

NATIONAL EXAMINATION, MAY 2013

04-ENV-A4-Water 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. BOD_5 and BOD_u (5 marks)
- ii. pH and Alkalinity (5 marks)
- iii. TKN and Ammonia Nitrogen (5 marks)
- iv. Total suspended solids and volatile suspended solids (5 marks)
- v. Free and combined residual chlorine (5 marks)

Q2 (25 marks)

- a. Describe the principal of hardness measurement (standard method) for a water sample. If a 50 mL water sample required 5 mL of N/50 EDTA to reach the end point of the titration, what is the hardness of the sample (10 marks)
- b. What is the importance of the "Blank" bottle in the standard BOD test? (7 marks)
- c. A 2% sewage sample had a DO of 8.0 mg/L at the start of a BOD_5 test. If the final DO values of the sewage sample and the "Blank" are 3 mg/L and 7.8 mg/L respectively, determine the BOD_5 of the undiluted raw sewage. (8 marks)

Q3 (25 marks)

- a. With the help of a neat diagram, describe the principal and working of a rapid sand filter for water treatment (15 marks)
- b. Explain the concepts of break point chlorination and superchlorination. (10 marks)

Q4 (25 marks)

A wastewater treatment plant with an average flow of $15,000 \text{ m}^3/\text{d}$ has a secondary clarifier with a hydraulic retention time (HRT) of 6.0 h and side water depth of 4.0 m. If the mixed liquor in the aeration tank has an MLSS concentration of 3000 mg/L;

- a. Determine the volume, surface overflow rate (SOR) and the solids loading rate (SLR) of the clarifier (10 marks)
- b. Determine the return activated sludge (RAS) flow rate to be maintained if the RAS TSS (underflow sludge) concentration is to be maintained at 6000 mg/L. (15 marks)

Q5 (25 marks)

- a. With the help of a sketch, describe the key components, principal and working of a single-stage anaerobic sludge digester. (15 marks)
- b. List and explain the key parameters associated with efficiency of VSS destruction, and indications of operational instability in an anaerobic sludge digester. (10 marks)