
UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2004/2005 Academic Session

October 2004

EAP 582/4 – Wastewater Engineering

Duration : 3 hours

Instructions to candidates:

Arahan kepada calon:

1. Ensure that this paper contains **NINE (9)** printed pages included appendices before you start your examination.
Sila pastikan kertas peperiksaan ini mengandungi SEMBILAN (9) muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.
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)**.
Kertas ini mengandungi ENAM (6) soalan. Jawab LIMA (5) soalan sahaja. Markah hanya akan dikira bagi LIMA (5) jawapan PERTAMA yang dimasukkan di dalam buku mengikut susunan dan bukannya LIMA (5) jawapan terbaik.
3. All questions **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.
Semua soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia ataupun kombinasi kedua-dua bahasa.
4. Each question carry equal marks.
Tiap-tiap soalan mempunyai markah yang sama.
5. All question **MUST BE** answered on a new sheet.
Semua jawapan MESTILAH dijawab pada muka surat yang baru.
6. 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) Define Cleaner Production (CP). Discuss the benefits of implementing CP by using one relevant example.

(10 marks)

- (a) Berikan pengertian 'Cleaner Production' (CP). Bincang mengenai kelebihan pelaksanaan CP menggunakan satu contoh yang sesuai.

(10 markah)

- (b) A study on the inorganic ammonium cyanate (NH_4OCN) can be converted into the organic compound urea (NH_2CONH_2). The following data were obtained:

t (min)	0	20	50	65	150
NH_4OCN (mole L^{-1})	0.381	0.264	0.180	0.151	0.086

Determine whether the reaction is zero-, first- or second-order and estimate the reaction rate.

(3 marks)

- (b) Kajian ke atas bahan bukan organik ammonium sianat (NH_4OCN) mendapati ianya boleh diubah kepada baja organik (NH_2CONH_2). Data-data berikut telah diperolehi:

t (min)	0	20	50	65	150
NH_4OCN (mole L^{-1})	0.381	0.264	0.180	0.151	0.086

Tentukan sama ada reaksi ini adalah tindakbalas tertib sifar, pertama atau kedua dan anggarkan kadar tindakbalasnya.

(3 markah)

1. (c) The characteristic of Vision Park Lake, Kepala Batas, Penang is as follows:

Area : $100,000 \text{ m}^2$

Mean Depth : 1.5

Inflow = outflow = $5000 \text{ m}^3/\text{d}$

Temperature: 28°C

The Vision Park Lake is a man-made lake and receives the input of a pollutant from several sources. Waste water discharge from residential area has a concentration of 10mg/L BOD. The NPC industrial area discharges of 50 kg/d , atmospheric fallout is counting 0.5g/d/m^2 . If the pollutant decays at the rate of $0.5/\text{d}$ at 20°C ($\theta = 1.05$).

- i) Determine the inflow concentration
- ii) Determine the steady-state concentration (c)

Please state any additional assumptions you made, and show all work.

(Note: $k = \theta^{t_n - t_{20}}$; $a = Q + kV$; $W_{\text{atm}} = JA$, $W = W_{\text{NPC}} + W_{\text{atm}} + W_{\text{inflow}}$, $c = W/a$)
(7 marks)

- (c) *Ciri-ciri Vision Park Lake, Kepala Batas, Pulau Pinang adalah seperti berikut:*

Kawasan: $100,000 \text{ m}^2$

Purata kedalaman: 1.5m

Kadar alir masuk = kadar alir keluar = $5000 \text{ m}^3/\text{d}$

Suhu: 28°C

Tasik Taman Wawasan ialah tasik buatan manusia dan menerima input pencemaran dari beberapa sumber. Air kumbahan yang datang dari kawasan penempatan penduduk mempunyai konsentrasi atau kepekatan 10mg/L BOD. Discaj dari kawasan industri NPC ialah sebanyak 50 kg/d , pencemaran atmosferik dikira pada 0.5g/d/m^2 . Jika pencemaran susut pada kadar $0.5/\text{d}$ pada 20°C ($\theta = 1.05$).

- i) Tentukan konsentrasi/kepekatan kadar alir masuk*
- ii) Tentukan kepekatan pada keadaan mantap (c)*

Sila nyatakan andaian yang anda gunakan, dan tunjukkan kesemua cara kerja anda.

(Nota: $k = \theta^{t_n - t_{20}}$; $a = Q + kV$; $W_{\text{atm}} = JA$, $W = W_{\text{NPC}} + W_{\text{atm}} + W_{\text{inflow}}$, $c = W/a$)

(7 markah)

2. (a) Discuss any **TWO (2)** of the following:
- (i) Importance of coliform bacteria

- (ii) Method of sewer testing
- (iii) Daily variation of municipal wastewater generation
- (iv) Equivalent weight of compounds

(8 marks)

(a) *Bincang sebarang DUA (2) dari yang berikut:*

- (i) *Kepentingan bakteria koliform*
- (ii) *Kaedah pengujian pembedung*
- (iii) *Perubahan harian penjana air sisa perbandaran/municipal*
- (iv) *Berat setara sebatian*

(8 markah)

(b) A 600 mm diameter sewer is built at a grade of 2.5 %. Calculate the depth and the velocity of flow in the pipe if the discharge is 200 L/s. Take $n = 0.013$.

(6 marks)

(b) *Sebuah pembedung berdiameter 600 mm dibina pada gred/keceruman 2.5%. Kirakan kedalaman dan halaju aliran dalam paip tersebut jika discaj adalah 200 L/s. Anggap $n = 0.013$.*

(6 markah)

(c) In a determination of alkalinity experiment, a 100 ml sample of water was titrated with 0.02N H_2SO_4 . The total volumes of the acid required to reach the phenolphthalein and methyl orange end-points were 14 ml and 38 ml respectively. Calculate the different forms of alkalinity in the water sample. Report your results in mg/L as $CaCO_3$.

(6 marks)

(c) *Dalam ujikaji penentuan kealkalian, 100 mL sampel air telah dititrat dengan 0.02N H_2SO_4 . Jumlah isipadu asid yang diperlukan untuk mencapai takat akhir fenolptalein dan metal jingga adalah masing-masing 14 mL dan 38 ml. Kira pelbagai jenis kealkalian yang hadir dalam sampel air tersebut. Berikan jawapan anda dalam mg/L sebagai $CaCO_3$.*

(6 markah)

3. (a) What is the difference between suspended growth and attached growth biological wastewater treatment processes?

(5 marks)

(a) *Apakah perbezaan di antara proses olahan pertumbuhan biologi terampai dengan pertumbuhan terlekat?*

(5 markah)

3. (b) The BOD_5 of a wastewater sample is 250 mg/l. The value of k at $20^\circ C$ is $0.23 d^{-1}$. Calculate the 5-day BOD if the test were run at $25^\circ C$?

(5 marks)

- (b) BOD_5 suatu sampel air sisa ialah 250 mg/L. Nilai k pada $20^\circ C$ adalah $0.23d^{-1}$. Kirakan BOD 5-hari jika ujian dijalankan pada $25^\circ C$.

(5 markah)

- (c) A conventional activated sludge process (ASP) is to be used for the treatment of $12,000 \text{ m}^3/\text{d}$ of municipal wastewater. The influent BOD to the ASP is 200 mg/L. As per requirements, the BOD of the effluent from the ASP should not exceed 10 mg/l. Assuming:

MLSS = 3,000 mg/L

Mean cell residence time = 10 d

Return sludge from secondary sedimentation tank (SST) = 10,000 mg/L

Yield coefficient = 0.6 kg/kg

Endogenous decay rate constant = 0.05 d^{-1}

Determine:

- (i) the volume of aeration tank
- (ii) the mass and volume of sludge to be wasted per day
- (iii) the recycle ratio
- (iv) food-to-microorganism ratio

(10 marks)

- (c) Loji enapcemar teraktif (ASP) lazim akan digunakan untuk rawatan $12,000 \text{ m}^3/\text{d}$ air sisa perbandaran. Nilai BOD influen ke ASP adalah 200 mg/L. Sebagai syarat keperluan, BOD efluen dari enapcemar teraktif (ASP) tidak boleh melebihi 10 mg/L. Anggap yang berikut:-

$MLSS = 3,000 \text{ mg/L}$

Masa tahanan purata sel = 10 h

Enapcemar kembali dari SST = 10,000 mg/L

Pekali pembiakan = 0.6 kg/kg

Pemalar kadar kematian endogenous = 0.05 d^{-1}

Tentukan:

- (i) Isipadu tangki pengudaraan
- (ii) Jisim dan isipadu enapcemar yang perlu dibuang per hari
- (iii) Nisbah kitar semula
- (iv) Nisbah makanan-ke-mikroorganisme

(10 markah)

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4. (a) Explain the air stripping method for ammonia removal. Give **THREE (3)** each of its advantages and disadvantages.

(10 marks)

(a) *Terangkan mengenai kaedah pelucutan udara untuk penyingkiran ammonia. Berikan **TIGA (3)** kelebihan dan kekurangannya?*

(10 markah)

(b) A tannery has to install a wastewater treatment plant.

(i) What would be the expected characteristics of the wastewater? (4 marks)

(ii) Suggest a possible flow diagram for the treatment of the wastewater. (6 marks)

(b) *Sebuah kilang kulit perlu membina loji olahan air sisanya.*

(i) *Apakah ciri-ciri air sisa yang dijangkakan.* (4 markah)

(ii) *Cadangkan rajah carta alir yang mungkin untuk merawat air sisa tersebut.*

(6 markah)

5. (a) Explain any **TWO (2)** of the following:

(i) Gravity thickening of sludge

(ii) Anaerobic sludge digestion

(iii) Wet air oxidation

(iv) Ultimate disposal of sludge

(10 marks)

(a) *Jelaskan sebarang **DUA (2)** dari berikut:*

(i) *Pemekatan enapcemar secara graviti*

(ii) *Pencernaan anaerobic enapcemar*

(iii) *Pengoksidan udara basah*

(iv) *Pelupusan muktamad enapcemar*

(10 markah)

5. (b) The following table shows the results of a column analysis that was used to determine the settling characteristics of an activated sludge suspension.

Concentration, mg/L	1000	2000	3000	4000	5000	6000
Settling velocity, m/h	3.30	1.54	0.55	0.22	0.11	0.08

If the influent to the secondary clarifier is 6000 m³/d with an MLSS concentration of 3000 mg/l, determine the diameter of the clarifier if the sludge is to be thickened to a concentration of 8 000 mg/l.

(10 marks)

- (b) *Jadual berikut menunjukkan analisis kolum yang digunakan untuk penciciran pemendapan ampaiian enapcemar teraktif*

<i>Kepekatan, mg/L</i>	<i>1000</i>	<i>2000</i>	<i>3000</i>	<i>4000</i>	<i>5000</i>	<i>6000</i>
<i>Hadlaju penganapan, m/jam</i>	<i>3.30</i>	<i>1.54</i>	<i>0.55</i>	<i>0.22</i>	<i>0.11</i>	<i>0.08</i>

Jika influen ke penjernih sekunder adalah 6000 m³/h dengan kepekatan MLSS sebanyak 3000 mg/L, tentukan diameter penjernih tersebut jika enapcemar perlu dipekatkan kepada 8000 mg/L.

(10 markah)

6. (a) Describe the working of a trickling filter. (10 marks)

- (a) *Bincang mengenai cara kerja turas cucur.* (10 markah)

- (b) The average wastewater flow from a community is 6000 and 8000 m³/d during winter and summer respectively. The average temperature is 8°C for the coldest month and 26°C for the hottest month. The average BOD₅ is 200 mg/l with 70% being soluble. The reaction rate coefficient k is 0.23 d⁻¹ at 20°C, the dispersion factor d is 0.5 and temperature coefficient θ is 1.05. Design a pond system for the community.

(10 marks)

- (b) *Halaju purata air sisa dari sebuah komuniti ialah 6000 dan 8000 m³/h semasa musim sejuk dan panas, masing-masing. Suhu purata ialah 8°C untuk bulan paling sejuk dan 26°C untuk bulan paling panas. Nilai purata BOD ialah 200 mg/L dengan 70% dalam bentuk terlarut. Pemalar kadar tindaklas k ialah 0.23 h-1 pada 20oC, faktor serahan, d ialah 1.5 dan pemalar suhu, ϕ ialah 1.05. Reka bentuk sistem kolam untuk komuniti tersebut.*

(10 markah)

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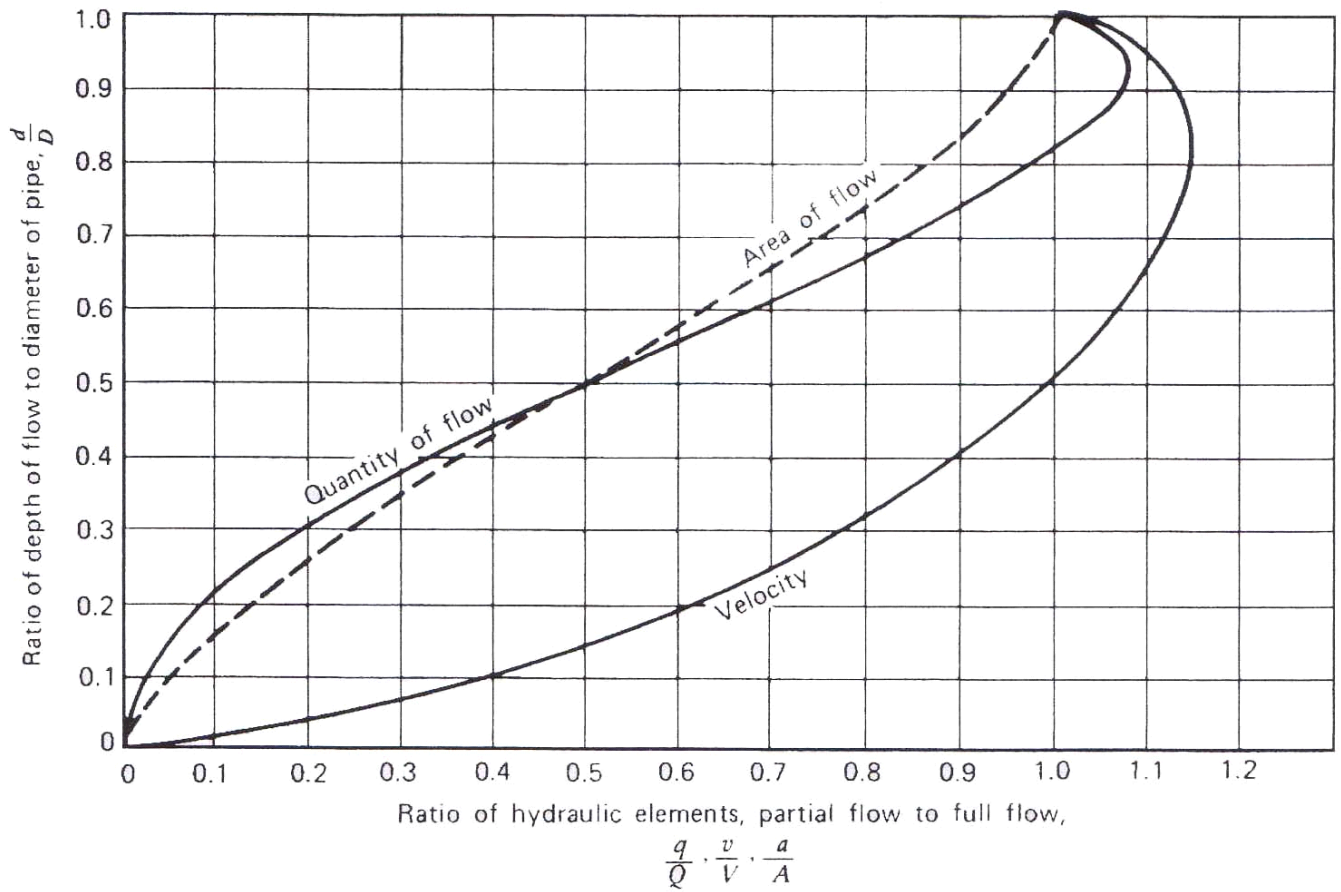


Figure – Partial flow diagram for a circular pipe

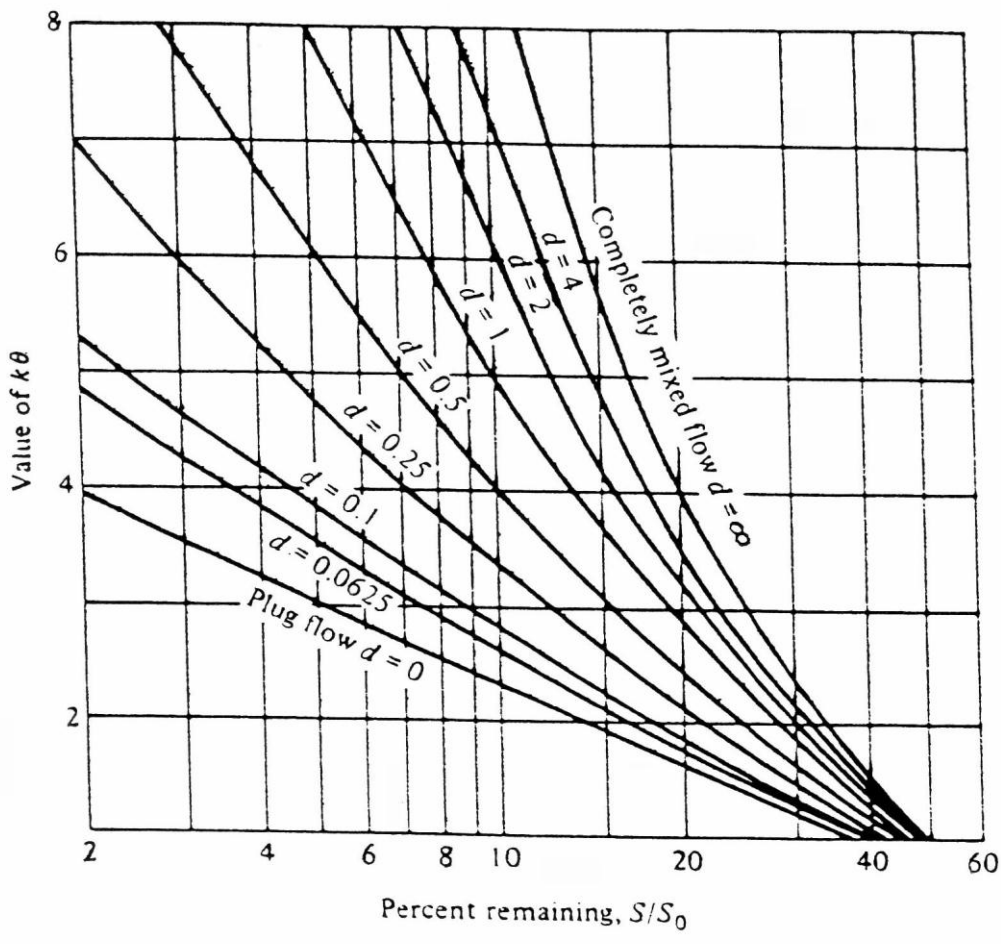


Figure – Relationship between $\frac{S}{S_0}$ (BOD remaining) and $k\theta$