

MRT 381-3 Water Treatment Methods

This paper consists of two (02) parts - Part A and Part B
Total number of questions: Part A: Two (02), Part B: Twenty Five (25)
Answer all questions
Time Allocated: Three (03) hours
Mark Allocation: 100 (Part A: 50, Part B: 50)

PART – A

01) Assume that you are a process engineer and have been asked to design a water treatment process for a town of 5,000 families.

a) List out all the assumptions you make in the above calculations. Justify each assumption with acceptable evidences.

(07 marks)

b) Calculate the total extraction expected to be done at the intake.

(08 marks)

c) Design the sedimentation tanks with dimensions (width, length and height) based on the following guidelines.

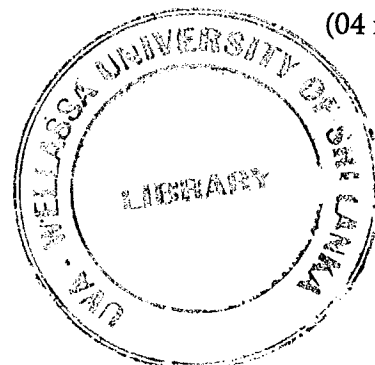
Parameter	Design value
Surface loading rate ($m^3/m^2.d$)	20 - 60
Mean horizontal velocity (m/min)	0.15 - 0.90
Water depth (m)	2-3
Detention time (h)	2-4
Weir loading rate ($m^3/m.d$)	100 - 200
Solid loading rate ($kg/m^2.d$):	
+ Primary sedimentation	15 - 34
+ Secondary clarifier	49 - 98

(06 marks)

d) Calculate the width and length of filters. Assume filter media height as 1200 mm and that they are packed on a concrete slab with air nozzles placed at equal distances.

Clue: Use the filtration rate as $120 m^3/m^2/day$

(04 marks)



02) A family of 06 members wants to construct a septic tank to manage total wastewater (grey and black water). Referring to the extract given below from the SLS 745: 2003, design a septic tank and produce the design details on an engineering sketch.

The working capacity of a septic tank shall be the sum of the volumes required for settling, sludge digestion and sludge and scum storage and shall be estimated as follows.

(25 marks)

- a) List all the assumptions as needed to complete the calculation as stated above.
 b) The volume required for settling, shall be calculated as follows.

$$V_s = t_s \cdot Q$$

where, V_s = volume required for settling (m^3) Q = average daily flow of wastewater (m^3/d) t_s = time required for settling (days) = $(1.5 - 0.3 \cdot \log Q)$, (> 0.2) (days.)

- c) The volume required for sludge digestion shall be calculated as follows.

$$V_d = q_s \cdot t_d \cdot p$$

where, V_d = volume required for sludge digestion (m^3)

q_s = volume of fresh sludge per person per day ($m^3/person/day$) = $0.001 m^3/p/d$ for all waste or grey water and = $0.00055 m^3/p/d$ for black water only

t_d = time required for sludge digestion (days) = 33 days (for an ambient temperature of $20^{\circ}C$)

p = population equivalent. = $Q (m^3/d) / 0.2 (m^3/p/d)$ for all waste = $Q (m^3/d) / 0.05 (m^3/p/d)$ for black water = $Q (m^3/d) / 0.15 (m^3/p/d)$ for grey water

- d) The volume required for sludge storage shall be calculated as follows.

$$V_{st} = r \cdot p \cdot n$$

where, V_{st} = volume required for sludge storage (m^3)

n = desludging interval (> 1) (years)

r = Volume of digested sludge per person per year ($m^3/p/y$) = $0.04 m^3/p/y$ for all waste or grey water = $0.022 m^3/p/y$ for black water only

- e) The volume required for scum storage shall be taken as $0.5V_{st}$.

- f) Then the design working capacity of the septic tank shall be

Required volume, $V = V_s + V_d + 1.5V_{st}$ (m^3)

PART – B

1. What is the general value of G for rapid mixer design?
2. What is the general surface loading rate design value of slow sand filters?
3. Name three basic types of water stabilization ponds.
4. What is the optimum horizontal velocity of a grit channel?
5. Explain importance of maintaining the above velocity.
6. What is the standard filtration rate for a rapid sand filter?
7. What is the general design range for retention time (HRT) of sedimentation process?
8. What are the three steps followed in a jar test experiment in a water treatment plant laboratory?
9. What is the optimum pH range of Aluminum Sulphate for better coagulation?
10. What are the five main stages used in a full-scale wastewater treatment process?
11. What is the expected range of residual chlorine (RCI) concentration to be maintained in a distribution system?
12. What are the main four component of a wetland system?
13. Explain the function of coagulant aids.
14. What does UASB stand for?
15. What are the four basic zones of a sedimentation basin?
16. What are the three base materials (raw materials) for activated carbon production?
17. What are the two basic forms of activated carbon available in the market?
18. Which is the best form of activated carbon to use in temporary contamination?
19. What is the most important parameter to consider in wastewater treatment process?
20. What is the mostly considered key parameter in water treatment process design?
21. What does MLVSS stands for?
22. What are the two main types of wastewater found in domestic establishments?
23. What is the maximum residual alum concentration to maintain in treated water?
24. What are the four main factors affecting on the efficiency of coagulation process?
25. What is the minimum retention time to be maintained in clear water reservoir?

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