NATIONAL EXAMINATION, MAY 2012

04-ENV-A4-Water and Wastewater Engineering

3 hours duration

Notes:

1. If doubts exist 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 a closed book exam. However, one aid sheet is allowed written on both sides.
3. An approved Casio or Sharp calculator is permitted.
4. Attempt any two questions from Part A, and any two questions from Part B.
5. Marks of all questions are indicated at the end of each question.
6. Clarity and organization of answers are important.

PART A (Total 50 marks)

A1 (25 marks)

i. A 200 mL sample of water has an initial pH of 10.5. 10 mL of 0.02N H_2SO_4 are required to bring its pH down to 8.3, and additional 20 mL are required to bring the pH further down to 4.5. Calculate the total and bicarbonate alkalinity of the sample. **(10 marks)**

ii. Explain the term "optimum coagulant dose" used in water treatment. Describe the procedure for jar test for determining the optimum coagulant dose in a lab. **(15 marks)**

A2 (25 marks)

i. What are indicator organisms? Discuss the characteristics of ideal pathogen indicators and name the microorganisms that most nearly exhibit these characteristics. **(10 marks)**

ii. Explain the phenomenon of break point chlorination with the help of a chlorine dosage vs. residual chlorine curve. **(15 marks)**

A3 (25 marks)

i. Explain briefly the principal of ion exchange process for removal of hardness from water. **(8 marks)**

ii. A filter plant is to be constructed to process 75,700 m^3/d of water. Pilot plant analysis on mixed media indicates that a filtration rate of 15m/h will be acceptable. Assuming a surface configuration of approximately 5m x 8m, how many filters will be required? Allow one unit out of service for backwashing. **(10 marks)**

iii. Describe the significance of hardness, fluorides, Iron and manganese in water. **(7 marks)**

PART B (Total 50 marks)

B1 (25 marks)

i. Define TKN of wastewater and explain how it is different from ammonia-N in wastewater. If TKN and ammonia-N are both 25 mg/L for a wastewater sample, what would you say about its organic nitrogen content? **(7 marks)**

ii. With regard to the standard five day BOD test of raw sewage, define and explain the significance of the following;
   a. Dilution of a sample**(3 marks)**
   b. Seed **(3 marks)**
   c. Blank sample **(3 marks)**

iii. What is the importance of alkalinity in wastewater? Explain how it is affected by nitrification and denitrification processes in a wastewater treatment plant **(9 marks).**

B2 (25 marks)

An activated sludge system treats a wastewater flow of 50,000 m^3/d. The operating parameters of the system are as follows:

a. Influent BOD_5 = 200 mg/L
b. Influent TSS = 220 mg/L
c. Primary clarifier TSS removal = 60%
d. Primary sludge concentration = 4%
e. Primary clarifier BOD removal = 35%
f. TSS yield in aeration tanks = 0.90 kg TSS/ kg BOD_5
g. Waste activated sludge concentration = 1%
h. Specific gravity of primary and waste activated sludge = 1.03

Determine the following:

1. Primary sludge volume per day **(6 marks)**
2. Waste activated sludge volume per day **(6 marks)**
3. Total sludge solids produced per day **(6 marks)**
4. Total dry tonnes of digested biosolids produced per day, if the combined sludge has VSS of 75% and there is 50% VSS destruction in the sludge digestion process. **(7 marks)**

B3 (25 marks)

A conventional activated sludge system treats a wastewater flow of 10,000 m^3/d. The influent BOD_5 and TP of the wastewater are 200mg/L and 5 mg/L respectively. Assuming 30% BOD_5 and 12% TP removal with the primary sludge, and a biomass yield of 0.6 kg-VSS/kg BOD_5, calculate the phosphorus removed via waste activated sludge. If 85% the remaining phosphorus is to be removed chemically, calculate the volume of 48% alum (specific gravity 1.33) required, if 15 kg of dry alum is required to remove 1 kg phosphorus. **(25 marks)**