

National Examination December 2009

98-Civ-B5, Water Supply and Wastewater Treatment

3 hours duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.
3. Any non-communicating calculator is permitted.
4. Answer all questions from PART A and any TWO questions from B1, B2, and B3.
5. Values of all questions are indicated.
6. Clarity and organization of the answer are important.

PART A (total 50 marks)

A1 (20 marks)

- (i) A digester is loaded at a rate of 600 lb BOD_l/d. Using a waste-utilization efficiency of 75 percent, what is the volume of gas produced when $\theta_c = 40$ d? $Y = 0.10$ and $k_d = 0.02$ d⁻¹. (10 marks)
- (ii) Determine the amount of activated carbon required per year to dechlorinate treated effluent containing a chlorine residual of 5 mg/L (Cl₂) from a plant with an average flow of 1.0 Mgal/d. What dosage of sulphur dioxide would be required? (10 marks)

A2 (20 marks)

- (i) Discuss the advantages and disadvantages of ozone, UV and chlorine as a disinfectant. (8 marks)
- (ii) FeSO₄ · 7H₂O is added at a rate of 150 lb/ Mgal to a wastewater to improve the efficiency of an existing primary sedimentation unit. How many lbs of lime (as CaO) should be added to complete the reaction? Assume alkalinity is present as Ca(HCO₃)₂. How many pounds of sludge are produced per Mgal. (12 marks).

A3

A wastewater contains 10mg/L of ammonia nitrogen and no organic carbon. The plant flow-rate is 2.5 Mgal/d. Estimate the methanol requirement and cell production in pounds per day for complete bacterial assimilation of ammonia. (10 marks)

Part B (50 marks). Answer two of the following three.

B1 (25 marks)

- (i) Phosphorus is to be removed from a secondary effluent. The plant discharge requirements have been set at 1.0 mg/L. If the soluble phosphorus in the effluent is equal to 10 mg/L, estimate the alum dose required to achieve the desired degree of removal. (10 marks)
- (ii) Assume that a particle has a constant settling velocity. What is the settling velocity of a particle that has taken 6 h to settle a depth of 3.0 m in an ideal circular clarifier with a Q/A of 35 m³/m²/d. The influent flow is distributed uniformly across the plan area of the clarifier and underflow is being removed from the clarifier at a rate of 7.5 m³/m²/d. (15 marks)

B2 (25 marks)

A rectangular clarifier with a length to width ratio of 3:1 receives a flow of 850 m³/d. The clarifier's depth is 4.0 m and the detention time of water in the clarifier is 2.4 h. What are the surface overflow rate and the horizontal flow-through velocity if flow is distributed uniformly across the cross-sectional area of the tank?

B3 (25 marks)

A complete mix activated sludge process operates with the following operating conditions: Volumetric flow rate, $Q = 8000 \text{ m}^3/\text{d}$, Inlet substrate concentration, $S_0 = 240 \text{ mg COD/L}$, Effluent concentration $S_e = 30 \text{ mg COD/L}$, Sludge retention time $\theta_x = 5.0 \text{ d}$, Hydraulic retention time, $\theta_d = 5.5 \text{ h}$ Mixed liquor VSS concentration, $X_v = 1500 \text{ mg/L}$. What is the rate of oxygen consumption (Kg/d) for the process with the given data.