First Semester Examination
Academic Session 2020/2021

February 2021

# EAP581 – Water Supply Engineering

Duration : 2 hours

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

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

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

**...2/-**

(1). (a). A sample of mineral water contains anions and cations. It is important to ensure the presence of both compounds is balanced, especially for drinking purposes. The following values were obtained from a chemical analysis of mineral water.

$Ca^{2+}$ = 70 mg/L
$Mg^{2+}$ = 30 mg/L
$Na^{+}$ = 125 mg/L
$HCO_3^{-}$ = 165 mg/L
$SO_4^{2-}$ = 173 mg/L
$Cl^{-}$ = 202 mg/L

Determine the ion balance for this water sample. Justify the importance of the ion balance analysis for a water sample and identify whether the ion balance is in the acceptable range.

[6 marks]

(b). (i). Alkalinity is a chemical characteristic of water quality. Explain the importance of pH in determining the alkalinity value.

[3 marks]

(ii). Based on the data given in **Table 1**, determine the total, $OH^{-}$, $CO_3^{2-}$ and $HCO_3^{-}$ alkalinity if the titrant used is 0.02N $H_2SO_4$ and the sample volume is 50 mL.

Report the results in mg/L $CaCO_3$.

**Table 1**

| Sample | Total mL titrant to reach the endpoint | |
|---|---|---|
| | 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 |

[8 marks]

(c). Suruhanjaya Perkhidmatan Air Negara (SPAN) or the National Water Services Commission is the national regulatory agency for the water sector in Malaysia.

(i). Briefly explain how the water use should be planned in the urban area to be sustainable in the future.

[4 marks]

(ii). Describe **TWO (2)** limitations that restrict good water governance.

[4 marks]

(2). (a). The design flow for a water treatment plant (WTP) is 7.2 x $10^3$ $m^3$/d. The rapid mixing tank will have a mechanical mixer and the average alum dosage is 50 mg/L. The theoretical mean hydraulic detention time of the tank is 1.5 minutes. Determine the followings:

(i). The quantity of alum needed on a daily basis.

(ii). The dimensions of the tank in meters for a tank with equal length, width, and depth.

(iii). The power input required for a G of 1000 $s^{-1}$ for a water temperature of 25°C.

[8 marks]

**...4/-**

(b). A water treatment of 35,000 $m^3$/day requires 20 mg/L of alum as a coagulant. The natural alkalinity of the water is equivalent to 4 mg/L of $CaCO_3$. Determine the required quantities of quicklime (containing 80% CaO) and alum.

*(Note: [$Ca^{2+}$] = 40.1 g/mol, [C] = 12 g/mol, [O] =16 g/mol)*

[5 marks]

(c). A water treatment plant is designed to cater a population of 20,000 and per capita consumption is 230 litres per day. Coagulation process involves with the construction of one mechanical rapid mixing tank with G equals 750$s^{-1}$ and a retention time of 1½ minutes. In the flocculation process, two tanks of equal size are constructed in series. Velocity gradients for the first and second tanks are 70$s^{-1}$ and 40$s^{-1}$, respectively. Retention time in each tank is 10 minutes with the dynamic viscosity of water 1.145x$10^{-3}$ $Nsm^{-2}$. Calculate the following parameters:

(i). Volume of the coagulation tank.

(ii). Power input in the coagulation tank.

(iii). Volume of the flocculation tank.

(iv). Power input at each of the flocculation tank.

[12 marks]

(3). (a). 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 at 300mg/L as $CaCO_3$. Resin media with the adsorption capacity of 100kg/$m^3$ at flow rate 0.5$m^3$/min./$m^2$ is proposed. Calculate the volume of media required for the water treatment and the surface area for the media.

[6 marks]

(b). A horizontal sedimentation tank has a capacity of 5 MLD (million litres per day) with a surface loading of 30 $m^3/m^2$.day. The minimum retention time in the tank is 2 hours. The tank is required to be designed with a length to width ratio of 4:1. Determine the dimensions of the tank and the length of the outlet weir.

[10 marks]

(c). A water treatment plant has a capacity of 110,000 $m^3$/day with two horizontal flow settling basins, 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.

[9 marks]

(4). (a). A pond is used to treat a dilute municipal wastewater before the liquid is discharged into a river. The inflow to the pond has a flow rate of 4500 $m^3$/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 discharge into the environment. BOD decays in the pond with a first-order rate constant equal to 0.25 $day^{-1}$. With the aid of sketches, determine the BOD concentration at the outflow of the pond.

[8 marks]

(b). **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. The lengths and diameters for pipes AB, BC, CD, and AD are as follows:

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

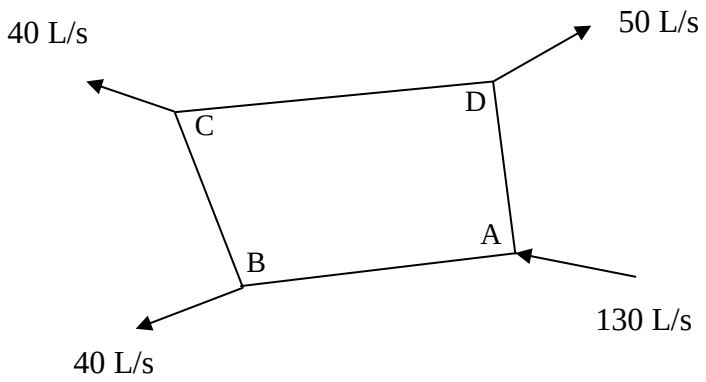


**Figure 1**: Reticulation system

[17 marks]

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