UNIVERSITI SAINS MALAYSIA

1st Semester Examination
2010/2011 Academic Session

November 2010

EAP 581/4 – Water Supply Engineering

Duration : 3 hours

Please check that this examination paper consists of **SIX (6)** printed pages before you begin the examination.

[Instructions: This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only.

You must answer the questions in English.

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

1. a) Briefly discuss about water quality standard in Malaysia.

[3 marks]

b) Briefly explain type of water classification based on Total Dissolved Solids.

[2 marks]

c) Raw water has the following composition :-

Ions			
Cation	**Concentration (mg/L)**	**Anion**	**Concentration (mg/L)**
Ca^{2+}	90	HCO_3^-	305
Mg^{2+}	30	Cl^-	36
Na^+	14	$SO_4^=$	85
K^+	5	$CO_3^=$	10

Note : AW for Ca=40.1, Mg=24.3 , Na=23, K=39, C=12, O=16, S=32, H=1, Cl=35.5

i. Convert all concentration to mg/L $CaCO_3$
ii. Calculate ion balance of the analysis.
iii. Compute TDS of the raw water

[8 marks]

d) A water treatment plant uses 49.9 kg/d of chlorine to treat 0.438 m^3/s (37850 m^3/d) of water. The residual Chlorine after 30min contact time is 0.55 mg/L. Determine the chlorine dosage and chlorine demand of the water.

[7 marks]

2. a) Water demand estimation involves various parameters such as factors affecting consumption, methods of determining demand, peak factors, planning horizon and stage development. Based on the given parameters, if you have been short listing by the client to present a proposal to evaluate water demand for one particular region which has urban and rural areas, discuss fundamental details to be prepared and presented to the client so that the job could be secured.

[10 marks]

b) A medium cost housing scheme consists of 4500 units of terrace houses, each unit has a floor area of 1200 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]

3. a) Describe briefly the following terms with respect to water supply engineering

   i. Dosing [2 marks]

   ii. Suspension [2 marks]

   b) For rapid mixing, waterworks engineer has the wisdom to use mechanical or hydraulic types of mixing. With the aid of sketch diagrams for both types of mixing, discuss their advantages and disadvantages.

   [6 marks]

   c) A water treatment plant is designed to cater a population of 100,000. Water demands for urban and rural areas are 230 and 160 litres per capita per day (lpcd) respectively. The percentage of population in the urban areas is 35% and the rest in the rural areas. Water demand for the industries and other categories is approximately 40% of the total domestic demand. Process design involves with the construction of rapid mixing tanks of equal sizes in parallel. After rapid mixing, it is followed with two-stage flocculation with the construction of two tanks of equal sizes. Velocity gradients for the first and second tanks are $60s^{-1}$ and $30s^{-1}$ respectively. Retention time in each tank is 15 minutes and the dynamic viscosity of the water is $1.145x10^{-3}$ Nsm^{-2}. Estimate the volume of the flocculation tank and the power input in each tank.

   [10 marks]

4. a) Explain briefly the following terms;

   i. Clarification [2 marks]

   ii. Thickening [2 marks]

   b) In designing of sedimentation tank, the inlet arrangement of the influent could be crucial so that laminar condition in the sedimentation basin could be sustained. With the aid of a sketch diagram discuss the requirements for the inlet arrangement of the sedimentation tank.

   [6 marks]

c) A water treatment plant has a capacity of 110,000m^3/day with two horizontal settling basins, each of which is 24m long, 18m wide and 3.6m deep. Calculate:

i. Surface loading rate of each basin. [4 marks]

ii. Surface loading rate of each basin that would have be obtained if prefabricated modules comprised of square tubes inclined at 60^0 installed at the last 12m of the basin. The modules are 60cm high and the cross-sectional area of each tube is 5cmx5cm. Given that efficiency factor for square tube settling system is 1.38.

[6 marks]

5. a) Discuss briefly the resistance of organisms to disinfectant agent with respect to potable water supply.

[4 marks]

b) Non-revenue water is composed of unbilled authorised consumption, apparent losses and real losses. Briefly discuss each component.

[6 marks]

c) Ramtek Water Treatment Plant in India was designed with dual media filter bed. It is composed of 0.3m thick coconut shell media with mean size of 2mm and was placed over 0.5m layer of sand with mean size of 0.6mm. The surface loading is 7m/hour. Assume the grain sphericity is 0.70 and porosity for both is 0.40; estimate the head loss through the filter using Carman-Kozeny equation. Given that the density and viscosity of water at 20^0C are 998 kg/m^3 and 1.003×10^{-3} Ns/m^2.

The following equation is relevant:

$$\frac{h}{L} = \frac{K\mu}{\rho g}\frac{(1-\varepsilon)^2}{\varepsilon^3}\left(\frac{a}{v}\right)^2 V$$

[10 marks]

6. a) Describe the meaning of Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO). Consider a small *closed* bottle containing BOD ℓ_0 mg/L and DO c_0 mg/L. Since this bottle is closed, no oxygen can enter into it. Describe what will happen to the BOD and DO in this closed bottle, using figures, diagrams and tables for illustration. Then write the differential equations to describe the time evolution of BOD and DO in this closed bottle, assuming *constant* rate of BOD decay, α d^{-1}. Solve and plot the general analytical solutions. All symbols used must be defined, with proper dimensions and units. Let $\ell_0 = 9$ mg/l, $c_0 = 6$ mg/l and $\alpha = 0.4$ d^{-1}. Solve and sketch the solution for ℓ and c.

[10 marks]

b) Consider a small uniformly mixed lake with constant BOD ℓ_0 mg/L and initial DO c_0 mg/L. This means that the BOD remains constant at $\ell = \ell_0$ mg/L for all time t. BOD decay rate is α d^{-1}, reaeration is β d^{-1} and oxygen saturation is c_s mg/L (all kinetic rates are constant). Then the equation for DO c mg/L is given by

$$\frac{dc}{dt} = -\alpha\ell_0 + \beta(c_s - c), \qquad c(0) = c_0 \qquad (1)$$

i. Explain the terms used in Equation (1).

ii. Sketch the solutions for Equation (1) without solving.

iii. Solve Equation (1) for $t \in [0, \infty)$.

Given the following values: $\alpha = 0.4$ per day, $\beta = 0.7$ per day, $\ell = \ell_0 = 9.0$ mg/L, $c_0 = 6.0$ mg/L, $c_s = 7.5$ mg/L. Find the solution c(t) to Equation (1) with this set of values given. Plot the curve for c(t) for $t \in [0, \infty)$.

[10 marks]

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