KUMARAGURU
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M.E DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

First Semester

ENVIRONMENTAL ENGINEERING

P18EET1003: Biological Treatment of Wastewater

COURSE OUTCOMES

CO1: Develop conceptual schematics required for the biological treatment of wastewater.

CO2: Design the microbial kinetics and process unit of Aerobic wastewater treatment.

CO3: Design the microbial kinetics and process unit of Anaerobic wastewater treatment.

CO4: Identify the composition of sludge generated and their treatment methodology.

CO5: Understand the troubleshooting and implement proper construction and maintenance Concepts.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 1 = 10 Marks)

1. BOD bottle is the best example for ------ CO1 [K_1]

   a) Anaerobic Suspended Growth Process Batch Reactor
   b) Aerobic Suspended Growth Process Batch Reactor
   c) Anaerobic Attached Growth Process Batch Reactor
   d) Aerobic Attached Growth Process Batch Reactor

2. Anaerobic digestion takes place through four successive stages. Sequence them as per the order CO3 [K_2]

   1. Acetogenesis 2. Acidogenesis, 3. Methanogenesis, 4. Hydrolysis;

   a) 4-3-2-1
   b) 4-2-1-3
   c) 4-2-3-4
   d) 4-3-2-1

3. What is a good Food to Microorganism Ratio? CO1 [K_2]

   a) Between 0.2 And 0.5
   b) Between 0.5 And 1.0
   c) Between 0.6 And 0.8
   d) Between 0.1 And 1.0

4. Matching type item with multiple choice code CO2 [K_2]

List I	List II
A. Fly Nuisance	1. Product of dewatering
B. Floating of sludge	2. Product of sludge Digestion
C. Humas	3. Attached Growth Process
D. Nonvolatile Solids	4. Suspended Growth Process
	5. Product of Incineration

a) A-1, B-2, C-3,D-4 b) A-3, B-4, C-2,D-1

c) A-1, B-2, C-3,D-5 d) A-3, B-4, C-2,D-5

5. Find the amount of bleaching power to be stored for 30 days in a treatment plant (Capacity 2 MLD) if it contains 60% chlorine and the dosage is 5 mg/L per day CO5 [K_3]

a) 180 kg b) 280 kg

c) 380 kg d) 480 kg

6. The instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables is known as ------ CO5 [K_2]

a) PID (proper instrument derivative) Controller b) PID (program integrated device) Controller

c) PID (proportional instrument detector) Controller d) PID (proportional integral derivative) Controller

7. **Assertion (A):** Centrifuging removes more water than other methods and leaves a solid material that is known as cake. CO4 [K_2]

Reason (R): Dewatering reduces sludge volume

a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true and R is not the correct explanation of A

c) A is false but R is true d) R is false but A is true

8. Find the sludge volume when its moisture content is reduced from 98% to 90% CO4 [K_3]

a) 1/2 of the original volume b) 1/3 of the original volume

c) 1/4 of the original volume d) 1/5 of the original volume

9. Select the correct statements from the following. CO2 [K_2]

1. Aerobic treatment of wastewater is a biological process that uses oxygen to break down organic contaminants and other pollutants like nitrogen and phosphorous.
2. The main advantage of anaerobic treatment is the production of fewer biological solids and the yield of biogas.
3. In the O&M of the wastewater treatment plant, the land cost comes under Opex Cost
4. Chemical conditioning is a pre-treatment of sludge in advance of thickening and dewatering processes.

a) 1,2,3,4 b) 1,2,4 only

c) 1,2,3 only d) 1 and 2 only

10. Typical geometrical and operating characteristics of the UASB reactor include a height-to-diameter ratio and an up-flow velocity as ---------- & ---------- respectively CO3 [K_2]
a) 0.2–0.5 & 0.5–1.0 m/h b) 0.3–0.6 & 0.5–1.0 m/h

c) 0.5–0.8 & 0.5–1.0 m/h d) 0.2–0.5 & 0.8–1.2 m/h

PART B (10 x 2 = 20 Marks)

11. State the primary objectives of wastewater treatment CO1 [K_2]
12. Compare the aerobic and anaerobic treatment of wastewater on technical grounds CO1 [K_2]
13. Draw the various phases of the Sequential batch Reactor and mention it's advantage CO2 [K_2]
14. Define the term Sloughing with a neat sketch CO2 [K_2]
15. Differentiate small and large installation septic tanks CO3 [K_2]
16. Draw the Anaerobic Hybrid Reactor (AHR) and mention it's advantages CO3 [K_2]
17. Find the specific gravity of sludge if it contains 10 % Volatile solids (Sp Gravity 1.2) and 10 % nonvolatile solids (Sp Gravity 2.50) and 80 % moisture content. CO4 [K_3]
18. Enlist the various method of sludge disposal CO4 [K_2]
19. Draw the breakeven chart and mark its salient features CO5 [K_2]
20. List down the various types of maintenance to be done in a wastewater treatment plant CO5 [K_2]

PART C (6 x 5 = 30 Marks)

21. If 1-day BOD @ 30 ^{o} C of sewage is 120 mg/l, find the 5-day BOD @ 20 ^{o} C and the Ultimate BOD of the sewage. Take decay constant as 0.13 per day @ 20 ^{o} C CO2 [K_3]
22. Draw a neat sketch and indicate various phases of microorganism growth in a reactor and explain the various factors affecting the growth of microorganisms CO1 [K_2]
23. Half a liter of sewage when allowed to settle for half an hour, gives a sludge volume of 125 cubic centimeters (CC). If the dry weight of the sludge is 5 g/L, then find the Sludge Volume Index (SVI)and Sludge Density Index (SDI). Comment your result. CO2 [K_3]
24. A sedimentation tank treats 10 MLD of wastewater having 250 mg/l of suspended solids and removes 70 % of suspended solids. Find the weight and volume of the sludge produced per day if the moisture content is 97.5% and 95%. Take the specific gravity of sludge as 1.02. and specific weight of water as 1000 kg/m3. Comment on your result. CO4 [K_3]
25. Design a single stage Trickling filter with recirculation from the following data Use NRC Equation. Flow – 4,5 MLD, Influent BOD 250 mg/l, Effluent BOD – 50 mg/l BOD removal in Primary Clarifier is 30 percent Recirculation Ratio as 1.5, Take depth of the filter as 1.5 m and free board as 0.5 m CO2 [K_3]
26. Discuss the importance of PLC/HMI and SCADA in the Operation and maintenance of wastewater treatment plant. CO5 [K_2]

Answer any FOUR Questions
PART D (4 x 10 = 40 Marks)

27. Explain the following in Biological Treatment of wastewater. 10 CO1 [K_2]
    i. Importance of BOD/COD Ratio (3)
    ii. Cell immolation techniques used in high-rate reactor (3)
    iii. Comparison of Conventional and High Rate Reactors (4)

28. I. Determine the BOD5 of effluent from a conventional trickling filter. Diameter of the filter 35 m and Depth of the filter 1.5 m. Hydraulic loading rate on filter is 2200 m^3/day and influent BOD 5 is 180 mg/L. Take Rate constant is 1.90 per day and efficiency of the filter is 75 %. Use Eckenfelder's Equation. 5 CO2 [K_3]
    ii. Find the HRT and Efficiency and length of an ASP reactor from the following data Influent BOD-300 mg/l Effluent BoD-30 mg/l Flow - 3840 m^3 per day Volume of aeration tank- 875 m^3. Horizontal flow velocity is 0.10 m/minute 5 CO2 [K_3]

29. Determine the Kinetic Constants of an Activated Sludge Process Reactor from the flowing lab experimental data and hence find the effluent concentration if the influent BOD is 820 mg/l and MLSS is 3000 mg/L 10 CO1 [K_3]

Unit No	**Influent BOD5(mg/l)**	**Effluent BOD (mg/l)**	**HRT Days**	**MLSS (mg/l)**	**SRT Days**
1	410	60	0.17	3960	3.1
2	410	15	0.17	2885	2.1
3	410	20	0.17	2120	1.6
4	410	50	0.17	1070	0.8
5	410	100	0.17	680	0.6

30. A wastewater treatment plant produces 1 ton of dry solids (Volatile solids 70 % (Sp Gravity 1.05) and Non-Volatile solids 30 % (Sp gravity of 2.50) in a moisture content of 95 %. Find the volume of sludges when i. Volatile solids reduced to 60 percent and moisture content reduced to 92 % ii. After dewatering to 80 % of moisture content iii. After drying to 10 % of Moisture content iv. Finally, after incineration of sludge and comment your result based on your finding 10 CO4 [K_3]

31. A settling analysis is run on sludge from an ASP reactor with the following results. Under Equilibrium conditions, the flows to the secondary clarifier is 4250 m^3/day with solids content of 2200 mg/L and for a pre-selected solid flux rate of 2.5 kg/m^2.h, determine the size of the clarifier. 10 CO2 [K_3]

Concentration of MLSS (mg/L)	1400	2200	3000	3700	4500	5200	6500	8200
Velocity(m/h)	3.00	1.90	1.20	0.75	0.45	0.30	0.15	0.10

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