

NATIONAL EXAMINATION, MAY 2015

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 explain the significance of following terms in water and wastewater engineering

- i. Ortho, poly and organic phosphates in wastewater (5 marks)
- ii. Seed and blank in BOD₅ test (5 marks)
- iii. Oxygen sag curve in stream pollution (5 marks)
- iv. Indicator organisms in biological testing of water (5 marks)
- v. Turbidity in water(5 marks)

Q2 (25 marks)

- a. Explain the principal and working of disinfection of water by UV radiation. State its key advantages and disadvantages over chlorination. (10 marks)
- b. Explain the function of coagulation, flocculation, filtration, adsorption and ion exchange in treatment of water by giving examples when these processes may be necessary in treatment of water. (15 marks)

Q3 (25 marks)

- a. Explain the principal of removal of BOD and nutrients in a facultative lagoon system. Also explain how a facultative lagoon differs from an aerated lagoon system. (10 marks)
- b. 5 ml of a raw sewage sample diluted to 300 mL in a BOD bottle had an initial DO of 9.0 mg/L. After 4 days of incubation at 20°C, the DO in the sample was measured at 4.3 mg/L. Assuming 2% of the oxygen demand over this 3 day period being contributed by the seed in the sample, determine the 4 day, 5 day and ultimate BOD of the sample. (15)

Q4 (25 marks)

Give a brief description of the following in water and wastewater treatment:

- a. Anaerobic sludge digestion (6 marks)
- b. Filter headloss, Schmutzdecke and filter backwash (6 marks)
- c. Biomass sloughing in a tricking filter (7 marks)
- d. HRT and SRT in biological treatment systems (6 marks)

Q5 (25 marks)

Primary clarifier of an activated sludge system treats an average day flow of 20,000 m³/d with TSS, VSS and BOD₅ of 200 mg/L, 170 mg/L and 160 mg/L respectively. If the TSS removal efficiency of the clarifier is 60%, calculate the following;

- I. TSS, VSS and BOD₅ loads in primary effluent. Assume appropriate BOD₅ removal for the given TSS removal in the clarifier. (7 marks)
- II. Volume of primary sludge produced per day, assuming a solids concentration of 4% and specific gravity of 1.03. (6 marks)
- III. Surface area of the primary clarifier for a surface overflow rate of 80 m³/m²-d at peak day flow, assuming a peaking factor of 2.25. (6 marks)
- IV. HRT at average day flow if the side water depth of the clarifier is 3.0 m. (6 marks)