BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIFTH YEAR SECOND SEMESTER - 2023

SUBJECT: ADVANCED WATER & WASTE WATER TREATMENT (CE/5/T/505C)

Time: 3 hours **Full Marks: 100**

Instructions: Answer any five questions.

<table>
<tr><th>Sl. No.</th><th>Question</th><th></th><th>Marks</th></tr>
<tr><td>1</td><td>A) Determine the value of k, K_s, μ_{max}, Y, K_d using data from a bench scale activated sludge reactor w/o recycling. In each case initial BOD is 350 mg/l.
<table>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>Final BOD</td><td>10</td><td>20</td><td>24</td><td>46</td><td>39</td><td>53</td></tr>
<tr><td>HRT (days)</td><td>3.2</td><td>2.4</td><td>1.7</td><td>1.2</td><td>1.3</td><td>1</td></tr>
</table>
B) Derive the Michaelis-Menten equation in connection with enzyme kinetics.</td><td></td><td>[13+7]</td></tr>
<tr><td>2</td><td>Design a two stage Trickling filter to treat a domestic sewage of flow 18 MLD having influent BOD_5 is 300 mg/l and desired effluent BOD strength is as per Indian standard. Also design the distribution system for the first stage TF. No need to design the under-drainage system. Assume any relevant data if needed.</td><td></td><td>[20]</td></tr>
<tr><td>3</td><td>Design a conventional activated sludge process with a flow of 45000 m^3/day, influent BOD_5 is 300 mg/l, TSS is 450 mg/l, Minimum and maximum temperature is 18℃ and 32℃ respectively. Primary sedimentation tank BOD and SS removal efficiency is 40% and 70% respectively. Suspended Solid concentration in primary and secondary sludge is 35 Kg/m^3 and 10 kg/m^3. Total BOD_5 and SS in the treated effluent should be $\leq$ 25 mg/l and $\leq$ 20 mg/l respectively. Assume Y = 0.5 and Kd = 0.06 day^{-1}. Assume sludge age is 7 day. Assume any relevant data if needed.</td><td></td><td>[20]</td></tr>
<tr><td>4</td><td>Design a tube settler module of square cross section with following data:
Average design flow: 260 m^3/hr; Cross-section of square tubes: 50 mm × 50 mm; Length of the tubes: 1 m; Thickness of the tube: 1.5 mm; Angle of inclination of the tube with horizontal: 60°; Dia of particle to be removed 100% is 0.04 mm; Specific gravity of particles: 2.65; Kinematic viscosity: 1.055 centistoke
Also compare size and retention time for a rectangular tank with same efficiency.</td><td></td><td>[20]</td></tr>
<tr><td>5</td><td>A) Find the terminal velocity at 20℃ of spherical particle of 1.1 mm diameter, 2.65 specific gravity. Flow is 10 MLD and kinematic viscosity at 20℃ is 1.01 centistoke.
B) Discuss electrical double layer theory in context of colloidal stability in water.</td><td></td><td>[15+5]</td></tr>
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6	A) The analysis of a hard water shows the following compositions: Free carbon-di-oxide:4 mg/l; Alkalinity: 65 mg/l; Non-carbonate hardness: 92 mg/l; Total magnesium: 15 mg/l; Assume that it is possible to remove all but 35 mg/l of carbonate hardness with lime and that the treated water is to have a total hardness of 80 mg/l. Determine the amount of hydrated lime and soda required for treatment per million liters of raw water. B) ***Discuss with necessary equation***: De-mineralisation process of water softening.		[11+9]
7	A) Well water containing some coliform organisms is to be irradiated by UV light (λ=2573), as it flows through a channel of 3.0 m length and 0.6 m wide at a depth of 7.62 cm, if 30 germicidal lamp is located above the channel, so that average intensity at the water surface = 610 μwatt/cm^2. At what rate (MLD) can the water be made to flow through the channel to obtain 99.9997% removal of coliform organism. Given: coefficient of absorption at well water is 0.0561 cm^{-1}. 1 watt= 14.34 calorie/min. B) At 20℃ the partial pressure (saturated) of chloroform $CHCl_3$ is 18 mm of mercury in a storage tank. Determine the equilibrium concentration of chloroform in water assuming that gas and liquid phases are ideal. Assume that heat absorbed in evaporation of 1 mole of gas from solution at 20°C and a total pressure of 1 atm is 4000 kcal/kmol and empirical constant J is 9.10.		[10+10]