

**NATIONAL EXAMINATION, MAY 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.
5. Marks of all questions are indicated at the end of each question.
6. Clarity and organization of answers are important.

**Must attempt question # 1 and then choose any 3 other questions from the remaining four (2, 3, 4, 5)**

**Q1 (25 marks)**

Define and briefly describe the significance of the following parameters or processes in water or wastewater treatment.

- i. Softening of water (5 marks)
- ii. F/M ratio in wastewater treatment (5 marks)
- iii. Surface overflow rate (5 marks)
- iv. Residual Chlorine (5 marks)
- v. Sludge Volume Index (5 marks)

**Q2 (25 marks)**

- a. Identify and explain briefly four key phenomenon by which particles get removed in filtration of water (10 marks)
- b. Define and differentiate between free residual and combined residual chlorine (8 marks)
- c. Describe the process of break-point chlorination (7 marks)

**Q3 (25 marks)**

A city has a wastewater treatment plant (WWTP) with a rated capacity of 10,000 m<sup>3</sup>/d and wants to expand the plant to a capacity of 15,000 m<sup>3</sup>/d. The treated effluent from WWTP is discharged to a river. The current effluent discharge limits for cBOD<sub>5</sub> and total phosphorus (TP) are 15 mg/L and 1 mg/L respectively. As a requirement of the expansion of WWTP, the regulatory authority has stipulated a condition that under the increased capacity of 15,000 m<sup>3</sup>/d, the effluent loading of cBOD<sub>5</sub> should be the same as at 12,000 m<sup>3</sup>/d flow and that of TP not more than 80% of the maximum permissible effluent TP load at a flow of 12,000 m<sup>3</sup>/d. Also, there is an additional condition of not exceeding total ammonia (TAN) load of 60 kg/d at the increased capacity of 15,000 m<sup>3</sup>/d. Determine the new effluent limits for cBOD<sub>5</sub>, TP and TAN based on the above conditions at the higher capacity (25 marks)

**Q4 (25 marks)**

A conventional activated sludge based wastewater treatment plant (WWTP) has an average flow of 15,000 m<sup>3</sup>/d. There are two (2) circular secondary clarifiers in the WWTP which operate at a surface overflow rate of 15 m<sup>3</sup>/m<sup>2</sup>-d at average flow.

- a. Determine the diameter of each secondary clarifier (8 marks)
- b. If the aeration tank in the WWTP is operated at an MLSS of 3,000 mg/L, and return activated sludge flow is 10,000 m<sup>3</sup>/d, determine the solids loading rate on the secondary clarifiers at average flow. (7 marks)
- c. With aeration tank volume of 5,000 m<sup>3</sup>; waste sludge rate of 150 m<sup>3</sup>/d at waste sludge MLSS of 6,000 mg/L, calculate the SRT of the system (10 marks)

**Q5 (25 marks)**

Draw the process schematic of a water treatment plant that has a raw water source with 150-200 NTU of turbidity, 300 mg/L of hardness, iron concentration of 1.0 mg/L and seasonal taste and odours. Show all liquid and solid streams, chemical injection points, and expected water quality with regards to hardness, turbidity, iron and pathogens after treatment. (25 marks)