UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2006/2007 Academic Session

October / November 2006

EAP 582/4 - Wastewater Engineering

Duration: 3 hours

Instructions to Candidates:

1. Ensure that this paper contains **FIVE (5)** printed pages including appendices 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 carries equal mark.

4. All questions **CAN BE** answered either in English or Bahasa Malaysia.

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

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

1. (a) Sketch one of the typical process flow diagrams for treating palm oil mill effluent (POME).

(5 marks)

   (b) Define Cleaner Production (CP). By giving an example, describe how 'product modification' can be applied for waste minimization.

(6 marks)

   (c) Design a septic tank for treating wastewater from 3 bungalow houses and 2 shop lots in Kerian District. These shops are having an individual area of 800 m^2. Assume length to width ratio is 3:1, depth 1.5 m and retention time 1 day. Take population equivalent of shop is 3 person per 100 m^2 floor area and water consumption rate 225 Liter/capita.day.

(4 marks)

   (d) Given that the value of BOD_5 load for Taman Anggun in Ipoh is 1500 kg/day. There a few treatment options for this wastewater. Suggest a suitable surface area of an aerated lagoon if the depth is 3 m and the Volumetric Organic Loading is 0.25 kg BOD_5/m^3.day.

(5 marks)

2. (a) A housing scheme is having a Population Equivalent of 5000 with BOD 250 mg/L. Determine the suitable dimension of a facultative pond for treating this wastewater if the Aerial Organic Loading is 0.050 kg BOD/m^2.day and the retention time is 20 days. Take length to width ratio as 3:1. Take water consumption rate as 225 Liter/capita.day.

(7 marks)

   (b) Explain briefly one of sludge dewatering techniques.

(6 marks)

   (c) Design a sludge drying bed using the following data:

   Population Equivalent 10,000 person
   Suspended Solids 300 mg/L
   SS removal at primary sedimentation tank 60%
   SS removal at secondary sedimentation tank 40%
   Specific Gravity of sludge 1.06
   Sludge cake storage period 30 day
   Maximum thickness of sludge 0.3 m
   Length to width ratio 4:1
   Take water consumption rate as 225 Liter/capita.day.

(7 marks)

3. (a) A trickling filter is receiving wastewater from a housing scheme as follows:

Number of houses	=	2000
Quantity of media in trickling filter	=	50 metric ton
Media density	=	950 kg/m^3
Media void	=	50%
Influent BOD$_5$	=	250 mg/L

Take water consumption rate as 225 Liter/capita.day.

Calculate the Volumetric Organic Loading for this trickling filter in kg BOD$_5$/m^3.day.

(10 marks)

(b) Describe the Upflow Anaerobic Sludge Blanket (UASB) reactor and explain its working with the help of a labelled diagram.

(10 marks)

4. (a) Discuss any **TWO (2)** of the following constituents of wastewater:
   (i)   Suspended solids
   (ii) Nitrogen
   (iii) Hardness
   (iv) Fluorides

(10 marks)

(b) Phosphorus can be removed from wastewater by precipitation as calcium phosphate. Calculate the solubility of $Ca_3(PO_4)_2$ at 25°C given that its solubility product $k_{sp} = 1 \times 10^{-27}$.

(4 marks)

(c) Draw the meq/l bar diagram for the following data and check whether the results are acceptable.

Na^+	= 22 mg/l	HCO_3^-	= 135 mg/l
Ca^{2+}	= 52 mg/l	Cl^-	= 50 mg/l
Mg^{2+}	= 18 mg/l	CO_3^{2-}	= 72 mg/l

Atomic mass: Na = 23, Ca = 40, Mg = 24, H = 1, C = 12, O = 16, Cl = 35.5

(6 marks)

5. (a) Describe the low pressure air test for sewer testing.

(10 marks)

(b) A 600 mm diameter pipe is required to carry at least 10 MLD of sewage at a velocity not less than 0.6 m/s. Suggest a suitable gradient.

(5 marks)

(c) List **FIVE (5)** advantages of anaerobic biological treatment processes over aerobic processes.

(5 marks)

6. (a) Using least-squares method, determine the ultimate BOD and the reaction rate constant for the following BOD data:

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

(6 marks)

(b) A survey of the wastewater discharge from a factory yielded:

Time	Flow, ℓ/s
8 am – 12 noon	80
12 noon – 4 pm	120
4 pm – 8 pm	50
8 pm – 12 midnight	120
12 midnight – 4 am	160
4 am – 8 am	70

Determine:

(i) The in-line storage volume required for an equalization tank so that a constant outflow from it can be maintained.

(10 marks)

(ii) The hydraulic retention time of the tank at the average flow.

(4 marks)

The vertical axis is labelled "Ratio of depth of flow to diameter of pipe, $\frac{d}{D}$" with values from 0 to 1.0.

The horizontal axis is labelled "Ratio of hydraulic elements, partial flow to full flow, $\frac{q}{Q} \cdot \frac{v}{V} \cdot \frac{a}{A}$" with values from 0 to 1.2.
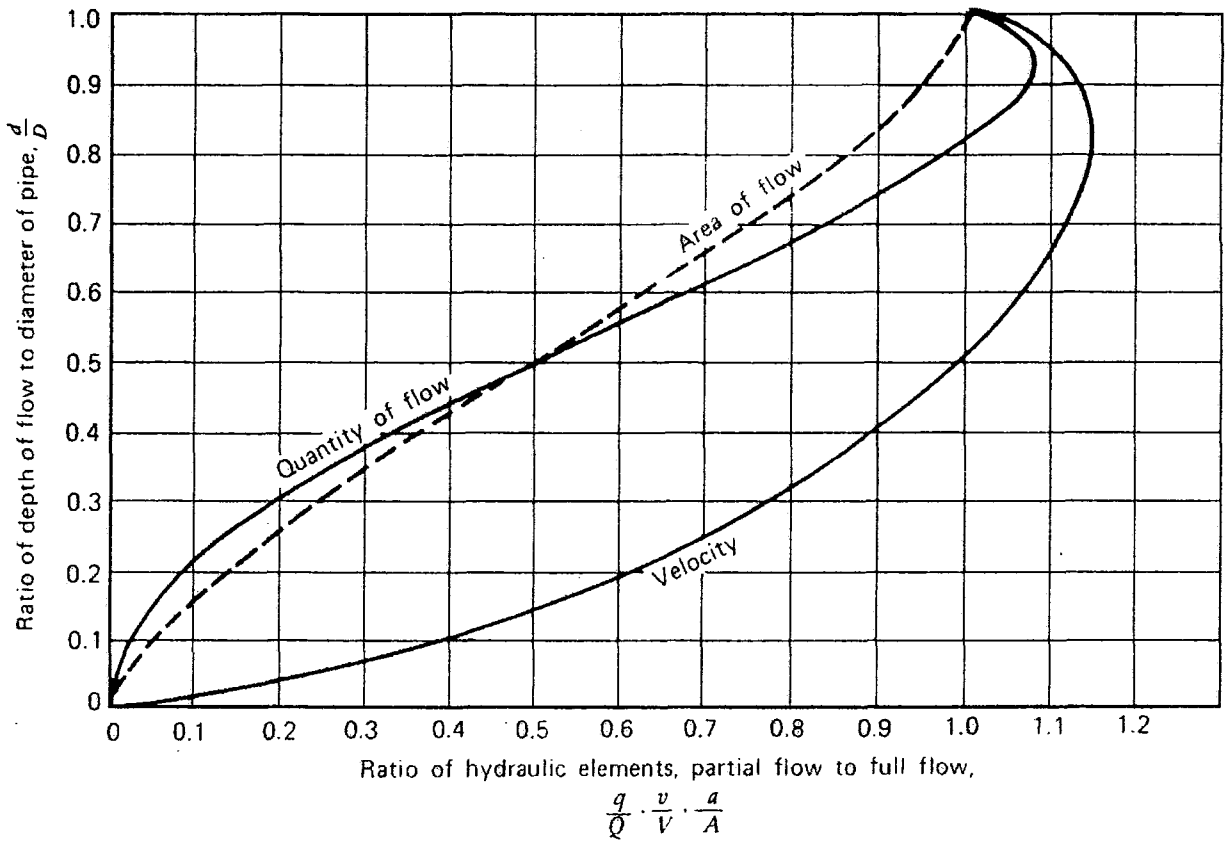
Curves: Area of flow, Quantity of flow, Velocity.

Figure – Partial flow diagram for a circular pipe