

**National Examination December 2011**

**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 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)**
- (ii)  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  is added at a rate of 230 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. **(10 marks)**

**A2 (20 marks)**

- (i) Discuss the advantages and disadvantages of UV versus chlorine dioxide. **(8 marks)**
- (ii) Determine the amount of activated carbon and sulphur dioxide required per year to dechlorinate treated effluent containing a chlorine residual of 2.5 mg/L ( $\text{Cl}_2$ ) from a plant with an average flow of 0.8 Mgal/d. **(12 marks)**

**A3**

An anaerobic biogas digester is loaded at a rate of 450 lb  $\text{BOD}_L/\text{d}$ . Using a waste-utilization efficiency of 75 percent, what is the volume of gas produced when  $\theta_c = 40 \text{ d}$ ?  $Y = 0.10$  and  $k_d = 0.02 \text{ d}^{-1}$ . **(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) A rectangular clarifier with a length to width ratio of 3:1 receives a flow of 850  $\text{m}^3/\text{d}$ . 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? **(15 marks)**

**B2 ( 25 marks)**

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  $35 \text{ m}^3/\text{m}^2/\text{d}$ . 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  $7.5 \text{ m}^3/\text{m}^2/\text{d}$ .

**B3 (25 marks)**

A complete mix activated sludge process operates with the following operating conditions: Volumetric flow rate,  $Q = 12000 \text{ m}^3/\text{d}$ , Inlet substrate concentration,  $S_0 = 340 \text{ mg COD/L}$ , Effluent concentration  $S_e = 20 \text{ mg COD/L}$ , Sludge retention time  $\theta_x = 5.0 \text{ d}$ , Hydraulic retention time,  $\theta_d = 6.5 \text{ h}$  Mixed liquor VSS concentration,  $X_v = 2500 \text{ mg/L}$ . What is the rate of oxygen consumption (Kg/d) for the process with the given data.