NATIONAL EXAMINATION, DECEMBER 2013

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 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. Explain mathematically that the settling of discrete particle in a primary sedimentation tank is a function of the surface area and not the depth of the tank. **(15 marks)**

ii. What is an indicator organism in biological examination of water? List the characteristics required of an organism to be selected as an indicator. **(10 marks)**

A2 (25 marks)

i. Labeling all unit processes, process streams and chemical injection points; draw a detailed process schematic of a water treatment plant that has raw water with following characteristics.
   a. Turbidity of 30-50 NTU
   b. Hardness of 200-250 mg/L
   c. Seasonal taste and odours
   d. pH range of 7.0 to 8.7

A3 (25 marks)

i. With the help of a general chlorination curve, explain the following
   a. Chlorine demand **(5 marks)**
   b. Formation of chloramines and organochlorines **(5 marks)**
   c. Breakpoint chlorination **(5 marks)**

ii. Define and explain the following terms in water treatment:
   a. Charge neutralization and ionic layer compression in coagulation **(5 marks)**
   b. Discrete and flocculent settling **(5 marks)**

PART B (Total 50 marks)

B1 (25 marks)

i. Define and differentiate between
   a. TSS, VSS and fixed suspended solids **(6 marks)**
   b. COD and BOD **(6 marks)**
   c. Orthophosphates, polyphosphates and organic phosphates **(7 marks)**
   d. Return activated sludge and waste activated sludge **(6 marks)**

B2 (25 marks)

An activated sludge system treating a wastewater flow of 20,000 m^3/d has the following primary effluent characteristics:

a. BOD_5 = 120 mg/L
b. TKN = 25 mg/L

I. For a VSS yield of 0.65 kg VSS/ kg BOD5, calculate the volume of waste activated sludge per day for a secondary clarifier underflow sludge concentration of 8,000 mg/L **(10 marks)**
II. Calculate the volume of aeration tank required. Choose an SRT with an assumption that system is required to consistently nitrify. **(15 marks)**

B3 (25 marks)

i. For the problem B2 above, calculate the total oxygen and air requirement per day **(10 marks)**
ii. With the help of a neat diagram, explain the operation of a single stage anaerobic digester. Discuss briefly the two key parameters that define the digester efficiency, and comment on the operating parameters that dictate the digester efficiency. **(15marks)**