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) $FeSO_4 . 7H_2O$ 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 $Ca(HCO_3)_2$. 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 (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 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)**

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 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? **(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 $m^3/m^2/d$. 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 $m^3/m^2/d$.

B3 (25 marks)

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