

**NATIONAL EXAMINATION, DECEMBER 2014**

**98-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. A Casio or Sharp approved models.
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<sub>5</sub> and COD (5 marks)
- iii. Surface overflow rate and solids loading rate (5 marks)
- iv. Total and 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, Sulfides 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 10,000 m<sup>3</sup>/d with the treated effluent from WWTP discharging to a river with a flow of 500,000 m<sup>3</sup>/d. The current effluent discharge limits for cBOD<sub>5</sub>, 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 20% of the upstream concentration to keep the water quality intact. Determine what level does the effluent TP limit needs 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 50,000 m<sup>3</sup>/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 3,000 mg/L, and the system has a waste sludge production rate of 500 m<sup>3</sup>/d at waste sludge MLSS of 8,000 mg/L, calculate the volume and HRT of the aeration tank. (10 marks)
- b. If the total secondary clarifier volume is 12,000 m<sup>3</sup> 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<sub>5</sub> of 150 mg/L, calculate the oxygen demand in kg/d for BOD removal. (8 marks)

**Q5 (25 marks)**

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