
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2008/2009

November 2008

EAP 313/2 – Wastewater Engineering
[Kejuruteraan Air Sisa]

Duration: 2 hours
[Masa : 2 jam]

Please check that this examination paper consists of **FOURTEEN (14)** pages of printed material including appendix before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **EMPAT BELAS (14)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: Answer **THREE (3)** questions only. Answer question 1 and any other **TWO (2)** questions. All questions carry the same marks.

*[Arahan: Jawab **TIGA (3)** soalan sahaja. Jawab soalan 1 dan mana-mana **DUA (2)** soalan lain. Semua soalan membawa jumlah markah yang sama.]*

You may answer the question either in Bahasa Malaysia or English.

[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

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

*[Semua jawapan **MESTILAH** dijawab pada muka surat baru.]*

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

[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

1. (a) Calculate the quantity of suspended solids production per person in gram per day from a locality of 1000 houses, suspended solids concentrations of 360mg/L and total flow of 1,200m³/day.

[8 marks/markah]

Kira kuantiti penghasilan pepejal terampai setiap orang dalam gram sehari, dari suatu kawasan dengan kepekatan pepejal terampai 360mg/L dan jumlah kadar alir 1,200m³/hari.

- (b) Name the present guideline to be followed by the engineer in designing the wastewater treatment plant in Malaysia.

[4 marks/markah]

Namakan Garis Panduan terkini yang perlu dipatuhi oleh jurutera dalam mereka bentuk loji olahan air sisa di Malaysia.

- (c) Using the given chart in Appendix, design a separate cast iron sewer which flows 65% full with gradient 0.35%. Take values of Q_{peak} to Q_{average} ratio and Q_{average} to Q_{minimum} ratio as recommended in the Guidelines in (b). Designed population is 35,000 people.

[13 marks/markah]

Menggunakan Carta di Lampiran, reka bentukkan pembedung besi tuang yang mengalir 65% penuh dengan kecerunan 0.35%. Ambil nisbah Q puncak ke Q purata dan Q purata ke Q minimum seperti yang disyorkan dalam Garis Panduan dalam (b). Reka bentuk penduduk adalah 35,000 orang.

- (d) A rectangular sedimentation tank is to be designed to treat a wastewater from 50,000 people. If the depth is 3m and retention time is 2 hours:

Suatu tangki enapan segi empat perlu di reka bentuk untuk mengolah air sisa dari 50,000 orang. Jika kedalaman tangki adalah 3 m dan masa tahanan 2 jam:

- (i) Calculate the Surface Overflow Rate of this tank. Design at Q peak.

[8 marks/markah]

Kira Kadar Beban Permukaan tangki ini.

- (ii) If the suspended solids is 400mg/L and the removal efficiency is 60%, calculate the quantity amount of sludge produced in m³/day. Take the specific gravity of sludge as 1.06. Design at Q average.

[7 marks/markah]

Jika kepekatan pepejal terampai adalah 400mg/L dan kecekapan penyingkiran 60%, kira kuantiti enap cemar yang terhasil dalam m³/hari. Ambil Graviti Tentu enap cemar sebagai 1.06. Reka bentuk pada Q purata.

2. (a) A small town discharges a wastewater flow of 1,000 m³/day, BOD of 250 mg/L and treated with a a trickling filter treatment plant. The final effluent is discharged into a nearby river with minimum flow of 0.127m³/s and BOD of 2.0mg/L. Calculate the BOD concentration downstream of the discharge point.

[8 marks/markah]

Sebuah bandar kecil melepaskan air sisa sebanyak 1,000 m³/hari, BOD sebanyak 250 mg/L dan diolah menggunakan loji turas cucur. Efluen akhir dilepaskan ke sungai berhampiran yang berkadar alir 0.127m³/s dan BOD 2.0mg/L. Kira kepekatan BOD di hilir titik pelepasan.

- (b) With the help of a sketch, define briefly self purification of a river.

[6 marks/markah]

Dengan bantuan lakaran, definisikan secara ringkas prinsip swacuci sebuah sungai.

(c) A secondary treatment plant is having the following design data:

Dry Weather Flow = $1,000\text{m}^3/\text{day}$

Ratio of Length: Width = 3:1

Width = 5m

Retention time = 2 hours

Mixed Liquor Suspended Solids = $3,000\text{mg/L}$

Calculate:

(i) Depth of tank [5 marks/markah]

(ii) Solids Loading Rate in $\text{kg/m}^2.\text{day}$ [5 marks/ markah]

Suatu loji olahan sekunder mempunyai data reka bentuk seperti berikut:

Kadar alir Puncak = $1,000\text{m}^3/\text{hari}$

Nisbah Panjang:Lebar = 3:1

Lebar = 5m

Masa tahanan = 2 hours

Likur Tercampur Pepejal Terampai = $3,000\text{mg/L}$

Kira:

(i) *Kedalaman tangki*

(ii) *Kadar Beban Pepejal dalam $\text{kg/m}^2.\text{hari}$*

(d) Prove that the design of sedimentation tank does not influence by depth.

[6 marks/markah]

Buktikan bahawa kedalaman tangki tidak mempengaruhi reka bentuk tangki enapan.

3. (a) Given **THREE (3)** sample of wastewater, sample A from paper mill factory with BOD_5^{30} 225mg/L, sample B from meat packing factory with BOD_5^{30} 200mg/L and sample C from livestock compound with BOD_5^{30} 175mg/L. The BOD rate constant at temperature 20°C are 0.16 day⁻¹ for sample A, 0.12 day⁻¹ for sample B and 0.08 day⁻¹ for sample C.

Diberi TIGA (3) sampel air kumbahan, sampel A daripada kilang membuat kertas dengan BOD_5^{30} 225mg/l, sampel B daripada kilang pembungkusan daging dengan BOD_5^{30} 200mg/l dan sampel C daripada pusat penternakan dengan BOD_5^{30} 175mg/l. Pekali kadar BOD pada suhu 20°C adalah 0.16 hari⁻¹ bagi sampel A, 0.12 hari⁻¹ bagi sampel B, 0.08 hari⁻¹ bagi sampel C.

- (i) Which one of that wastewater will have a fastest oxidizing process and what is the factor that makes it is consider the fastest.

[2 marks/markah]

Mana satukah antara air kumbahan tersebut mempunyai process pengosidaan yang terpantas dan apakah faktor yang membuatkan ia dianggap terpantas.

- (ii) Determine the 1-day BOD for sample A if conducted at temperature 25°C

[10 marks/markah]

Tentukan BOD 1-hari bagi sampel A sekiranya dilakukan pada suhu 25°C

- (b) What are the difference of digested sludge characteristics between source from Aerobic Digester and Anaerobic Digester in terms of colour and odour.

[6 marks/markah]

Apakah perbezaan ciri enapcemar tercerna antara daripada sumber Pencerna Aerobik dan Pencerna Anaerobik dari segi warna dan bau.

- (c) If disposal of wastewater sludge into secure landfill is not allowed by the government because of lack of available landfill area, NAME **TWO (2)** other options for ultimate sludge disposal.

[2 marks/markah]

Sekiranya pelupusan enapcemar sisa kumbahan ke dalam tapak pelupusan sampah tidak lagi dibenarkan oleh kerajaan kerana masalah kekurangan kawasan pelupusan sampah, NAMAKAN DUA (2) opsyen pelupusan muktamad erap cemar.

- (d) Calculate the quantity of oxygen required for a given aeration tank design with design data as follows:

Organic load = 250kg/day

MLSS = 3,000mg/L

$y = 0.6\text{mg/mg}$

$k_d = 0.05\text{day}^{-1}$

$\theta_c = 9\text{ days}$

Only 65% BOD is degraded on day 5

[10 marks/markah]

- (d) Kira kuantiti oksigen yang diperlukan oleh suatu tangki pengudaraan dengan data reka bentuk seperti berikut:

Beban organik = 250kg/hari

MLSS = 3,000mg/L

$y = 0.6\text{mg/mg}$

$k_d = 0.05\text{ day}^{-1}$

$\theta_c = 9\text{ hari}$

Hanya 65% BOD terurai pada hari ke 5

4. (a) Sketch a process flow diagram of an extended aeration activated sludge system.

[6 marks/markah]

Lakarkan rajah proses kadaralir untuk suatu sistem enap cemar teraktif pengudaraan lanjutan

- (b) A wastewater treatment plant is to be designed based on the following data:

Population equivalent = 100,000

BOD rate = 55 gram/capita.day

Design at Dry Weather Flow

Suatu loji olahan air sisa perlu direka bentuk berdasarkan data berikut:

Penduduk Setara= 100,000

Kadar BOD = 55 gram/kapita.hari

Reka bentuk pada Kadaralir Cuaca Kering

- (i) Calculate the Volumetric Organic Loading and the Aerial Organic Loading of a cylindrical trickling filter with diameter 5m and depth 10m. Assume the net volume of filter is 50% of the total volume.

[12 marks/markah]

Kira Beban Organik Isipadu dan Beban Organik Kawasan suatu turas cucur selinder dengan diameter 5 m dan kedalaman 10m. Anggap isipadu bersih turas adalah 50% dari isipadu jumlah..

- (ii) Determine the Food to Microorganism (F:M) ratio of an extended aeration activated sludge system if the retention time is 8 hours and the MLSS concentration is 2500mg/L.

[12 marks/markah]

Tentukan nisbah Makanan: Mikroorganisma suatu sistem enap cemar teraktif pengudaraan lanjutan jika masa tahanan 8 jam dan kepekatan MLSS 2,500mg/L.

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LAMPIRAN

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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 = Organic load from premises

Organic load from 1 person

*Penduduk Setara = Beban Organik Premis**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 = $\frac{(\text{width of blade} + \text{opening})}{\text{opening}} \frac{(\text{Discharge})}{(\text{velocity}) (\text{depth of wastewater})}$ *Lebar saring = $\frac{(\text{Lebar bilah} + \text{saiz bukaan})}{\text{Saiz bukaan}} \frac{(\text{Kadaralir})}{(\text{Halaju}) (\text{Kedalaman air sisa})}$* Pumping cycle = $\frac{\text{Actual volume}}{\text{Dry Weather Flow}} + \frac{\text{Actual volume}}{(\text{Pumping rate}-\text{Dry Weather Flow})}$ *Sela pengepaman = $\frac{\text{Isipadu sebenar}}{\text{Kadaralir Cuaca Kering}} + \frac{\text{Isipadu sebenar}}{(\text{Kadar pam}-\text{Kadaralir Cuaca Kering})}$* Surface Overflow Rate = $\frac{\text{Discharge}}{\text{Surface Area}}$ *Kadar Beban Permukaan = $\frac{\text{Kadaralir}}{\text{Luas Permukaan}}$* Solids Loading Rate = (Discharge) (Mixed Liquor)

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LAMPIRAN

Surface Area

$$\text{Kadar Beban Pepejal} = \frac{(\text{Kadaralir}) (\text{Likur Tercampur})}{\text{Luas Permukaan}}$$

$$\text{Weir Loading Rate} = \frac{\text{Discharge}}{\text{Length of weir}}$$

$$\text{Kadar Beban Empang Limpah} = \frac{\text{Kadaralir}}{\text{Panjang Empang Limpah}}$$

$$\text{Volume of pyramid} = (1/3) (\text{base area}) (\text{height})$$

$$\text{Isipadu Piramid} = (1/3) (\text{luas dasar}) (\text{tinggi})$$

$$\text{Organic Load} = (\text{Discharge}) (\text{BOD})$$

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

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

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

$$\text{Kinetik BOD} \quad \text{BOD}_t = L_0(1 - 10^{-k_1 t})$$

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

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

$$\text{Thomas:} \quad (t/\text{BOD})^{1/3} = (kL_0)^{-1/3} + (k^{2/3}/6L_0^{1/3}) t$$

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

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

...10/-

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

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

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

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

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

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

$$\text{Keperluan Oksigen} = aLr + bSa$$

$$a = \text{Pekali penyingkiran BOD}$$

$$Lr = \text{BOD tersingkir}$$

$$b = \text{pekali endogenous enap cemar}$$

$$Sa = \text{Jisim Likur Tercampur}$$

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

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

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/Institusi Pengajian : - 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	Mesjid	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 kadar alir adalah setara dengan 225 liter/kapita/day

Table A.1 Recommended Population Equivalent

Type of Premises/Establishment	Population Equivalent (Recommended)
Residential	5 per house
Commercial: Includes offices, shopping complex, entertainment/recreational centres, restaurants, cafeteria, theatres	3 per 100 m ² gross area
Schools/Educational Institutions: - Day schools/Institutions - Fully residential - Partial residential	0.2 per student 1 per student 0.2 per non-residential student 1 per residential student
Hospitals	4 per bed
Hotels with dining and laundry facilities	4 per room
Factories, excluding process water	0.3 per staff
Market (wet type)	3 per stall
Market (dry type)	1 per stall
Petrol kiosks/Service stations	15 per toilet
Bus terminal	4 per bus bay
Taxi terminal	4 per taxi bay
Mosque	0.2 per person
Church/Temple	0.2 per person
Stadium	0.2 per person
Swimming pool/Sports complex	0.5 per person
Public toilet	15 per toilet
Airport	0.2 per passenger bay 0.3 per employee
Laundry	10 per machine
Prison	1 per person
Golf course	20 per hole

Water consumption rate = 225 liter/capita.day

LAMPIRAN

