First Semester Examination
2017/2018 Academic Session

January 2018

# EAP581 – Water Supply Engineering

Duration : 2 hours

Please check that this examination paper consists of SEVEN (7) pages of printed material including appendix before you begin the examination.

**Instructions :** This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions.

All questions must be answer in English.

Each questions **MUST BE** answered on a new page.

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1. (a) Discuss the type of demand and factors affecting the consumption in term of water supply.

[10 marks]

(b) Describe physical characteristics in water quality parameters.

[5 marks]

(c) Calculate the total $OH^-$, $CO_3^{2-}$ and $HCO_3^-$ alkalinity for the following, if the titrant used is 0.02N $H_2SO_4$ and the sample volume is 50 mL. Report your results in mg/L as $CaCO_3$.

| Sample | Total ml titrant to reach end point | |
|---|---|---|
| | Phenolphthalein | Methyl Orange |
| V | 0.0 | 10.5 |
| W | 15.4 | 28.2 |
| X | 8.2 | 16.3 |
| Y | 6.3 | 6.4 |
| Z | 12.2 | 29.8 |

[10 marks]

2. (a) Describe the following terms with respect to potable water treatment:

(i) Suspension

[3 marks]

(ii) Coagulation

[3 marks]

(b) A water treatment plant has a capacity of 2 million liter per day (MLD). Calculate the size of the tank and power input in the coagulation tank based on the following data:

Retention time = 1.5 minutes
Velocity gradient, G = 700 $s^{-1}$.
Dynamic viscosity of water = $0.87 \times 10^{-3}$ $Ns/m^2$.

[7 marks]

(c) Head loss through an upflow and downflow baffles of a flocculation tank is 0.405 when the output is 20 MLD (million litres per day) at a temperature of 20°C. At this flowrate, the retention time in the flocculation chamber is 30 minutes.

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(i) Calculate the velocity gradient and camp number for the above condition.

(ii) Calculate the velocity gradient and camp number when the flowrate is changed to 15 MLD at a temperature of 25°C.

Given that:
At 20°C; absolute viscosity $\mu$ = 1.005 x $10^{-3}$ kg/ms and density $\rho$ = 998 kg/$m^3$

At 25°C; absolute viscosity $\mu$ = 0.894 x $10^{-3}$ kg/ms and density $\rho$ = 997 kg/$m^3$

[12 marks]

3. (a) Explain **THREE (3)** types of water softening process that are normally used and for each process explain on its appropriateness.

[6 marks]

(b) A treatment plant with a capacity of 20 MLD (million litres per day) is required to have an ion exchange process due to water hardness containing $CaCO_3$ [300 mg/L]. Resin media with the adsorption capacity of 100 kg/$m^3$ at flow rate 0.5 $m^3$/min/$m^2$ is proposed. Calculate the volume of media required for the water treatment and surface area for the media.

[9 marks]

(c) Two sets of jar tests are carried out in the laboratory on raw water with a turbidity of 30 NTU and an alkalinity concentration of $CaCO_3$ [50 mg/L]. Based on Table 1, calculate the optimum pH, coagulant dose and theoretical alkalinity used at the optimum dosage. Given that the molecular weights of aluminium = 27, sulphur = 32, oxygen =16, hydrogen = 1 and carbon = 12.

Chemical reaction for aluminium sulphate when added with raw water is given as follows:

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

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**Table 1: Jar Test Result**

| **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) | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 |
| Turbidity (NTU) | 14.0 | 9.0 | 5.0 | 7.0 | 11.0 | 13.0 |
| **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) | 6.0 | 8.0 | 12.0 | 14.0 | 16.0 | 18.0 |
| Turbidity (NTU) | 14.0 | 10.0 | 5.0 | 4.5 | 6.5 | 13.0 |

[10 marks]

4. (a) Water distribution systems are classified according to their layout. With the help of sketches, explain **THREE (3)** types of water distribution networks.

[6 marks]

(b) With the aid of sketch diagram, discuss the disadvantages of dead-end water system with respect to water supply engineering.

[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 iterations. Adopt Hazen-William coefficient, C, as 100. Use initial flowrate of 65 litres per second (L/s) from point A to B. The lengths and diameters for pipes AB, BC, CD, and DA are as follows:

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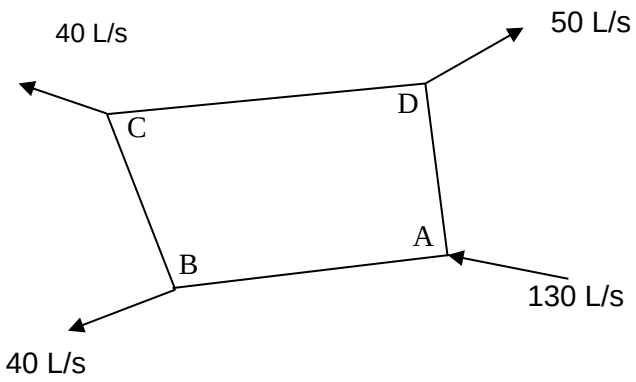


**Figure 1: Reticulation system**

Pipe AB: length = 950 m and diameter = 250 mm

Pipe BC: length = 750 m and diameter = 200 mm

Pipe CD: length = 750 m and diameter = 200 mm

Pipe AD: length = 900 m and diameter = 250 mm

[14 marks]

5. (a) A small lake has the following characteristics:

Volume= 84 500 $m^3$
Mean depth= 3.5 m
Inflow = outflow = 5000 $m^3$/day
Temperature= 27 °C

The lake receives the input of a pollutant from two sources: a slaughterhouse discharge of 40 kg/d and the inflow stream that has a concentration of 11 mg/L. If the pollutant decays at the rate of 0.30/day at 20 °C ($\theta$ = 1.05),

(i) Compute the assimilation factor

(ii) Determine the steady state concentration.

[10 marks]

...6/-

(b) A pond is used to treat a diluted municipal wastewater before the liquid is discharged into a river. The inflow to the pond has a flow rate of 4000 $m^3$/day and a BOD concentration of 25 mg/L. The volume of the pond is 20,000 $m^3$. The purpose of the pond is to allow time for the decay of BOD to occur before discharging into the environment. BOD decays in the pond with a first-order rate constant equal to 0.25 $day^{-1}$. With the help of sketches, determine the BOD concentration at the outflow of the pond, in units of mg/L.

[7 marks]

(c) Based on the Water Services Act 2006, answer the following questions:

(i) Explain **TWO (2)** wrongful acts that can lead to the offence of contaminating public water supply.

[4 marks]

(ii) Describe the differences of the principle roles and authority held by the Federal Government and water authorities owned by State Governments.

[4 marks]

**APPENDIX**

$$H_L = \frac{10.67}{D^{4.87}} L \left[\frac{Q}{C}\right]^{1.85}$$

$$H_L = \frac{12.25 \times 10^9}{D^{4.87}} L \left[\frac{Q}{C}\right]^{1.85}$$

$$k(T) = k(20)\theta^{T-20}$$

$$V\frac{dc}{dt} = W(t) - Qc - kVc - vA_s c$$

$$c = \frac{W}{Q + kV = vA_s}$$

$$c = \frac{1}{a}W$$

$$a = Q + kV + vA_s$$

$$Accumulation = V\frac{dc}{dt}$$

$$Loading = Qc_{in}(t)$$

**-oooOooo-**