UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama
Sidang Akademik 2003/04

September/Oktober 2003

IEK 305E - REKABENTUK PERALATAN PENGOLAHAN AIR

Masa: 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi SEMBILAN mukasurat (termasuk empat keping Lampiran) yang bercetak sebelum anda memulakan peperiksaan ini.

Jawab **LIMA** soalan. Semua soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia.

1. Satu tangki digunakan untuk memecat pepejal terampai dari air sisa. Kadar aliran air sisa, yang mengandungi pepejal terampai dengan kepekatan 220 mg/L, ke dalam tangki pemendakan ialah 10 L/s. Keefisienan pemecatan pepejal terampai di dalam tangki pemendakan ialah 75%. Apakah amaun pepejal terampai (enapcemar) tertmpuk di dalam zon enapcemar setiap hari? Anggapkan bahawa amaun air yang akan diundur dalam keadaan mantap jika amaun enapcemar yang dipamkan keluar dari zon enapcemar adalah sedikit berbanding dengan aliran masuk air sisa.

   A settling tank is used to remove suspended solids from wastewater. The rate of flow of wastewater, with a suspended solids concentration of 220 mg/L, into the settling tank is 10 L/s. The efficiency of the suspended solids removal of the settling tank is 75%. What is the amount of suspended solids (sludge) accumulated in the sludge zone each day? Assume that the amount of water that will be withdrawn at steady state when pumping out the sludge from the sludge zone is very small compared to the inflow of wastewater.

   (100 markah)

2. (a) Tindak balas bagi pemecatan kekerasan kalsium melalui pelembutan mendakan kapur ialah: $CaO + Ca(HCO_3)_2 = 2\,CaCO_3\downarrow + H_2O$. Apakah dos kapur yang berketulenen 85% CaO diperlukan untuk bergabung dengan 75 mg/L kalsium?

   The chemical reaction for removal of calcium hardness by lime precipitation softening is : $CaO + Ca(HCO_3)_2 = 2\,CaCO_3\downarrow + H_2O$. *What dosage of lime with a purity of 85% CaO is required to combine with 75 mg/L of calcium?*

Berat atom:	C = 12.01	Ca = 40.08	H = 1.008
(Atomic weight):	O = 16.0		

   (70 markah)

(b) Suatu kilang mendiscaskan sisanya ke dalam satu sungai yang mempunyai kadar alira minimum 8.15 m^3/s. Bahan cemar di dalam sisa tersebut ialah P. Arus sisa mengalir pada 0.18 m^3/s dengan kepekatan P 3300 mg/L di dalam arus sisa. Pencemaran di hulu telah menyebabkan kepekatan 28 mg/L P di dalam sungai hulu daripada discas industri dalam keadaan aliran minimum. Mengikut undang-undang, had maksimum P di dalam sungai ialah 95 mg/L. Adakah kilang tersebut perlu mengolahkan air sisanya sebelum ianya didiscaskan ke dalam sungai?

An industry discharges its waste into a river that has a minimum flowrate of 8.15 m^3/s. The pollutant in the waste is P. The waste stream flows at 0.18 m^3/s with a concentration of P of 3300 mg/L in the waste stream. Upstream pollution has caused a concentration of 28 mg/L P in the river upstream of the industrial discharge under the minimum flow conditions. The maximum limit of P is to be 95 mg/L in the river. Does the industry need to treat its wastewater before discharging into the river?

(30 markah)

3. (a) Air mengalir pada kadar 35 L/s di d alam satu paip air 200-mm dengan C = 100. Apakah halaju aliran dan kerugian kepala?

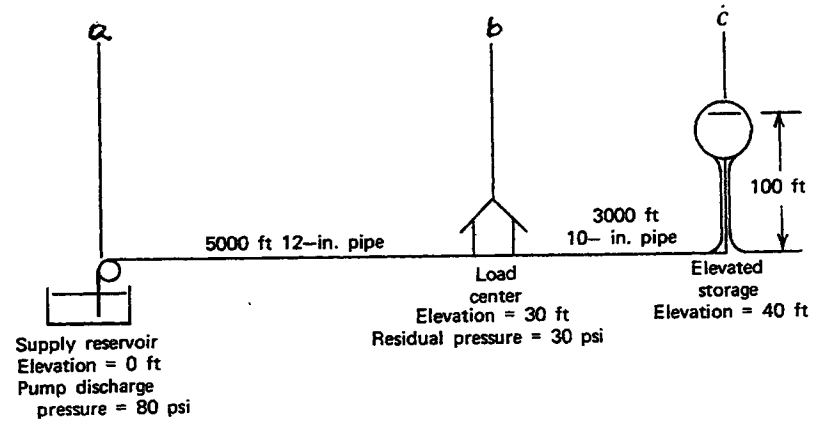
A 200-mm water main with C = 100 is carrying a volumetric flow of 35 L/s. What is the velocity of flow and head loss?

(30 markah)

(b) Satu sistem pembekalan air yang mangandungi satu takungan dengan pam lif, storan ternaik, paip, dan satu pusat beban (titik pengunduran) adalah ditunjukkan di bawah. Berdasarkan kepada data berikut, (i) lakarkan kecerunan hidraulik untuk sistem tersebut; (ii) kirakan kadar aliran pada titik b dari kedua-dua pam pembekal dan storan ternaik. Anggapkan C = 100 dan saiz paip seperti ditunjukkan.

A simplified water supply system consisting of a reservoir with lift pumps, elevated storage, piping, and a load center (withdrawer point) is shown below. Based on the following data, (i) sketch the hydraulic gradient for the system; (ii) compute the flow available at point b from both supply pumps and elevated storage. Assume C = 100 and pipe size as shown.

$P_a = 80$ psi, $Z_a = 0$ ft; $P_b = 30$ psi, $Z_b = 30$ ft; $P_c = 100$ ft (paras air di dalam tangki) (*water level in tank*), $Z_c = 40$ ft.



(70 markah)

4. (a) Dengan bantuan gambarajah, bincangkan berbagai fasa pertumbuhan bakteria.

With the help of a diagram, discuss different phases of bacterial growth.

(20 markah)

(b) Bincangkan sumber-sumber air.

Discuss water resources.

(30 markah)

(c) Bincangkan pengklasan pengolahan fizikal, pengolahan kimia, dan pengolahan biologi.

Discuss classification of physical treatment, chemical treatment and biological treatment.

(50 markah)

5. (a) Dengan bantuan ujian Jar, bincangkan kajian pemecatan kekeruhan dengan menggunakan kaedah pengentalan.

With the help of Jar Test, discuss the turbidity removal study using coagulation method.

(50 markah)

(b) Bincangkan mengenai penggunaan klorin dalam proses penyahbasmian air.

Discuss the use of chlorine in the disinfection of water.

(50 markah)

6. (a) Bincangkan tentang proses pemendakan dan dua jenis penjernih yang digunakan dalam pengolahan air.

Discuss sedimentation process and two types of clarifier used in water treatment.

(50 markah)

(b) Dua tangki pemendakan primer mempunyai 86 ft diameter dan kedalaman sisi air 7 ft. Empang limpah efluen diletakkan di persisian tangki. Pada aliran air sisa 7.5 mil gal/d, hitungkan kadar aliran limpah, masa tahanan, dan beban empangan limpah. Beban empangan limpah adalah kuantiti aliran limpah harian purata dibahagi dengan jumah panjang empangan limpah, gal/ft.d.

Two primary settling tanks are 86 ft in diameter with a 7-ft side water depth. Single effluent weirs are located on the peripheries of the tanks. For a wastewater flow of 7.5 million gallons per day, calculate the overflow rate, detention time, and weir loading. Weir loading is the average daily quantity of overflow divided by the total weir length, gal/ft.d.

(50 markah)

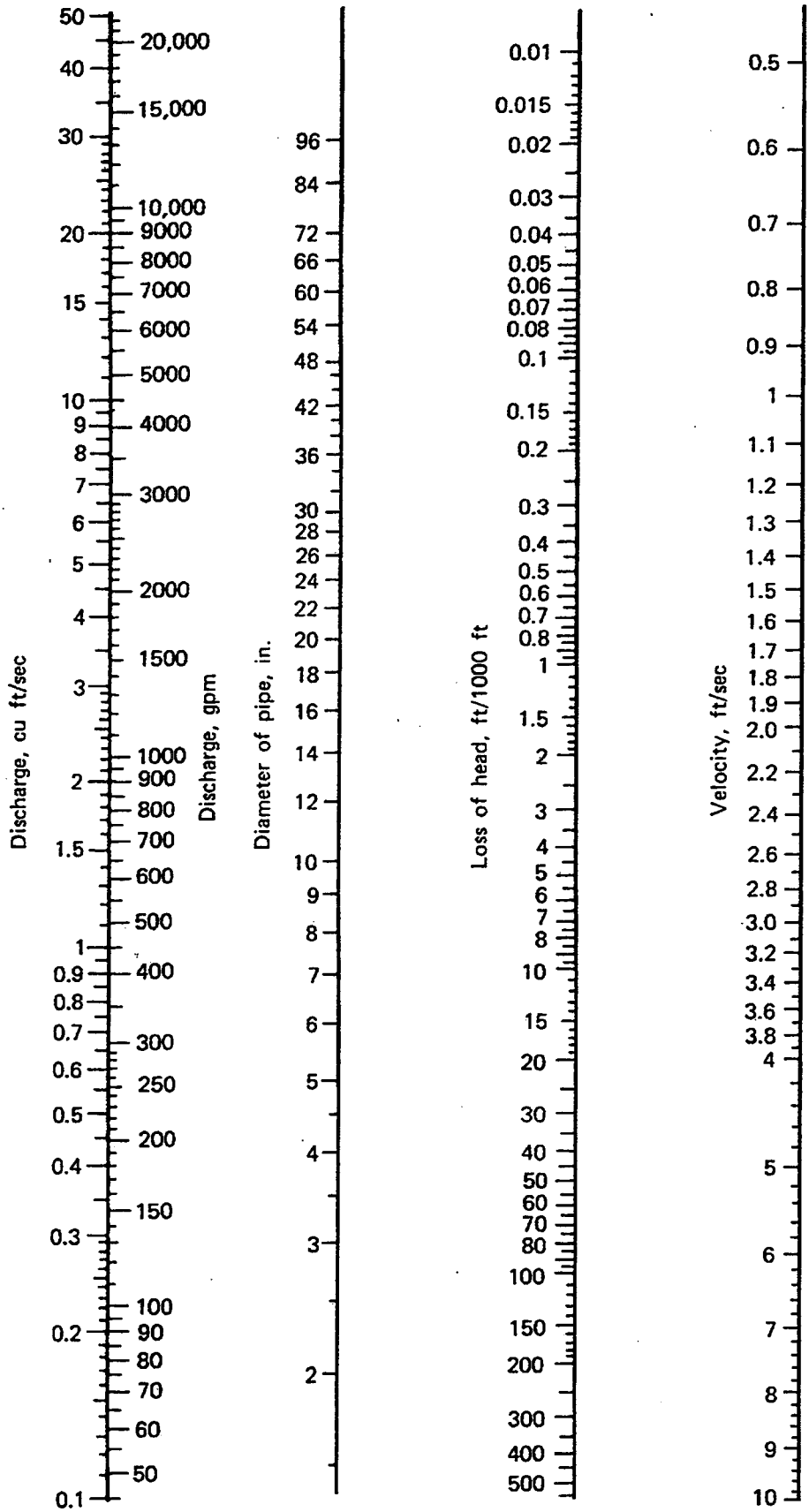


Figure Nomograph for Hazen Williams formula, based on $C = 100$.

VALUES OF GAS CONSTANT

Temperature	Mass	Energy	*R*
Kelvins	kg mol	J	8314.47
		cal_{IT}	1.9859×10^{3}
		cal	1.9873×10^{3}
		m^3-atm	82.056×10^{-3}
	g mol	cm^3-atm	82.056
Degrees Rankine	lb mol	Btu	1.9858
		$ft\text{-}lb_f$	1545.3
		Hp-h	7.8045×10^{-4}
		kWh	5.8198×10^{-4}

CONVERSION FACTORS AND CONSTANTS OF NATURE

To convert from	To	Multiply by†
acre	ft^2	43,560*
	m^2	4046.85
atm	N/m^2	$1.01325* \times 10^{5}$
	$lb_f/in.^2$	14.696
Avogadro number	particles/g mol	6.022169×10^{23}
barrel (petroleum)	ft^3	5.6146
	gal (U.S.)	42*
	m^3	0.15899
bar	N/m^2	$1* \times 10^{5}$
	$lb_f/in.^2$	14.504
Boltzmann constant	J/K	1.380622×10^{-23}
Btu	cal_{IT}	251.996
	$ft\text{-}lb_f$	778.17
	J	1055.06
	kWh	2.9307×10^{-4}
Btu/lb	cal_{IT}/g	0.55556
Btu/lb-°F	cal_{IT}/g-°C	1*
Btu/ft^2-h	W/m^2	3.1546
Btu/ft^2-h-°F	W/m^2-°C	5.6783
	$kcal/m^2$-h-K	4.882
Btu-ft/ft^2-h-°F	W-m/m^2-°C	1.73073
	kcal/m-h-K	1.488

(Continued)

To convert from	To	Multiply by†
cal_{IT}	Btu	3.9683×10^{-3}
	ft-lb_f	3.0873
	J	4.1868*
cal	J	4.184*
cm	in.	0.39370
	ft	0.0328084
cm^3	ft^3	3.531467×10^{-5}
	gal (U.S)	2.64172×10^{-4}
cP (centipoise)	kg/m-s	$1* \times 10^{-3}$
	lb/ft-h	2.4191
	lb/ft-s	6.7197×10^{-4}
cSt (centistoke)	m^2/s	$1* \times 10^{-6}$
faraday	C/g mol	9.648670×10^4
ft	m	0.3048*
ft-lb_f	Btu	1.2851×10^{-3}
	cal_{IT}	0.32383
	J	1.35582
ft-lb_f/s	Btu/h	4.6262
	hp	1.81818×10^{-3}
ft^2/h	m^2/s	2.581×10^{-5}
	cm^2/s	0.2581
ft^3	cm^3	2.8316839×10^4
	gal (U.S.)	7.48052
	L	28.31684
ft^3-atm	Btu	2.71948
	cal_{IT}	685.29
	J	2.8692×10^3
ft^3/s	gal (U.S)/min	448.83
gal (U.S.)	ft^3	0.13368
	$in.^3$	231*
gravitational constant	N-m^2/kg^2	6.673×10^{-11}
gravity acceleration, standard	m/s^2	9.80665*
h	min	60*
	s	3600*
hp	Btu/h	2544.43
	kW	0.74624
hp/1000 gal	kW/m^3	0.197
in.	cm	2.54*
$in.^3$	cm^3	16.3871
J	erg	$1* \times 10^7$
	ft-lb_f	0.73756
kg	lb	2.20462
kWh	Btu	3412.1
L	m^3	$1* \times 10^{-3}$
lb	kg	0.45359237*
lb/ft^3	kg/m^3	16.018
	g/cm^3	0.016018
$lb_f/in.^2$	N/m^2	6.89473×10^3
lb mol/ft^2-h	kg mol/m^2-s	1.3562×10^{-3}
	g mol/cm^2-s	1.3562×10^{-4}
light, speed of	m/s	2.997925×10^8

(Continued)

To convert from	To	Multiply by†
m	ft	3.280840
	in.	39.3701
m^3	ft^3	35.3147
	gal (U.S.)	264.17
N	dyn	$1* \times 10^5$
	lb_f	0.22481
N/m^2	$lb_f/in.^2$	1.4498×10^{-4}
Planck constant	J-s	6.626196×10^{-34}
proof (U.S.)	percent alcohol by volume	0.5
ton (long)	kg	1016
	lb	2240*
ton (short)	lb	2000*
ton (metric)	kg	1000*
	lb	2204.6
yd	ft	3*
	m	0.9144*

† Values that end in an asterisk are exact, by definition.

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