
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

EAP 582/4 – Wastewater Engineering

Duration : 3 hours

Please check that this examination paper consists of **SIX (6)** printed pages before you begin the examination.

Instructions:

This paper contains **SIX (6)** questions. Answer **FIVE (5)** question only.

You may answer the question either in Bahasa Malaysia or English

All questions **MUST BE** answered on a new page.

Write the answered question numbers on the cover sheet of the answer script.

1. a) i) Explain briefly how to calculate/measure ThOD, COD and BOD.
 ii) Write the order of oxygen demand value between them.
 iii) Why the BOD value is never equal to the ThOD or COD?.

(6 marks)

- b) Sketch and explain briefly, what are the two processes by which the activated sludge process removes soluble carbonaceous material from sewage.

(4 marks)

- c) The following kinetic coefficients (parameter) values for anaerobic digestion of domestic sludge wastewater treatment over the temperature range from 20-35°C are given as follows:

K_s	= half-velocity constant (substrate concentration at one-half the max. growth rate) = $1.8 \times (1.112^{(T-35)})$	[g COD/L] ;
μ_m	= max. specific growth rate = $0.27 \times (1.035^{(T-35)})$	[day ⁻¹] ;
k	= max. rate of substrate utilization = $6.67 \times (1.035^{(T-35)})$	[day ⁻¹] ;
k_d	= endogenous decay coefficient = $0.03 \times (1.035^{(T-35)})$	[day ⁻¹] ;
Y	= max. cell yield (mass of cells formed to the mass of substrate consumed) = 0.04	[g VSS/g COD] ;
T	= temperature	[°C]

If flow rate of the sludge into the reactor were doubled and the reactor temperature decreased from 35°C to 25°C, what is the decreasing ratio of safety factors?. Assume S (concentration of growth-limiting substrate) is much greater than K_s .

(10 marks)

2. a) The characteristic of a given wastewater are as follows: $BOD_5 = 515$ mg/L; $NH_3 = 64$ mg/L; and $k=0.37$ day⁻¹. Estimate the total quantity of oxygen (in mg/L) that required to completely stabilize this kind of wastewater?

(6 marks)

- b) i) Give **FIVE (5)** types of pump which is generally used in wastewater treatment facilities.
- ii) Give **FIVE (5)** of pumping applications at wastewater treatment facilities.
(4 marks)
- c) In the municipal wastewater treatment systems, explain the differences among pretreatment, primary treatment, secondary treatment and tertiary treatment. Show how they are related.
(5 marks)
- d) i) Explain why anaerobic reactors may fail if organic loading rate (OLR) is increased suddenly?
- ii) What are the early warnings of this reactor failure?
- iii) How to prevent such failure?
(5 marks)
3. a) The BOD₅ (20°C) value of a given domestic wastewater is 330 mg/L.
- i) Calculate the ultimate BOD?
- ii) Determine the 10-day BOD?.
- iii) Calculate the BOD₅ value, if the bottle had been incubated at 30°C. (Assume reaction constant, $k = 0.25 \text{ day}^{-1}$ and temperature coefficient, $\theta = 1.056$).
(7 marks)
- b) i).List **THREE (3)** types of sewer system and their difference.
(3 marks)
- c) Write two differences in the nature of recycling between trickling filter and activated sludge processes.
(4 marks)

- d) A domestic wastewater with a sludge flowrate of 5.68×10^6 L/d and BOD_5 value of 410 mg/L (after settling) is being treated using an activated-sludge plant. The hydraulic detention time (θ) of the activated-sludge plant is 9 h. Find out the concentration of MLVSS (in mg/L) in the plant, if the process loading is 0.45 kg BOD/d. kg MLVSS.

(6 marks)

4. As an environmental officer, you have received a report from water supply authority that the water quality of untreated water from one supply scheme decreasing dramatically within last 2 years. Further investigation found that one premises situated 375 meter from effected river might be the main source that causing this problem. This premise own by private company which operating as slaughter house and meat packing factory was start operating about 3 years ago. Pre-ground investigation on soil and water sample also shown that high possibility pollutant come from this premise.

- a) Describe briefly **THREE (3)** term to define emit, discharge or deposit waste into inland water as under section 25 (Restrictions on pollution of inland water) of Environmental Quality Act 1974 which can be use as reference to charge this company on felony under this section.

(6 marks)

- b) Describe briefly the information that can be used from list of catchment areas where Standard A applies in Fourth Schedule of Environmental Quality (Sewerage and Industrial Effluents) Regulation 1978 to prove that felony had occurred.

(2 marks)

- c) Identify the EMS stage that was used by this company which possibly has flaw, even though the premise has been rewarded MS ISO 14000 since it started.

(4 marks)

- d) Give **TWO (2)** justification why further ground investigation should be carry out and describe briefly **TWO (2)** disadvantage of conducting trail pit for this case base on BS 10175:2001.

(8 marks)

5. a) What is the organic content of primary and secondary sludge?. Name and describe the most common methods available for volume reduction of sludge.

(6 marks)

- b) A wastewater-treatment plant consist of primary treatment followed by an activated-sludge secondary system. Sludge from the primary clarifier and waste-activated sludge from the underflow are mixed and thickened in a gravity thickener. The primary sludge contains 1250 kg of dry solids per day with a 4% solids content. The waste – activated sludge contains 525 kg of dry solids per day and has a solids content of 1.2%. After thickening, the mixture has a solids content of 3.0%. Calculate (i) the volume of sludge that must be processed after thickening (ii) the volume reduction in the thickener.

(8 marks)

- c) A waste water treatment plant discharge to a small stream. The characteristics of effluent from wastewater and the characteristics of stream are given below.

Table 1

Stream	Effluent
Flow = 0.5 m ³ /s	Flow = 10,000 m ³ /d
BOD = 1.0 mg/L	BOD = 15 mg/L
Phosphate = 0.2 mg/L	Phosphate = 5.0 mg/L
Ammonia = 0 mg/L	Ammonia = 5 mg/L

Determine the stream characteristics after mixing with the waste has occurred.

(6 marks)

6. a) A lagoon system contains two cell in series. Each cell has a dimension of 110 m x 220 m insize with a maximum operating depth of 1.64 m and a minimum operating depth of 0.55 m. The wastewater flow is from 4500 people with the average BOD₅ of 110 mg/L. Determine the organic loading rate and the detention time of the lagoon.

(8 marks)

- b) In advanced treatment, phosphorous can be removed using chemical treatment and biological treatment processes, explain including the reaction occurred.

(4 marks)

- c) A wastewater has a soluble phosphorous concentration of 5.0 mg/L as P. Determine the stoichiometric quantity of ferric chloride required to remove P completely based on the reaction occurred.

(8 marks)