National Examination May 2010

04-Env-A4, Water and Wastewater Engineering

3 hours duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.
3. Any non-communicating calculator is permitted.
4. Answer all questions from PART A and any TWO questions from B1, B2, and B3.
5. Values of all questions are indicated.
6. Clarity and organization of the answer are important.

PART A (total 50 marks)

A1 (20 marks)

    (i)   Discuss and describe some of the reasons for variability in BOD determination. (10 marks)

    (ii)   A wastewater contains 200 mg/L of phenol (C_6H_5OH). Determine the COD of the wastewater. ((10 marks)

A2 (20 marks)

    (i)   A spherical particle with a diameter of 0.6 mm and a specific gravity of 2.65 is settling in a water at temperature of 22 deg C. Assume Type 1 settling and calculate the settling velocity of the particle. (12 marks)

    (ii)   Write down the half-reactions for the reduction of ClO_2 to Cl^- and Cl_2 to Cl^-. Based on these half reactions, how many chlorine atoms will be added to a water when chlorine dioxide is used as the disinfecting agent compared to chlorine? (8 marks)

A3 (10 marks)

    The 5 day BOD at 20 deg C is equal to 250 mg/L for 3 different samples but the 20 deg C k values are equal to 0.25 d^{-1} , 0.35 d^{-1} and 0.46 d^{-1}. Determine the ultimate BOD of each sample.

Part B (50 marks). Answer two of the following three.

B1 (25 marks)

    A conventional activated sludge plant treats 1.0 Mgal/d of wastewater with a BOD_5 of 200 mg/L after settling. The process loading is 0.30 lb BOD/d.lb MLVSS. The detention time is 6 h and the recirculation ratio is 0.33. Determine the concentration of the MLVSS.

B2 (25 marks)

    Design an aerated grit chamber for an average wastewater flow rate of 0.3 m^3/s and a peak flow rate of 1.0 m^3/s. The average depth is 3 m, the width to depth ratio is 1.5 to 1.0 and the detention time at peak flow is 3.5 min. the aeration rate is 0.4 m^3 per min per m of tank length. Determine the dimensions of the grit chamber and the total air requirements.

B3 (25 marks)

Clean water at 20 deg C is passed through a bed of uniform sand at a filtering velocity of 5.0 m/h. The sand grains are 0.35 mm in diameter with a shape factor of 0.85 and a specific gravity of 2.65. The porosity of the bed is 0.4. Calculate the filter bed depth to achieve a head loss of 0.6 m through the filter bed.