NATIONAL EXAMINATION, MAY 2017

16-CIV-B5-Water Supply and Wastewater Engineering

3 hours duration

Notes:

1. Question 1 is compulsory, attempt any three questions from the remaining four questions.
2. 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.
3. This is a closed book exam. However, one aid sheet is allowed written on both sides.
4. An approved calculator is permitted.
5. Marks of all questions are indicated at the end of each question.
6. Clarity and organization of answers are important.

Q1 (25 marks)

Define and differentiate between the following:

i.   MLSS and MLVSS **(5 marks)**
ii. BOD_5 and $cBOD_5$ **(5 marks)**
iii. Surface overflow rate and solids loading rate **(5 marks)**
iv.   Combined and Free Residual Chlorine **(5 marks)**
v.   Hydroxyl and Bicarbonate alkalinity **(5 marks)**

Q2 (25 marks)

a.   Explain briefly with the help of chemical equations the ion exchange process for water softening **(10 marks)**

b.   Explain the significance of Fluorides, Nitrates, Sulfates, Alkalinity and Hardness as water quality parameters **(15 marks)**

Q3 (25 marks)

A city has a secondary level wastewater treatment plant (WWTP) with a rated capacity of 5,000 m^3/d with the treated effluent from WWTP discharging to a river with a flow of 500,000 m^3/d. The current effluent discharge limits for $cBOD_5$, TSS and total phosphorus (TP) as 15 mg/L, 15 mg/l and 1 mg/L respectively. A study has established the background TP concentration of 0.02 mg/L in the river and recommends that downstream concentration should not deteriorate more than 10% of the upstream concentration to keep the water quality intact. Determine what level does the effluent TP limit need to be adjusted to in order to meet the above condition. Also comment on the potential changes or upgrades required to the WWTP to meet this condition. **(25 marks)**

Q4 (25 marks)

A conventional activated sludge based wastewater treatment plant (WWTP) has an average flow of 10,000 m^3/d. The system is operated at an SRT of 10 days.

a.   If the aeration tank in the WWTP is operated at an MLSS of 3,500 mg/L, and the system has a waste sludge production rate of 100 m^3/d at waste sludge MLSS of 10,000 mg/L, calculate the volume and HRT of the aeration tank. **(10 marks)**

b.   If the total secondary clarifier volume is 3,500 m^3 with a side water depth of 3.5m, calculate the surface overflow rate and solids loading rate for the secondary clarifiers. **(7 marks)**

c.   For a primary clarifier effluent BOD_5 of 150 mg/L, calculate the oxygen demand in kg/d for BOD removal. **(8 marks)**

Q5 (25 marks)

With the help of a diagram, explain the working principal and operation of a rapid sand filter, with special reference to "Shmutzdecke", filter backwash and air scouring. **(25 marks)**