UNIVERSITI SAINS MALAYSIA

First Semester Examination
2007/2008 Academic Session

October / November 2007

EAP 581/4 – Water Supply Engineering

Duration: 3 hours

Please check that this examination paper consists of **FIVE** pages of printed material before you begin the examination.

Instructions: Answer **FIVE (5)** questions only. All questions carry the same marks.

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

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

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

1. (a) Turbid water may be not palatable as well as subjected to various sources of pollution. Define turbidity and discuss the problems of turbidity and its solution in water treatment engineering.

(6 marks)

(b) Define pH and alkalinity. Describe the effects of pH and alkalinity on water quality with respect to water treatment and water supply engineering.

(8 marks)

(c) Bacteriological analysis is normally carried out to determine whether the water source is safe and free from pathogenic organisms. Describe the procedures for the determination of faecal origin coliform organisms particularly *Escherichia Coli.*

(6 marks)

2. (a) At a brackish water reverse osmosis (RO) treatment plant, the net pressure is 40 atmospheres. The membrane manufacturer provides that the membrane flux rate coefficient of 1.8×10^{-6} sm^{-1}. Compute the flux of water.

(5 marks)

(b) Water demand is normally varies from time to time. The knowledge on these variations is important for water supply engineer. Discuss briefly maximum daily demand with respect to water supply engineering.

(5 marks)

(c) Population data for certain area are shown in Table 1. Calculate the projected population in the rural areas in 2030 using the following methods:

[i] Arithmetic
[ii] Geometric
[iii] Incremental increase and
[iv] Decreasing rate of increase

Table 1

Year	1980	1990	2000
Total population	50,000	65,000	85,000
Percentage of urban population	30	35	38

(10 marks)

3. (a) With the aid of a sketch diagram describe recycle-flow dissolved air flotation process for solid-liquid separation in terms of the processes involved including the functions of each unit process

(5 marks)

(b) Sedimentation Class II involves settlement of dilute suspensions of flocculent particles. Briefly describe the phenomena involve under Sedimentation Class II.

(5 marks)

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3. (c) A medium cost housing scheme consists of 5000 units of terrace houses, each unit has a floor area of 900 square feet. The building is made up of ordinary construction. Domestic water demand is estimated at 300 litres per capital per day with population equivalent of 5 per unit. With the aid of the following information estimate the total flow required. You may use Tables 2 and 3 to help your estimation.

$F=18C(A)^{0.5}$

Note: Gallon per minute = [(L/min)/3.78], $1m^2=10.76\ ft^2$,

Table 2 : Residential fire flows

Distance between adjacent units (m)	Required fire flow (litre/minute)
>30.5	1890
9.5 – 30.5	2835 – 3780
3.4 – 9.2	3780 – 5670
<3.0	5670 - 7560

Table 3 : Residential flow duration

Required fire flow (litre/minute)	Duration (hour)
<3780 (<1000gpm)	4
3780-4725 (1000-1250 gpm)	5
4725-5670 (1250-1500 gpm)	6
5670-6615(1500-1750 gpm)	7
6615-7560 (1750-2000 gpm)	8
7560-8505 (2000-2250 gpm)	9
>8505(>2250 gpm)	10

(10 marks)

4. (a) A sinuous channel has 15 round-the-end cross-walls. Water is passed along with a velocity of 0.2 ms^{-1} between the cross-walls and 0.5 ms^{-1} round the ends. The flow rate is $0.25m^3s^{-1}$ and the nominal retention time is 25 minutes. For a water temperature of 20^0C where the dynamic viscosity is $1.003x10^{-3}Nsm^{-2}$, estimate the additional head loss in the channel, the power dissipated, the velocity gradient and Camp Number.

(10 marks)

4. (b) Two sets of jar tests are conducted on raw water containing 30 NTU and an HCO_3^- alkalinity concentration of 40 mg/L expressed as $CaCO_3$. Given the data as shown in Table 4, find the optimal pH, coagulant dose and the theoretical amount of alkalinity that would be consumed at the optimal dose. The reaction occurs when water is added with alum is shown below:

$$Al_2(SO_4)_3.14H_2O + 6HCO_3^- \rightarrow 2Al(OH)_3 + 6CO_2 + 14H_2O + 3SO_4^{2-}$$

Molecular weights of the elements are shown as follows:

Oxygen = 16, sulphur = 32, aluminium = 27, hydrogen = 1 and carbon = 12.

Table 4

Jar Test 1						
Jar	1	2	3	4	5	6
pH	5.0	5.5	6.0	6.5	7.0	7.5
Alum dose (mg/L)	15	15	15	15	15	15
Turbidity (NTU)	14	8	4.5	6.0	9	13
Jar Test 2						
Jar	1	2	3	4	5	6
pH	6.0	6.0	6.0	6.0	6.0	6.0
Alum dose (mg/L)	6	8	12	14	16	18
Turbidity (NTU)	14	10	4.5	4.0	6	13

(10 marks)

5. (a) Rapid filtration normally uses granular filter media. Describe five properties required for the medium.

(5 marks)

(b) Non-revenue water is a matter of concern not only among water supply operators but the government. In Malaysia this phenomena is quite serious. If you are a waterworks engineer that has been given the task to deal with non-revenue water, briefly explain your action plan to resolve this problem.

(5 marks)

5. (c) A water treatment plant has a capacity of 110,000 cubic metres per day (m^3d^{-1}) with two horizontal flow settling basin, each of which is 24.5 m long, 18 m wide and 3.7 m deep. Calculate:

[i] The actual surface loading (settling velocity) of each basin.
[ii] The surface loading rate (settling velocity) that would be obtained if prefabricated modules comprised of square tubes inclined at 60^0 are installed for the last 12 m of each basin. The modules are 60 cm high and the cross-sectional area of each tube is 5.0 cm x 5.0 cm.

The following equations may be useful:

$$v_{sc} = \frac{kv_0}{\sin\theta + L_u \cos\theta}$$

$$L_u = L_R - 0.013R_N$$

(10 marks)

6. (a) A lake receives pollution from three sources with decay coefficient of 0.2/h;
[i] factory waste 100 kg/h
[ii] pollutant from river 20 mg/l
[iii] atmospheric flux $2g/m^2/h$ with decay coefficient of 0.25/h

Find the assimilation factor, the pollutant steady-state concentration and the mass changes.

Please state any additional assumptions you made, and show all work.
(Note: $k = \theta^{t-t_{20}}$; $a = Q + kV$; $W_{atm} = JA$, $W = W_{NPC} + W_{atm} + W_{inflow}$, $c = W/a$)

(10 marks)

(b) Determine whether the reaction is zero-, first- or second-order and estimate the reaction rate of follows:

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

(5 marks)

Time, d	1	2	3	4	5
BOD, mg/l	95	180	240	285	320

(5 marks)

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