/L,
- Overflow rate, SOR = 2.7 m^3/m^2.hour
- Find the effectiveness of settling column.

Time (t)	5	10	20	40	60	90	120
Depth, m	Percent Removal (%R)						
0.6	41	50	60	67	72	73	76
1.2	19	33	45	58	62	70	74
1.8	15	31	38	54	59	63	71

Find:

- detention time,
- Plot the graph (%R at depth (h) vs Time (t))
- The effectiveness of settling column

20. Fill in the blanks with suitable words and write your mathematical solution

1. Water hammer is caused because by: __________________________ and _______________________
2. There are four zones in sedimentation tanks, the bottom zone of the tank is known as _______________ and the zone that the pure water leaves the tank is called ________________.
3. The dissolved oxygen levels will be deceased when the concentration of ___________________will be decrease and the temperature is ________________.
4. Open channels have different types such as half hexagon, __________________ and ___________________.
5. Stresses such as: ______________________and _______________________.
6. Expansion-contraction problems happened because of ____________ and create a____________ stress.
7. The relation between Reynolds' number and drag coefficient can be found in two ways either ___________or _____________
8. The Selection of pipe quality depends upon Pressure (External and internal pressures), ________________ and _________________
9. The pipe size is specified with two numbers: The __________________ and __________________.
10. The design life is expressed in _______________________ and it is called also _______________.
11. Pipe fitting has different types such as _______________________ and _____________________.
12. There are, four different types of pipe networks; such as Dead-End System, __________ and ___________.
13. There are four zones in sedimentation tanks, the first zone that the wastewater enter the tank is known as ____________ and the largest zone is _______________.
14. Sudden closure of valve or Sudden stoppage of pump caused ________________phenomena
15. When BOD levels are high, the level of _______________ decrease

16. A ductile pipe with length 130 feet is heated from 20 to 300ºF. The expansion coefficient is 12×10^{-6} (in/inºF). The expansion of this pipe in inches = ________

[write your solution steps] ____

21. What are the types of sedimentation tanks? Draw them and shown the zones in each type

22. *Note: Round off your results to three decimal digits.*

A steel pipe 5m long and 200mm inside diameter find:

The thermal stress in this pipe, this thermal stress is generated due to a change in temperature from 25ºF to 80ºF.

The change in pipe length in (mm).

Estimate the force generated in the pipe if the shell thickness is 6mm.

For your information: Modulus of elasticity of pipe, (E_{steel})=2 × 10^{11} N/m², coefficient of thermal expansion, (α_{steel}) = 11.7×10^{-6} 1/Cº

Celsius to Fahrenheit: (°C × 9/5) + 32 = °F

Fahrenheit to Celsius: (°F − 32) x 5/9 = °C

23. *Note: Round off your results to three decimal digits.*

17. If BOD_5 of a wastewater sample measured at 20ºC is 300 mg/L and the reaction constant K' (to base e) is 0.25 d^{-1}, compute the ultimate (L_o) and the 3-day BOD (L_3).

24. *Note: Round off your results to three decimal digits.*

25. Find the settling velocity (v_s) for sand particles with a diameter of 0.020 mm and for particles with D = 0.5 mm. If ρ_w =1000 kg/m³, ρ_s = 2650 kg/m³, μ= 1.002 X 10^{-3} N.s/m² at 20⁰C. *Note: Round your results to the nearest whole number*

26. The populations in village X was found:

- For current year (2021) was 80,000 capita /km² in 240,000 m², with average water consumption 180 lpd.
- Before one decade was 55,000 capita /km² in 210,000 m², with average water consumption 160 lpd.
- Before two decades was 32,000 capita /km² in 200,000 m², with average water consumption 140 lpd.
- Before three decades was 29,000 capita /km² in 190,000 m², with average water consumption 120 lpd.

Forecast the population in 2031 by applying arithmetic increase method and find the maximum daily demand in at that year (m³/d) when the average water consumption will be 200 lpd. *Note: Round off your results to three decimal digits.*

27. Find the settling velocity of sand particles in a water with a diameter of 0.09 mm and density, $\rho_p = 2650\ kg/m^3$. At 20ºC, the properties of water were: the density, $\rho_{water} = 998.2\ kg/m^3$ and the viscosity, $\nu_{water} = 1.007 \times 10^{-6}\ m^2/$

s. Then design the rectangular sedimentation tank by finding width, length, depth, volume, and weir loading rate. For your information the width to length ratio is 1:4, the flow in this tank was 30 MLD, the weir length is 60m, the detention time was 2 hours and those particles which settle are entirely removed have which means their $v_s \geq$ SOR.

28.

Note: Round off your results to three decimal digits.

Find the head loss of 120 m long pipe made of riveted steel (10 years old) with diameter = 30 cm carries wastewater with discharge flow of $0.03 m^3/s$.

Pipe	Value of C
Cast iron-new	130
5 years old	120
10 years old	110
20 years old	90-100
30 years old	75-90
Concrete or Cement lined	130-140
Plastic	150
Asbestos- Cement	120 -140
Welded steel	Cast iron 5 years older
Riveted steel	Cast iron 10 years older

29. The reservoir for a community is 110,000 gal. The well will produce 60 gpm. What is the detention time in the reservoir in hours?

30. Find the detention time in (min & Hour) for a 55,000 gal reservoir if the flow are 75 gpm
31. If the fuel consumption to the boiler is 30 gpd, how many days will the 1000 gal tank last?
32. Design a bar screen chamber for average sewage flow 20 MLD, minimum sewage flow of 12 MLD and maximum flow of 30 MLD.

- *For your information:*
- Assume manual cleaning and angle of inclination of bars with horizontal as 30^o.
- Assume size of bars 9 mm x 50 mm, 9 mm facing the flow.
- A clear spacing of 30 mm between the bars is provided.
- Assume velocity of flow normal to screen as 0.3 m/sec at average flow.
- Assume velocity of flow normal to the screen as 0.75 m/sec at maximum flow
- The submerged vertical cross-sectional area of the screen = $0.5 m^2$
- Provide free board of 0.3 m
- Assume sharp-edged rectangular bars→ $\boldsymbol{\beta}$= 2.42

33. What are the main types of settlings particles?
34. Design a grit chamber for population 50,000 with water consumption of 135 LPCD
35. What is the Stokes law? and what are the conditions to apply it?
36. What is the Newton's law? and what are the conditions to apply it?
37. Determine the terminal settling velocity for a discretely settling particle having a diameter of 0.2 mm and Sp. Gr. 2.65. Assume temp. of wastewater stream to be 30^oC. Density of water at 30^oC =995.7 kg/m^3, density of particles = 2650 kg/m^3 diameter of particles =0.2 mm= ($0.2 X10^{-3}$ m)
38. Compute settling velocity for the data below by determining the Re number
39. What are the main units in Preliminary water & wastewater treatment plant?

40. What are the main units in Primary water & wastewater treatment plant?
41. What are the main units in Secondary water & wastewater treatment plant?
42. What are the main units in Advance water & wastewater treatment plant?
43. Why we remove oil and grease from sewage water?
44. What is the main Concept of Primary Sedimentation Tank?
45. Sedimentation tank is classified depending on what?