UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2005/2006 Academic Session

November 2005

EAP 313/2 – Wastewater Treatment

Duration: 3 hours

Instructions to Candidates:

1. Ensure that this paper contains **EIGHT (8)** printed pages including appendices before you start your examination.

2. This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only. Marks will be given to the **FIRST FIVE (5)** questions put in order on the answer script and **NOT** the **BEST FIVE (5).**

3. Each question carry equal marks.

4. All questions **MUST BE** answered in English

5. Each question **MUST BE** answered on a new sheet.

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

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1. (a) Sketch process flow diagram of domestic wastewater treatment in Malaysia.

(4 marks)

(b) Give the relation between Organic Loading and Population Equivalent in wastewater treatment.

(3 marks)

(c) A sewer with diameter 1.0 m is flowing a wastewater from a housing estate. If wastewater inside the sewer flows 75% full, ratio of sewage to supplied water is 0.75, allowable slope 1:500, calculate the maximum number of houses contributed to the wastewater in the sewer. Take n = 0.013.

(7 marks)

(d) A wastewater treatment plant is planned to be constructed to treat wastewater from a housing scheme as below. Determine the suitable width of screen and the required number of bar.

Number of houses	10,000 unit
Opening	2.5 cm
Width of bar	1.0 cm
Approaching velocity	1.0 m/s
Depth of chamber	0.85 m

(6 marks)

2. (a) Discuss the influence of nitrification in BOD_5 determination.

(5 marks)

(b) Based on the given data, determine the required facultative pond to treat wastewater from an area with 5,000 population.

Temperature	30°C
Influent BOD_5	250 mg/L
Effluent BOD_5	50 mg/L
Depth	1.75 m

(9 marks)

(c) Name **FOUR (4)** types of settling behaviour in wastewater treatment and name the common place of their occurrence.

(6 marks)

3. (a) Sketch the treatment plant buffer zone criteria guidelines for an open types of wastewater plant, by showing the required distance of buffer zone and the distance of access and screening.

(5 marks)

3. (b) A town is producing an organic load (BOD_5) of 280 kg/day. An extended aeration activated sludge process is used to treat this wastewater whereby the effluent is discharged into a nearby river with existing minimum flow of 0.127 m^3/s and BOD_5 of 2.0 mg/L. Determine the maximum allowable BOD_5 level of the effluent and the required removal percentage of the plant. The BOD_5 downstream of the discharge point is not to exceed 4.0 mg/L.

(9 marks)

(c) Calculate the wet volume of sludge in m^3/hari that will be produced by the sedimentation tank with population of 10,000. Assume the influent suspended solids as 300 mg/L, the maximum removal percentage as 70% and the Specific Gravity 1.03.

(6 marks)

4. (a) Name **FOUR (4)** main types of wastewater pump.

(4 marks)

(b) Design a suitable pump sump for a housing scheme with data in Table 1:

Table 1: Design data

Type of premises	Data
Single storey medium cost	1,000
Double storey semi-detached	500
Double storey shop lots Ground floor – 6.1m x 12.65m First floor – 6.1m x 15.54m	50
Petrol station	1
Daily school without hostels @ 1,500 pupils	1
Mosque @ 1,000 people	1
Dry market @ 30 shops	1

Take retention time at Q_{peak} as 30 minutes.

(6 marks)

(c) Given the BOD_5 of a domestic wastewater is 350 mg/L. The wastewater comes from a housing scheme (200 houses) and 10 small industries with 10 workers each. If the water consumption rate is 225 liter/capita.day, calculate:

i. The appropriate organic loading of a Rotating Biological Contactor (RBC).

(6 marks)

ii. The surface area of a trickling filter with depth 3 meter and the volumetric organic loading 0.8 kg BOD_5/m^3. day.

(4 marks)

5. (a) Briefly explain the difference between 'suspended cultures' and 'fixed-film' wastewater treatment system.

(5 marks)

(b) An extended aeration activated sludge process is having a design data as follows:

Population equivalent (PE) = 1500
Influent BOD_5 = 250 mg/L
MLVSS / MLSS = 0.75
MLSS = 4000 mg/l
Retention time = 18 hours

Calculate:

i. Dimension of tank.

(3 marks)

ii. Required oxygen in kg/day:

(6 marks)

iii. Mixing requirement in Watt/m^3.

(3 marks)

iv. Sludge Volume Index (SVI) if 200 mL sludge settles in 30 minutes.

(3 marks)

6. (a) By using the equations for aerobic and anaerobic reactions, give **TWO (2)** differences between them

(5 marks)

(b) The value of BOD_5 for a wastewater at 20ºC is 150 mg/L. What is the value of BOD_{10} for this sample if the test was carried out at 12ºC. Assume that the constant for BOD, K_1 is 0.15/day.

(4 marks)

(c) Calculate the BOD constant rate, k_1 and ultimate BOD, L_o for the following data using Thomas Method:

Time (days)	2	4	6	8
BOD (mg/L)	120	195	215	228

(8 marks)

(d) During the BOD test, the oxidation of nitrogen may be taking place. Discuss the importance of this phenomenon.

(3 marks)

APPENDICES

Peak Factor = $4.7\ p^{-0.11}$ (p in thousand)
Faktor Puncak = $4.7\ p^{-0.11}$ (p dalam ribu)

Retention time = Volume/discharge
Masa tahanan = Isipadu /kadaralir

Population Equivalent = $\frac{\text{Organic load from premises}}{\text{Organic load from 1 person}}$
Penduduk Setara = $\frac{\text{Beban Organik Premis}}{\text{Beban Organik 1 orang}}$

Manning: $Q = (1/n)\ (A)\ (R)^{2/3}\ (s)^{1/2}$

$V = (1/n)\ (R)^{2/3}\ (s)^{1/2}$

$R = A/P$

Width of screen = $\frac{\text{(width of blade + opening)}}{\text{opening}} \frac{\text{(Discharge)}}{\text{(velocity) (depth of wastewater)}}$
Lebar saring = $\frac{\text{(Lebar bilah + saiz bukaan)}}{\text{Saiz bukaan}} \frac{\text{(Kadaralir)}}{\text{(Halaju) (Kedalaman air sisa)}}$

Pumping cycle = $\frac{\text{Actual volume}}{\text{Dry Weather Flow}} + \frac{\text{Actual volume}}{\text{(Pumping rate-Dry Weather Flow)}}$
Sela pengepaman = $\frac{\text{Isipadu sebenar}}{\text{Kadaralir Cuaca Kering}} + \frac{\text{Isipadu sebenar}}{\text{(Kadar pam-Kadaralir Cuaca Kering)}}$

Surface Overflow Rate = $\frac{\text{Discharge}}{\text{Surface Area}}$
Kadar Beban Permukaan = $\frac{\text{Kadaralir}}{\text{Luas Permukaan}}$

Solids Loading Rate = $\frac{\text{(Discharge) (Mixed Liquor)}}{\text{Surface Area}}$
Kadar Beban Pepejal = $\frac{\text{(Kadaralir) (Likur Tercampur)}}{\text{Luas Permukaan}}$

Weir Loading Rate = $\frac{\text{Discharge}}{\text{Length of weir}}$
Kadar Beban Empang Limpah = $\frac{\text{Kadaralir}}{\text{Panjang Empang Limpah}}$

Volume of pyramid = (1/3) (base area) (height)
Isipadu Piramid = (1/3) (luas dasar) (tinggi)

Organic Load = (Discharge) (BOD)
Beban Organik = (Kadaralir) (BOD)

APPENDICES

Keluasan Tangki enap primer = $\frac{\text{(Kadaralir + Kadaralir Pusing Balik) (Likur Tercampur)}}{\text{Fluks}}$

Fluks Pepejal = $\frac{\text{Halaju enapan}}{\text{(1/Kepekatan Pepejal) - (1/Kepekatan Pepejal Terenap)}}$

Kinetik BOD $BOD_t = Lo(1-10^{-k1t})$

$k_T = k_{20}(1.047)^{(T-20)}$

$L_T = L_{20}[1+0.02(T-20)]$

Thomas: $(t/BOD)^{1/3} = (kL_o)^{-1/3} + (k^{2/3}/6L_o^{1/3})\ t$

Beban Organik = (Kadaralir) (BOD)

Beban Organik Isipadu = $\frac{\text{(Kadaralir) (BOD)}}{\text{Isipadu}}$

Makanan: Microorganism = $\frac{\text{(Kadaralir) (BOD)}}{\text{(Isipadu) (Likur Tercampur)}}$

Beban Organik Kawasan = $\frac{\text{(Kadaralir) (BOD)}}{\text{Luas Permukaan}}$

Keperluan Oksigen = $\frac{Q \times BOD_5}{BOD_5/BOD_L}$ - 1.42 Px

Pertambahan Likur Tercampur = $\frac{y}{1+kd\theta c}$ (Kadaralir)(BOD)

Nisbah enap cemar kembali $R = \frac{\text{Kadaralir kembali}}{\text{Kadaralir}}$

$X_a = X_R(1/1+R)$

Keperluan Oksigen = aLr + bSa

a = Pekali penyingkiran BOD
Lr = BOD tersingkir
b = pekali endagenous enap cemar
Sa = Jisim Likur Tercampur

Kadar Bekalan Oksigen = $\frac{\text{Oksigen Diperlu}}{\text{BOD tersingkir}}$

APPENDICES

Umur = $\frac{\text{(Isipadu) (Likur Tercampur)}}{\text{(Kadaralir Disingkir)(Likur Tercampur Pusing Balik) + (Kadaralir Efluen)(Pepejal Terampai Efluen)}}$
E.C.

$$1/\theta = yu\text{-}k_d$$

$$\theta_c = \frac{V.MLSS}{Q_w.SS}$$

Indeks Isipadu Enap cemar (SVI) = (Isipadu MLSS mengenap dalam 30 minit)/MLSS

Tangki Septik, C=225P

Pond design:
Pond design:

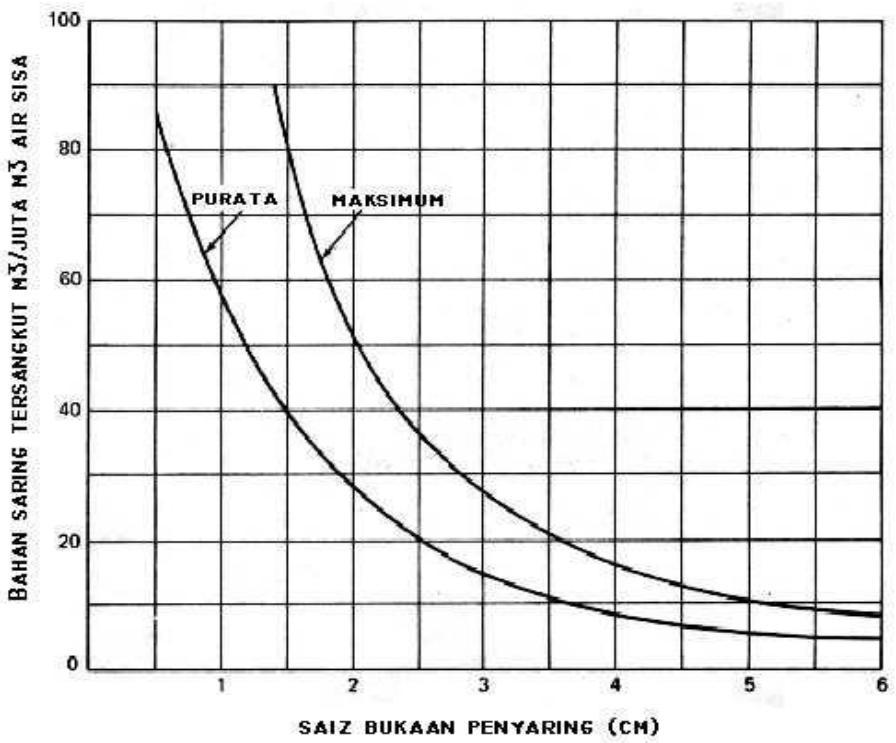
$$L_e/L_i = 1/(1+k_1t)$$

$$A = Q/Dk_1 [L_i/L_e\text{-}1]$$

$$k_T = 0.30\ (1.085)^{T-20}$$

Organic Loading = L_iQ/A
Beban Organik = L_iQ/A

Maximum Organic Loading = $7.5\ (1.054)^T$
Beban Organik Maksimum = $7.5\ (1.054)^T$



Screen designing chart

APPENDICES

Jadual Penduduk Setara

(Dipetik dari MS 1228 : 1991 : MALAYSIAN STANDARD: Code of Practice for Design and Installation of Sewerage Systems) dan Guidelines for Developers, Seksyen 1 dan 2, 1995

No	Jenis Premis	Penduduk Setara (dicadangkan)
1	Kediaman	5 per unit*
2	Komersial (termasuk pusat hiburan/rekreasi, kafeteria, teater)	3 per 100 m^2 kawasan kasar
3	Sekolah/InstitusiPengajian : - Sekolah/institusi siang - Dengan asrama penuh - Dengan sebahagian asrama	 0.2 per pelajar 1 per pelajar 0.2 per pelajar untuk pelajar tanpa asrama 1 per pelajar untuk penduduk asrama
4	Hospital	4 per katil
5	Hotel (dengan kemudahan masakan dan cucian pakaian)	4 per bilik
6	Kilang (tidak termasuk sisa yang diproses)	0.3 per pekerja
7	Pasar (jenis basah)	3 per gerai
8	Pasar (jenis kering)	1 per gerai
9	Stesyen petrol/Perkhidmatan	15 per tandas
10	Stesyen bas	4 per petak bas
11	Stesyen teksi	4 per petak teksi
12	Masjid	0.2 per orang
13	Gereja/Kuil	0.2 per orang
14	Stadium	0.2 per orang
15	Kolam renang/Kompleks sukan	0.5 per orang
16	Tandas awam	15 per tandas
17	Lapangan terbang	0.2 per petak penumpang 0.3 per pekerja
18	Laundri	10 per mesin
19	Penjara	1 per orang
20	Padang golf	20 per lubang

* 1 kadaralir adalah setara dengan 225 liter/kapita/day