Name.....Student ID.....

Prince of Songkla University

Faculty of Engineering

Exam: Mid-term Exam: Semester II | Academic Year: 2009

Date: 27 December 2009 | Time: 09:00 – 12:00

Subject: 230-333 Environmental Control | Room: R300

- All books and notes are allowed
- All calculator models are allowed
- Use of pencil is allowed
- The exam paper has 8 pages, including first page.

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Problem number	Points Value	Score
1	10	
2	10	
3	15	
4	20	
5	10	
6	25	
Total	**90**	

Exam prepared by

Pakamas Chetpattananondh

21 December 2009

Name.....Student ID.....

1. A wastewater sample is at 30°C. The dilution ratio is 1:150. The initial dissolved-oxygen concentration is 6 mg/L, a final dissolved-oxygen concentration of wastewater and dilution water is 3 mg/L, and a final dissolved-oxygen concentration of dilution water is 2 mg/L. The suspended solid is 1,500 mg/L. Can we discharge this wastewater to a river? Explain the reasons and give some suggestions on treatment process for this wastewater. (10 Points)

Name.....Student ID.....

2. Jar testing was performed using alum on two raw drinking-water sources: water A and water B. Both water sources contained an initial turbidity of 20 NTU. For water A the optimum coagulant dosage was determined as 18 mg/L with a final turbidity of 0.25 NTU. For water B the optimum coagulant dosage was determined as 20 mg/L with a final turbidity of 5 NTU.

   (a) Determine the quantity of alkalinity consumed as $CaCO_3$ for water A. (5 Points)

   (b) Which water has lower alkalinity? (1 Points)

   (c) If pH of water is 7 what is the form of alum in water? With that form of alum which mechanism of coagulation will be occurred? (4 Points)

Name.....Student ID.....

3. Calculate the lime dosage required for softening **by selective calcium removal** for the following water analysis. The dissolved solids in the water are CO_2 = 17.6 mg/L, Ca^{2+} = 63 mg/L, Mg^{2+} = 15 mg/L, Na^{+} = 20 mg/L, Alk (HCO_3^{-}) = 189 mg/L as $CaCO_3$, SO_4^{2-} = 80 mg/L, Cl^{-} = 10 mg/L. (15 points)

Name.....Student ID.....

4. A wastewater treatment plant receives a flow of 35,000 m^3/day at 10°C.
   (a) Calculate the required volume (m^3) for a 3 m deep horizontal flow grit chamber that will remove particles with a specific gravity of more than 1.3 and a size greater than 0.2 mm diameter. (12 points)
   (b) What is the detention time of grit chamber? (3 points)
   (c) If a flow-through velocity of 0.5 m/s will be maintained. Determine the length of the grit chamber. (2 points)
   (d) What removal percentage should be expected for particles that have settling velocities of 2 m/hr? (3 points)

Name.....Student ID.....

5. A water sample is passed through a filtration system with a rate of 5 m/h. The filter media has porosity of 0.45. A sieve analysis curve of a typical filter sand gives d_{10} = 0.54 mm and d_{60} = 0.94mm.
   (a) What is its uniformity coefficient? (2 points)

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4. A wastewater treatment plant receives a flow of 35,000 m^3/day at 10°C.

   (a) Calculate the required volume (m^3) for a 3 m deep horizontal flow grit chamber that will remove particles with a specific gravity of more than 1.3 and a size greater than 0.2 mm diameter. (12 points)

   (b) What is the detention time of grit chamber? (3 points)

   (c) If a flow-through velocity of 0.5 m/s will be maintained. Determine the length of the grit chamber. (2 points)

   (d) What removal percentage should be expected for particles that have settling velocities of 2 m/hr? (3 points)

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5. A water sample is passed through a filtration system with a rate of 5 m/h. The filter media has porosity of 0.45. A sieve analysis curve of a typical filter sand gives d_{10} = 0.54 mm and d_{60} = 0.94mm.

   (a) What is its uniformity coefficient? (2 points)

   (b) Which media will be applicable for the filtration? (2 points)

   (c) What is the head loss? (2 points)

   (d) Which type of filtration for this system? (2 points)

   (e) Can this system treat water with 100 NTU turbidity? (2 points)

Name.....Student ID.....

6. You are provided the following information about a municipal wastewater treatment plant. This plant uses the traditional activated-sludge process. Assume the microorganisms are 55 percent efficient at converting food to biomass, the organisms have a first-order death rate constant of 0.05/day, and the microbes reach half of their maximum growth rate when the BOD_5 concentration is 10 mg/L. There are 150,000 people in the community (their wastewater production is 225 L/person-day, 0.1 kg BOD_5/ person-day). The effluent standard is BOD_5 = 20 mg/L and TSS = 20 mg/L. Suspended solids were measured as 4,300 mg/L in a wastewater sample obtained from the biological reactor, 15,000 mg/L in the secondary sludge, 200 mg/L in the plant influent, and 100 mg/L in the primary clarifier effluent. SRT is equal to 4 days. (a) What is the design volume of the aeration basin (m^3)? (b) What is the plant's aeration period (days)? (c) How many kg of secondary dry solids need to be processed daily from the treatment plants? (d) If the sludge wastage rate (Q_w) is increased in the plant, will the solids retention time go up, go down, or remain the same? (e) Determine the F/M ratio in units of kg BOD_5/kg MLVSS-day? (f) What is the mean cell residence time? (25 points)