

**PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING**

Final Examination: Semester I
Date: October 4, 2005
Subject: 223-471 Wastewater Engineering and Design

Academic Year: 2005
Time: 13:30 -16:30
Room R 300

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1. Answer Question 1 and any other five (5) selected questions from Question 2 to 7
 2. Total points = 100
 3. Text books and lecture note are not allowed.
 4. Calculator and dictionary are allowed.
 5. All questions should be answered in English;
 6. Read the questions carefully and answer only what is required.
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1. (25 points)

An anaerobic digester system for waste sludge from a secondary plant is being evaluated for its design and performance. It consists of two stage digestion with 2 digesters in each stage, i.e. 2 primary digesters and 2 secondary digesters. The primary digesters are 20 m in diameter and 5 m side water depth. The secondary digesters are 18 m in diameter and 5 m side water depth. The sludge entering the primary digesters comes from a gravity thickener at 3 % solids. The volume of the influent sludge is 480 m³/d.

Determine if the SRT for the primary digesters is adequate. (10 points)

If VSS = 0.8 TSS, determine the VSS loading to the digesters in kg/m³.d. (5 points)

The overall VSS reduction in the digester was 45%, determine the volume of digested sludge and supernatant if the digested sludge leaving the secondary digester is 2.5 % solids.(10 points)

The sludge specific gravity = 1.014.

2. (15 points)

- a. Sketch a schematic drawing of a recycle pressurization Dissolved Air Flotation (DAF) unit for waste activated sludge thickening.
- b. Sketch a cross section of an UASB process for anaerobically treating industrial wastewater.
- c. Sketch a cross section of a belt filter press showing the three main stages-conditioning, gravity drainage and pressure dewatering.

3. (15 points)

Answer if the following statements are **True or False** by marking at the appropriate place.

- a. Most important factor for dewatering sludge in a sludge lagoon is drainage of water through the lagoon bottom into the soil underneath.
..... **T rue.....False**
- b. In a belt filter press process, sludge holding facility is used to equalize the quality of the incoming sludge before it is conditioned.**True.....False**
- c. For land application of sludge the sludge parameters of interest are: sludge % solids, sludge total bacteria counts and sludge sulfate concentration.
..... **True****False**
- d. Wastewater sludge vector attraction refers to its hydraulic flow properties.
.....**True****False**
- e. In composting operation of sludge with bulking agent the temperature rises to about 60° C which is needed to stabilize the organic matter present in the sludge.
.....**True****False.**

4. (15 points)

In a compost operation 1500kg (total weight) of dewatered sludge at 18 % solids will be windrow composted with wood chips as a bulking agent having a moisture level of 9 %. It is desired that the mixture (sludge + wood chips) moisture level be 48 %. How much wood chips will be needed to achieve the required moisture level? (8 points)

If the C/N of sludge is 12 and that of the wood chip is 120, what would be the C/N of the mixture? Is this acceptable C/N ratio for proper composting? (7 points)

5. (15 points)

- a. Write a general equation for the **aerobic** sludge digestion process where microbial cell components are being used for cell maintenance and ultimately they die.
- b. What is the key intermediate compound in the anaerobic sludge digestion process where complex organic compounds in the sludge are being degraded in stages to CH₄, CO₂ and stable organic matter?
- c. What parameters are monitored to assess the performance of an anaerobic sludge digestion process?

6. (15 points)

Determine the amount (volume m³/d and mass kg/d) of primary and secondary sludge produced from a wastewater plant with the following data:

Wastewater flow rate, $Q = 7,500 \text{ m}^3/\text{d}$

Influent BOD of raw wastewater = 275 mg/L

Influent Suspended Solids (SS) of wastewater = 300 mg/L

BOD removed in Primary settling tank = 35 %

SS removed in Primary settling tank = 45 %

Specific gravity of sludge = 1.015;

Final effluent soluble BOD₅, $S_e = 15 \text{ mg/L}$;

Final effluent SS = 20 mg/L ;

Assume: $Y_{\text{obs}} = 0.3$; $\text{TVSS} = 0.85 \text{ TSS}$;

Solids in primary sludge = 3 %; Solids in secondary sludge = 1 %.

[Given: Sludge from secondary process, $\text{kg/d} = Y_{\text{obs}} (S_o - S_e)Q$].

Assume any other data needed.

7. (15 points)

- Draw a cross section of a sludge drying bed for dewatering digested sludge.
- What happens to the drained water from the sludge drying beds?
- What factors affect the dewatering operation in a sludge drying bed?
- How is the dried sludge removed from the sludge drying bed?

Prof. S. K. Banerji