NATIONAL EXAMINATION, MAY 2014

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 water and wastewater quality parameters.

    i.   Total ammonia and free ammonia **(5 marks)**
    ii.   COD and BOD **(5 marks)**
    iii.   Hydroxyl and carbonate alkalinity **(5 marks)**
    iv.   Temporary and permanent hardness **(5 marks)**
    v.   Mineral and carbon dioxide acidity **(5 marks)**

Q2 (25 marks)

    a. Explain the principal of water softening with ion exchange process **(10 marks)**
    b. Describe the jar test procedure for determining optimum coagulant dose in water treatment **(10 marks)**
    c. Define and describe the significance of residual chlorine in water supplies **(5 marks)**.

Q3 (25 marks)

a. With a neat diagram, explain the principal and working of a rotating biological contactor system in wastewater treatment **(15 marks)**

b. A dairy processing wastewater produces a wastewater flow of 1000 m^3/d with a COD of 10,000 mg/L. The industry is required to meet the municipal sewer use by-law that requires the treated effluent discharge to municipal sewers with COD not exceeding 500 mg/L. The industry wants to find a treatment solution with minimum footprint and energy requirements. Explain the reasons for your choice, describe the system you will recommend as a wastewater engineer that meets the industry requirements. **(10 marks)**

Q4 (25 marks)

A conventional activated sludge based wastewater treatment plant (WWTP) has an average flow of 15,000 m^3/d. For a primary effluent BOD_5 value of 150 mg/L, and a peak hourly flow factor 3.0 determine the following:

    a. Oxygen demand and air requirement for 95% BOD removal **(10 marks)**
    b. Volume of aeration tank for an SRT of 4d, TSS yield of 0.8 kg TSS/kg-BOD_5 and MLSS of 2,000 mg/L **(8 marks)**
    c. Secondary clarifier area for maximum allowable peak hourly surface overflow rate of 35 m^3/m^2-d **(7 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, 100 mg/L of hardness, pH of 6.5 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)**