UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Perama
Sidang Akademik 2006/2007
1st. Semester Examination
2006/2007 Academic Session

October / November 2006

EAP 313/2 – Kejuruteraan Air Sisa

EAP 313/2 – Wastewater Engineering

Masa : 2 jam
Duration : 2 hours

Arahan Kepada calon:
Instructions to Candidates:

1. Sila pastikan kertas peperiksaan ini mengandungi **DUA BELAS (12)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.
   *Ensure that this paper contains **TWELVE (12)** printed pages including appendices before you start your examination.*

2. Kertas ini mengandungi **EMPAT (4)** soalan. Jawab **SOALAN 1** (soalan wajib) dan **MANA-MANA 2 SOALAN LAIN**.
   *This paper contains **FOUR (4)** questions. Answer **QUESTION 1 (compulsory question)** and **ANY OTHER TWO (2)** questions.*

3. Semua soalan **BOLEH** dijawab dalam Bahasa Malaysia atau Bahasa Inggeris.
   *All questions **CAN BE** answered either in Bahasa Malaysia or English.*

4. Taip-tiap jawapan **MESTILAH** dimulakan pada muka surat yang baru.
   *Each question **MUST BE** answered on a new sheet.*

5. Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.
   Write the answered question numbers on the cover sheet of the answer script.

...2/-

1. (a) Berikan lakaran kasar carta aliran proses enap cemar teraktif pengudaraan lanjutan yang biasa untuk mengolah air sisa domestik.

(6 markah)

Sketch a typical process flow diagram of an extended aeration activated sludge process for treating domestic wastewater.

(b) Berikan syarat jarak minimum loji olahan terbuka serta loji olahan tertutup dari kawasan perumahan.

(4 markah)

Give minimum distance requirements from housing area for opened type and closed type treatment plant.

(c) Diberi bahawa nilai Beban BOD_5 puncak untuk Taman Damai di Parit Buntar adalah 2,665 kg/hari. Taman ini mempunyai sebanyak 2000 rumah dan sebuah sekolah harian dengan jumlah murid 1,000 orang. Kirakan nilai BOD_5 air sisa ini.

(8 markah)

Given that the value of peak BOD_5 load for Taman Damai in Parit Buntar is 2,665 kg/day. The Taman Damai has a total number of 2000 houses and a day school with 1000 pupil. Calculate the BOD_5 value of this wastewater.

(d) Air sisa dari sebuah kawasan berpenduduk 2,500 orang disaring secara sistem mekanik di loji olahan. Jika masa penstoran bahan saring ditetapkan sebagai 5 hari pada kadaralir puncak, menggunakan data-data di Lampiran, kirakan luas permukaan maksimum tangki bahan saring yang diperlukan. Ambil bukaan saring 20 mm dan kedalaman tangki bahan saring 2.5 meter.

(8 markah)

A wastewater form an area with population 2,500 is mechanically screen at the treatment plant. If the storage period of screenings is set to be 5 days at peak flow, using data in Appendices, calculate the required maximum surface area of the screenings tank. Take screen's opening 20 mm and tank's depth 2.5 meter.

(e) Suatu analisis BOD memberikan data seperti berikut:

$BOD_5 = 300$ mg/L
k1 pada 20°C = 0.16 $hari^{-1}$

Kirakan nilai BOD muktamad, Lo.

(6 markah)

A BOD analysis produced the following data:

BOD_5 =300 mg/L
k1 at 20°C = 0.16 $days^{-1}$

Calculate the ultimate BOD, Lo.

...3/-

1. (f) Suatu air sisa dari kawasan perumahan baru dengan penduduk setara 5,000 orang perlu melalui proses olahan fizikal menggunakan tangki enap primer. Sekiranya masa tahanan tangki adalah 2 jam, kirakan halaju permukaan tangki jika lebar tangki ialah 6 meter dan nisbah panjang kepada lebar adalah 3:1.

(8 markah)

A wastewater from a new housing scheme with population 5,000 people is to be treated by a physical process using a primary sedimentation tank. If retention time of the tank is 2 hours, calculate the approaching velocity to the tank if width of the tank is 6 meter and the length to with ratio is 3:1.

2. Suatu sistem sistem pembetung perlu mengalirkan air sisa dari kawasan perumahan berdasarkan data seperti di Jadual 1:

Jadual 1: Data reka bentuk

Jenis Premis	Data
Rumah 1 tingkat kos sederhana	2,750
Rumah berkembar 2 tingkat	100
Rumah kedai 2 tingkat Paras lantai – 6.1m x 12.65m Tingkat 1 – 6.1m x 15.54m	50
Stesyen minyak	1
Sekolah harian @ 1,300 murid	1
Masjid @ 1,000 orang	1

Rekabentukkan sebuah pembetung terasing jenis besi tuang (n = 0.013) yang mengalir 70% penuh pada $Q_{maksimum}$. Kecerunan yang dibenarkan ialah 1:600. Anggap nisbah $Q_{maksimum}$ terhadap Q_{purata} serta Q_{purata} terhadap $Q_{minimum}$ berpandukan Guidelines for Developers:Sewage Treatment Plant Volume IV, 1998 dan MS1228 (1991). Halaju swabersih air sisa adalah berpandukan nilai dalam Jadual 2.

Jadual 2: Halaju swabersih air sisa

Diameter (mm)	Halaju (m/s)
150-250	1.00
300-600	0.75
>600	0.60

(30 markah)

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2. *A sewer system flows a wastewater from a housing scheme with data as given in Table 1:*

Table 1: Design data

Premis type	***Data***
Single storey medium cost house	*2,750*
Double storey semi-detached house	*100*
Double storey shop house *Ground floor – 6.1m x 12.65m* *First floor – 6.1m x 15.54m*	*50*
Petrol station	*1*
Day school @ 1,300 pupils	*1*
Mosque @ 1,000 people	*1*

Design a cast iron separate sewer (n=0.013) which flows 70% full at $Q_{maximum}$. Allowable slope 1:600. Assume ratio $Q_{maximum}$ to $Q_{average}$ and $Q_{average}$ to $Q_{minimum}$ is in accordance with the Guidelines for Developers:Sewage Treatment Plant Volume IV, 1998 and MS1228 (1991). Self cleansing velocities of wastewater are given in Table 2.

Table 2: Self cleansing velocity of wastewater

Diameter (mm)	***Halaju (m/s)***
150-250	*1.00*
300-600	*0.75*
>600	*0.60*

3. (a) Suatu loji pengudaran proses enap cemar teraktif lazim mempunyai data seperti berikut:

Kadaralir = 2,500 m^3/hari
BOD_5 = 250 mg/L
F:M = 0.3
MLSS = 2,500 mg/L
y = 0.5 mg/mg
k_d = 0.06 $hari^{-1}$
θ_c = 10 hari
Hanya 60% BOD mengurai pada hari ke 5

Tentukan:

(i) Isipadu tangki pengudaraan yang sesuai. (4 markah)

(ii) Masa tahanan tangki. (4 markah)

(iii) Kuantiti Oksigen yang diperlukan dalam kg/hari. (10 markah)

(iv) Kuasa pengacauan yang diperlukan dalam Watt. Disyaratkan keperluan pengacauan minimum adalah 20 Watt/m^3. (4 markah)

3. (a) *An aeration tank of a conventional activated sludge process is having the following data:*

Flowrate = 2,500 m^3/day
BOD_5 = 250 mg/L
F:M = 0.3
MLSS = 2,500 mg/L
y = 0.5 mg/mg
$k_d = 0.06\ day^{-1}$
θ_c = 10 hari
Only 60% BOD is degraded on day 5

Determine:

(i) Volume of suitable aeration tank.

(ii) Retention time of tank.

(iii) Required quantity of oxygen in kg/day.

(iv) Required power of mixing in Watt. The minimum mixing is 20 Watt/m^3.

3. (b) Suatu loji turas cucur berbentuk silinder mempunyai nilai Beban Organik Isipadu 0.764 kg BOD_5/m^3.hari. Sekiranya isipadu kasar media turas cucur adalah 982 m^3 di mana 55% daripadanya berongga, kirakan nilai Beban Organik loji ini dalam kg/day.

(8 markah)

A cylindrical trickling filters plant is having a Volumetric Organic Loading of 0.764 kg BOD_5/m^3day. If the growth volume of media is 982 m^3 where 55% is void, calculatethe Organic Loading of this plant in kg/day.

4. (a) Terangkan secara ringkas kaedah penentuan Indeks Isipadu Enap cemar (SVI).

(6 markah)

Explain briefly the determination procedures of Sludge Volume Index (SVI).

4. (b) Tentukan nilai SVI berdasarkan data berikut:

MLVSS	=	2,750 mg/L
MLVSS terenap dalam 30 minit	=	100 mL/L
Enap cemar	=	70% organik

(8 markah)

Determine the SVI based on the following:

MLVSS	=	*2,750 mg/L*
MLVSS settled in 30 minutes	=	*100 mL/L*
Sludge	=	*70% organik*

(c) Diberi bahawa nilai BOD_5 suatu air sisa domestik sebagai 250 mg/L dan kadaralirnya datang dari suatu kawasan berpenduduk 10,000 orang. Cadangkan luas permukaan kolam fakultatif dengan nilai Beban Organik Kawasan 450 kg BOD/ha.hari.

(8 markah)

A BOD of a domestic wastewater from 10,000 people is 250 mg/L. Suggest the surface area of a facultative pond with Aerial Organic Loading 450 kg BOD/ha.day.

4. (d) Suatu aliran air sisa yang dihasilkan oleh suatu kawasan perumahan dengan nilai kandungan organik setara dengan 12.5 kg/hari, ingin diolah menggunakan loji Penyentuh Biologi Berputar (RBC). Loji ini menggunakan sistem RBC 1 siri, setiap siri mengandungi aci sepanjang 3 meter dengan 30 cakera setiap meter. Diamater cakera adalah 2.5 m. Kirakan nilai Beban Organik loji ini dalam gram BOD_5/m^2.hari.

(8 markah)

A wastewater flow from a housing area with organic content equivalent with 12.5 kg/day is to be treated by a single series Rotating Biological Contacter plant (RBC). Each series is 3 meter long with 30 disks per meter. Diameter of disk is 2.5 m. Calculate the Organic Loading of this plant in gram BOD_5/m^2.day.

LAMPIRAN

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 = $\frac{\textit{Beban Organik Premis}}{\textit{Beban Organik 1 orang}}$

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 = $\frac{\textit{(Lebar bilah + saiz bukaan)}}{\textit{Saiz bukaan}} \frac{\textit{(Kadaralir)}}{\textit{(Halaju) (Kedalaman air sisa)}}$

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

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

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

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

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

...8/-

LAMPIRAN

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

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

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

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

$1/\theta = yu - k_d$

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

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

Tangki Septik, C=225P

Pond design:

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

$A = Q/Dk_1 [L_i/L_e-1]$

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

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

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

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Jadual Penduduk Setara

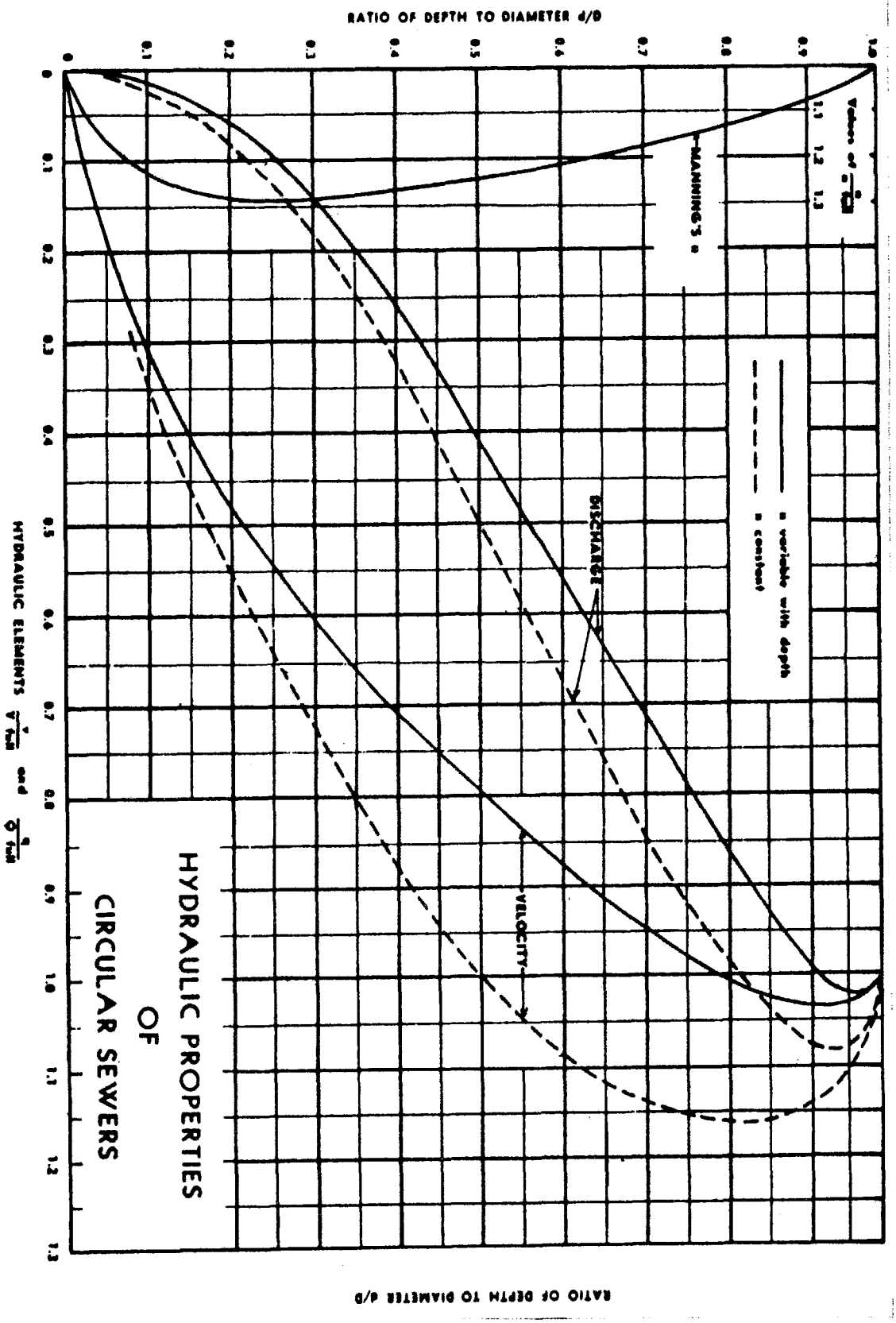
(Dipetik dari MS 1228 : 1991 : MALAYSIAN STANDARD: Code of Practice for Design and Installation of Sewerage Systems) dan Guidelines for Developers, Seksyen 1 dan 2, 1995

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	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 kadaralir adalah setara dengan 225 liter/kapita/day

...11/-

LAMPIRAN


RATIO OF DEPTH TO DIAMETER d/D
HYDRAULIC PROPERTIES
OF
CIRCULAR SEWERS
MANNING'S n
= variable with depth
= constant
DISCHARGE
VELOCITY
HYDRAULIC ELEMENTS
RATIO OF DEPTH TO DIAMETER d/D

LAMPIRAN

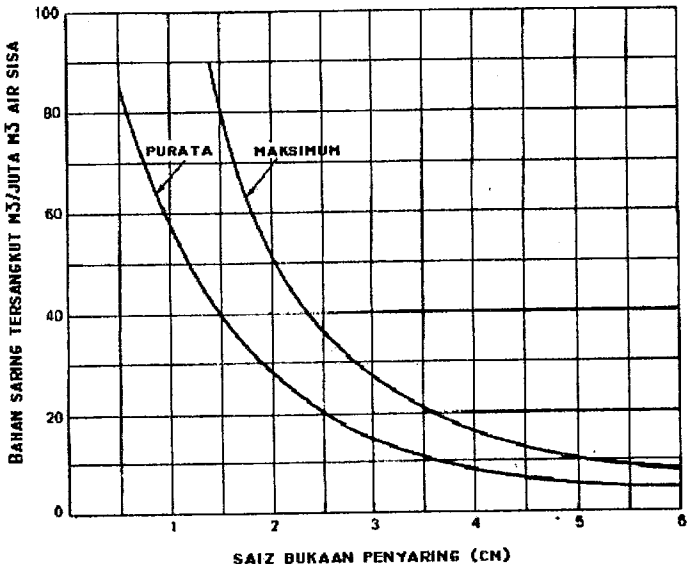
Table 5.8 Design Parameters for Primary Sedimentation

Description	Unit	Design Criteria
Sedimentation followed by secondary treatment		
Detention time at Q_{peak}	hr	2
Surface overflow rate at Q_{peak} - circular (maximum)* - rectangular (maximum)	 $m^3/m^2/d$ $m^3/m^2/d$	30 - 45 45 30
Weir loading at Q_{peak}	$m^3/m/d$	100 min, 200 max
Upward flow rate at Q_{peak}	m/hr	1.2 - 2.0
Sedimentation with RAS return		
Detention time at Q_{peak}	hr	1.5 - 2.0
Surface overflow rate at Q_{peak} - Circular (maximum)* - Rectangular (maximum)	 $m^3/m^2/d$ $m^3/m^2/d$	 40 30
Weir loading at Q_{peak}	$m^3/m/d$	100 min, 200 max
Upward flow rate at Q_{peak}	m/hr	1.3 - 1.7
Sizing of rectangular tanks		
Length : Width		3:1

* Circular tanks shall be no more than 50 m in diameter and the side water depth shall be at a minimum of 3.0 m.

Note: If weir loading exceeds 100 m^3/day/m at average flow, a multiple v-notch weir must be used.

Refer also to Clause 6.3.6 of MS 1228.



Screen designing chart
Carta reka bentuk penyaring

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