Ref. No.: Ex/CE/5/T/505C/2024

BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIFTH YEAR SECOND SEMESTER - 2024

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

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

Instructions: Answer any four 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, , Y, K_d using data from a bench scale activated sludge reactor w/o recycling. In each case initial BOD is 300 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>
<tr><td>MLVSS (mg/ltr)</td><td>130</td><td>125</td><td>135</td><td>122</td><td>135</td><td>130</td></tr>
</table>
B) Derive the Michaelis-Menten equation in connection with enzyme kinetics.</td><td></td><td>[17+8]</td></tr>
<tr><td>2</td><td>Design a conventional activated sludge process with a flow of 40000 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 25 mg/l and mg/l respectively. Assume Y = 0.5 and K_d = 0.06 . Assume sludge age is 7 day. Assume any relevant data if needed.</td><td></td><td>[25]</td></tr>
<tr><td>3</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.
C) Discuss with necessary equation: De-mineralisation process of water softening.</td><td></td><td>[15+5 + 5]</td></tr>
<tr><td>4</td><td>A) The analysis of a hard water shows the following compositions:
Free carbon-di-oxide:4 mg/l; Alkalinity: 60 mg/l;
Non-carbonate hardness: 92 mg/l; Total magnesium: 15 mg/l;
Assume that it is possible to remove all but 30 mg/l of carbonate hardness with lime and that the treated water is to have a total hardness of 70 mg/l. Determine the amount of hydrated lime and soda required for treatment per million liters of raw water.
B) Design a conventional rectangular horizontal-shaft flocculation tank (mechanical slow mixer or paddle type flocculator) unit for a flow of 300 m^3/hr of settled raw water after coagulant addition and rapid mixing. Assume water temperature to be 20.</td><td></td><td>[9+16]</td></tr>
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[Turn over

5	A) Well water containing some coliform organisms is to be irradiated by UV light (λ=2573 Å), as it flows through a channel of 3.0 m length and 0.6 m wide at a depth of 7.62 cm, if 25 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. 1 watt= 14.34 calorie/min. B) At 20 the partial pressure (saturated) of chloroform $CHCl_3$ is 17.5 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]
6	Design a spray aerator given the following data: Design flow 250 m^3/hr, Iron present in the water: 1 mg/L, Manganese present in the water: 0.5 mg/L, saturation concentration of O_2: 7.92 mg/L, Aeration constant (base 10): 70 cm/hr. Wind velocity is 6 kmph.		[25]
7	A) Find out capacity of storage reservoir to supply a flow of 200 m3/hr to a city by graphical method. City power is not available from 6 a.m. to 10 a.m. daily. 12 hrs of pumping is done during 4 am to 10 am and 12 noon to 6 pm. Peak water demand is during i) 6 a.m. to 10 a.m. , ii) 1 p.m. to 2 p.m., 5 p.m. to 6 p.m. Assume a peak factor of 2.25. Other than peak hours hourly demands are as follows: i. 20% of average hourly demand : 11 pm to 4 am ii. 40% of average hourly demand : 4 am to 5 am and 10 pm to 11 pm iii. 60% of average hourly demand : 12 noon to 1 pm iv. 70% of average hourly demand : 2 pm to 5 pm and 8 pm to 10 pm v. 80% of average hourly demand : 5 am to 6am vi. 90% of average hourly demand : 6 pm to 8 pm vii. 100% of average hourly demand: 10 am to 12 noon. Water supply is continuous. B) Determine the % of HOCl in an aquous solution, and at a temperature , ,		[20+5]