

National Examination December 2009

04-Env-A4, Water and Wastewater Engineering

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) 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) A digester is loaded at a rate of 600 lb BOD_t/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)**

A2 (20 marks)

- (i) 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. **(14 marks)**
- (ii) Discuss the advantages and disadvantages of ozone, and UV as a disinfectant? **(6 marks)**

A3 (10 marks)

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.

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

B1 (25 marks)

A complete mix activated sludge process operates with the following operating conditions: Volumetric flow rate, $Q = 8000$ m³/d, Inlet substrate concentration, $S_0 = 240$ mg COD/L, Effluent concentration $S_e = 30$ mg COD/L, Sludge retention time $\theta_x = 5.0$ d, Hydraulic retention time, $\theta_d = 5.5$ h Mixed liquor VSS concentration, $X_v = 1500$ mg/L. What is the rate of oxygen consumption (Kg/d) for the process with the given data.

B2 (25 marks)

A mechanically cleaned wastewater bar screen is constructed using 6.5 mm-wide bars spaced 5.0 cm apart center to center. The wastewater flow velocity in the channel immediately upstream of the screen will vary from 0.4 to 0.9 m/s.

What is the design head-loss for the screens at the two extremes of flow?
Assume the friction coefficient is 0.84.

B3 (25 marks)

- (i) Determine the amount of activated carbon required per year to dechlorinate treated effluent containing a chlorine residual of 5 mg/L (Cl_2) from a plant with an average flow of 1.0 Mgal/d. What dosage of sulphur dioxide would be required. **(10 marks)**.

- (ii) $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ 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 $\text{Ca}(\text{HCO}_3)_2$. How many pounds of sludge are produced per Mgal. **(15 marks)**.