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B.Sc. Engg. (CEE)/7th Sem. October 4, 2023 (Wednesday)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

TERM: MID SEMESTER EXAMINATION
COURSE NO.: CEE 4733
COURSE TITLE: Industrial Wastewater Engineering

WINTER SEMESTER: 2022-2023
TIME: 1.5 Hours
FULL MARKS: 75

There are **3 (Three)** questions. Answer **ALL** questions. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO in the brackets. Symbols convey their usual meanings. Assume reasonable values for any necessary design data where required.

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1. (a) Differentiate between sanitary, industrial and municipal wastewater. **(4) (CO1, PO1)**

(b) Sketch a diagram to show the sources of municipal wastewater in relation to collector sewers and treatment. Describe briefly the wastewater sources, treatment, reuse and effluent disposal options. **(7) (CO1, PO1)**

(c) Two primary settling tanks in the Great Lakes area of the United States are 95 ft in diameter with a 7-ft side water depth. Single effluent weirs are located on the peripheries of the tanks. For an average design flow of 10.0 mgd and peak flow of 15.4 mgd, determine the overflow rates, detention times and weir loadings considering both flows. Assume that the both tanks are in service. **(14) (CO2, PO2)**

Do you think the detention times can be obtained in an alternative way considering both flows? How?
Comment on the determined detention times to select the better one.
What are your suggestions to comply with the standards design criteria, if for primary tanks, weir loadings are not to exceed 10,000 gpd/foot (125 m^3/m.d) for plants.
Do you think rectangular design of the primary tank is better and why?
Select the pollutants in wastewater that can be removed by primary tank and justify your statement.

2. (a) What is aeration. Why we use aeration? Mention the common types of aerators with a diagram. **(4) (CO1, PO1)**

(b) Sketch a complete process flow diagram/profile to show the combined filtration (biotower) and aeration process with direct recirculation through the tower and recirculation of activated sludge from the clarifier. Describe briefly. **(7) (CO1, PO1)**

(c) A fine-bubble aeration system is used to remove BOD_5 and fully nitrify the industrial wastewater. The temperature of the wastewater is 54°F, site elevation is 5000 ft, diffuser depth is 18 ft and there is a 2 mg/l dissolved oxygen residual. Determine the followings: i) oxygen demand, ii) total horsepower (hp) requirement, iii) number of surface aerators if 20 hp for each aerator, and iv) airflow requirement (cfm) using an influent flow of 3.5 mgd, BOD_5 of 140 mg/l in primary effluent and of 15 mg/l in plant effluent, and ammonia of 23 mg/l? Assume that $\alpha = 0.65$, $\beta = 0.95$, $F = 0.75$, peaking **(14) (CO2, PO2)**

factor = 2, $C_{T,P,de}$ = 8.8 mg/l (for the elevation is 5000 ft at 54°F), $C_{20,1,de}$ = 9.1 mg/l (at standard conditions) and SOTR ranges from 4 to 7.7 O_2 lb/hp.hr.

How can you produce fine bubbles in the aeration basin?
Do you think the course bubbles are better than fine bubbles in the aeration basin and why?

3. (a) Sketch a process flow diagram for membrane biological reactor treatment. Describe briefly. **(4)** (CO1, PO1)

(b) Sketch a diagram of a typical small extended-aeration plant with diffused aeration, air-lift pump in clarifier, equalization tank and effluent chlorination. Describe the operational procedure of this plant. **(7)** (CO1, PO1)

(c) As a Design Engineer, you are assigned to design a small extended-aeration plant for the treatment of industrial wastewater without sludge-wasting facilities at a loading rate of 1 mgd, 10.5 lb BOD_5/1000 cft/day with an aeration period of 24 hr. The measured suspended solids buildup rate in the aeration tank is 68 mg/l/day. What percentage of the raw influent BOD_5 is converted and retained as MLSS? If the MLSS concentration is allowed to increase from 2000 mg/l to 6000 mg/l before wasting solids, how long would this buildup take? **(14)** (CO3, PO3)

Design and sketch the small extended-aeration plant with proper dimensions.
Do you think cylindrical design of the extended-aeration plant is better and why?
Select the pollutants in wastewater that can be removed by extended-aeration plant and justify your statement.

Formulae

$$O_2 \text{ demand} = Q(BOD_i - BOD_e) \cdot 8.34 - (\text{waste TSS})(1.4) + (\text{BOD in recycle and return flows}) + 4.6Q(NO_3)\,8.34$$

$$Cde/C = 1 + 0.01205(\text{diffuser depth})\,(1 + 5.6 \cdot 10^{-7} \times (\text{site elevation}))$$

$$OTR = SOTR\left(\frac{\beta \cdot C_{T,P,de} - C_L}{C_{20,1,de}}\right)(\theta^{T-20})(\alpha F) \qquad Q_{air} = \frac{Q_{O2}}{OTE \cdot \rho_{air} \cdot f_{O2} \cdot 24 \cdot 60}$$