UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2005/2006 Academic Session

November 2005

EAP 581/4 – Waste Supply Engineering

Duration: 3 hours

Instructions to Candidates:

1. Ensure that this paper contains **FIVE (5)** printed pages before you start your examination.

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).**

3. Each question carry equal marks.

4. All questions **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.

5. Each question **MUST BE** answered on a new sheet.

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

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1. (a) Under what circumstances *Escherichia coli*, thermotolerant coliforms, and total coliforms should be used as indicator organisms?

(3 marks)

(b) What are the rationales (reasons) for limiting fluoride, arsenic and mercury to 1.5, 0.01 and 0.001 mg/L, respectively in WHO guidelines for drinking water quality?

(3 marks)

(c) List the membrane desalination processes for separating salts from water and their range of applicability in terms of salinity (TDS) of the feed water.

(4 marks)

(d) With the aid of a sketch, explain briefly the working principle of one of the processes.

(7 marks)

(e) What pretreatment of the water will be necessary prior to application of these processes?

(3 marks)

2. (a) Draw a schematic flow diagram of the treatment processes commonly used in treating surface waters and state the function of each treatment process.

(6 marks)

(b) Can the required coagulant (alum) dose be estimated beforehand from what is known about the water? If not, by what test the coagulant dose is estimated?

(2 marks)

(c) Show that addition of 1 mg/L of alum [$Al_2(SO_4)_3 \cdot 14H_2O$] will neutralise 0.505 mg $CaCO_3$/L of bicarbonate alkalinity [$Ca(HCO_3)_2$]. What chemical is added to the water for coagulation of low-alkalinity waters?
[Al: 27; Ca: 40; C: 12; H: 1; O: 16; S: 32].

(3 marks)

(d) A laboratory column analysis indicates that a surface overflow rate (surface loading) of 25 m/d produces satisfactory sedimentation at a depth of 4.0 m for an alum-coagulated surface water. Determine the dimensions of a rectangular sedimentation tank (length to width ratio 3:1) and length of the outlet weir for a flow of 10 MLD (million litres per day). Check for retention time and horizontal flow velocity. Draw a sketch of the sedimentation tank.

(9 marks)

3. (a) A flocculation tank (20 m long, 14 m wide and 4 m deep) is equipped with revolving paddles and treats a flow of 40 MLD (million litres per day). The power input to provide paddle-blade velocities of 0.3 and 0.4 m/s, for the inner and outer blades, respectively, is 1.2 kW. Calculate the retention time, horizontal flow velocity, G (the mean velocity gradient) and Gt. Comment on the G and Gt values. [Dynamic viscosity of water at 25°C is 1.002×10^{-3} N · s/m^2].

(6 marks)

(b) Draw cross-sectional sketch of a rapid sand filter and explain the filtration and backwash cycles. Explain how colloidal particles and flocs having dimensions 0.01-10 μm are removed in the filter where the dimensions of the pores in the sand bed are 35-50 μm.

(10 marks)

(c) In many water distribution systems, a combined chlorine residual following breakpoint chlorination provides a longer lasting residual. If the chlorine dose required to achieve 1 mg Cl_2/L free chlorine residual is 10 mg Cl_2/L in a 100 MLD (million litres per day) water treatment plant (water pH 8.0), calculate the kg/d of chlorine and ammonia required. Assume a water temperature of 20°C.
[Ionisation constant for hypochlorous acid at 20°C is 2.5×10^{-8} mol/L.
H: 1; O: 16; Cl: 35.5; N: 14].

(4 marks)

4. (a) Discuss **FIVE (5)** factors that affecting the amount of water consumed with respect to water supply engineering.

(5 marks)

(b) A medium cost housing scheme consists of 4000 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 350 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 1 and 2 to help your estimation.

$F = 18C(A)^{0.5}$
Note: Gallon per minute = [(L/min)/3.78], 1m^2=10.76 ft^2,

Table 1 - 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 2 - 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. (c) With the aid of a sketch diagram describe on the 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)

5. (a) Describe **FIVE (5)** requirements that need to be considered for the design and construction of a water distribution system with respect to water supply engineering.

(5 marks)

(b) Non-revenue water in Malaysia in 2001 published by Malaysian Water Association was between 18% to above 60%. This phenomenon is very serious and need to be ratified. If you were a waterworks engineer in one of the serious district in Malaysia, elaborate your action plan to combat non-revenue water.

(5 marks)

(c) Figure 1 shows a reticulation system. Estimate the flow rate in each pipeline using Hardy-Cross Method and Hazen-William formula up-to two iteration. Adopt Hazen-Willian coefficient C as 110. Use an initial flow rate of 60 litres per second (lps) from point A to B. The lengths and diameters for pipes AB, BC, CD and AD are as follows:

Pipe AB: length = 800m and diameter = 250mm
Pipe BC: length = 700m and diameter = 200mm
Pipe CD: length = 700m and diameter = 200mm
Pipe AD: length= 700m and diameter = 250mm.

The following formula may be useful

$$H_L = \frac{12.25x10^9}{D^{4.87}} L\left(\frac{Q}{C}\right)^{1.85}$$

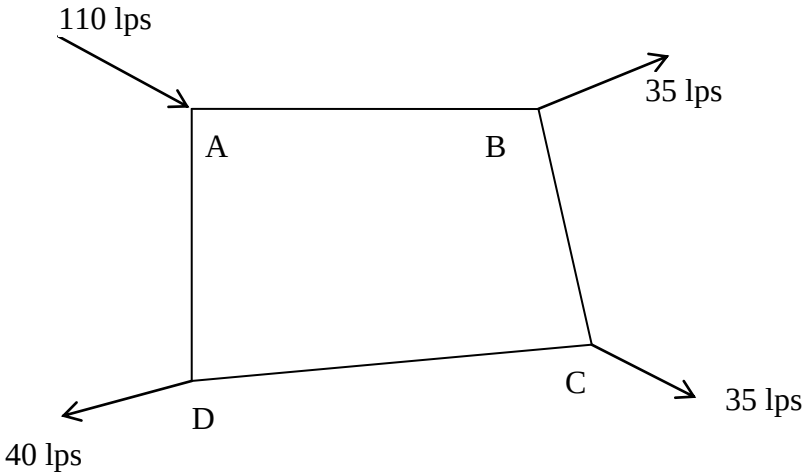

Figure 1

(10 marks)

6. (a) Most of Bylaws used by Thames Water, South Staffordshire Waterworks Company and Perak Water Board are more concerned with prevention of waste, undue consumption, misuse or contamination of water. Describe and discuss the requirements to be imposed for storage cistern supplying water for domestic purposes with respect to prevention of waste or contamination of stored water.

(10 marks)

(b) A lake receives pollutants from three sources with decay coefficient of 0.2/h;

(i) factory waste 100 kg/h
(ii) pollutant from river 10 mg/l
(iii) atmospheric flux 1 gm/m^2h with decay coefficient of 0.20/h

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

Please state any additional ssumptions you made, and show all work.
(Note: $k = \theta^{tn-t20}$; $a = Q + kV$; $W_{atm} = JA$, $W = W_{NPC} + W_{atm} + W_{inflow}$, $c = W/a$)

(10 marks)

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