UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2005/2006 Academic Session

November 2005

EAP 582/4 – Wastewater Engineering

Duration: 3 hours

Instructions to Candidates:

1. Ensure that this paper contains **SIX (6)** 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 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.

1. (a) Draw the meq/l bar diagram for the following data and determine total hardness, carbonate hardness and non-carbonate hardness. Express your results in mg/l as $CaCO_3$.

Na^+	= 15 mg/l	HCO_3^-	= 95 mg/l
K^+	= 22 mg/l	Cl^-	= 32 mg/l
Ca^{2+}	= 35 mg/l	NO_3^-	= 7 mg/l
Mg^{2+}	= 12 mg/l	CO_3^{2-}	= 48 mg/l
Al^{3+}	= 4 mg/l	SO_4^{2-}	= 11 mg/l

Atomic mass: Na = 23, K = 39, Ca = 40, Mg = 24, Al = 27, H = 1, C = 12, O = 16, Cl = 35.5, N = 14, S = 32.

(8 marks)

(b) A wastewater pump has a 250 mm suction and a 200 mm discharge. The readings on the suction and discharge gauges located at the centreline of the impeller are 30 kN/m^2 and 200 kN/m^2 respectively. If the total head on the pump is 20 m, determine:

i) the pump discharge
ii) the energy input to the motor

Assume pump and motor efficiencies as 75% and 85% respectively. Specific weight of wastewater can be taken as 9810 N/m^3.

(6 marks)

(c) What is the purpose of a drop inlet? Draw a labelled vertical section of a drop inlet.

(6 marks)

2. (a) Write down **FIVE (5)** differences between aerobic and anaerobic processes of wastewater treatment?

(5 marks)

(b) A sample of wastewater was diluted 1 in 500 with seeded dilution water for BOD determination. If the initial and 5-day DO for the diluted sample were 8.5 and 2.9 mg/l, respectively and these values for the blank were 8.6 and 7.3 mg/l respectively, calculate the BOD of the wastewater sample.

(5 marks)

(c) Describe the A^2/O process for the removal of nitrogen and phosphorus from wastewater.

(10 marks)

3. (a) Explain in-line and off-line equalisation. Write down **FIVE (5)** functions of an equalisation tank.

(10 marks)

(b) Derive the expression for surface overflow rate (SOR) of a settling tank and show that particle removal is not governed by the depth of the tank.

(10 marks)

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4. (a) Explain any **TWO (2)** of the following:
   (i) Determination of BOD constants (L_0 and k) by least-squares method.
   (ii) Aerobic sludge digestion.
   (iii) Sludge drying beds.

(10 marks)

(b) Municipal wastewater is treated in a treatment plant whose schematic diagram is shown below (Figure 1).

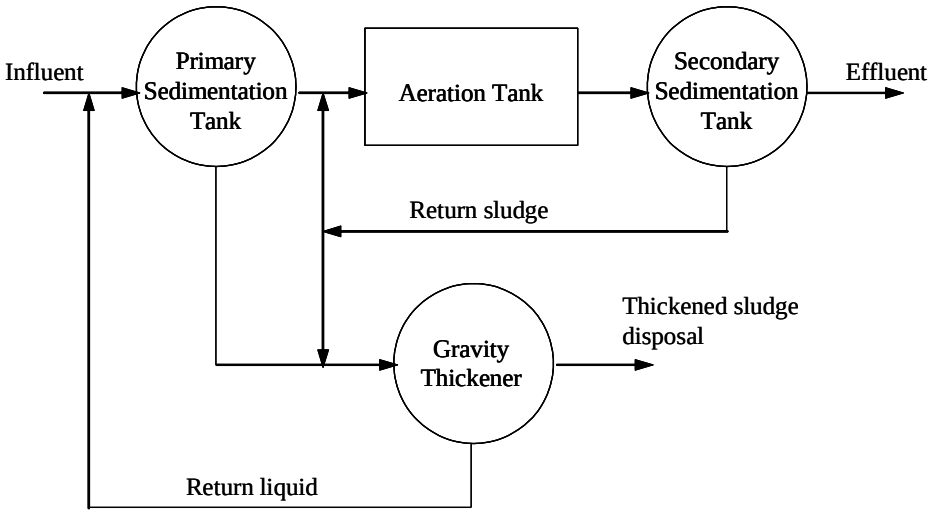

Figure 1

Characteristics of the treatment plant, wastewater and sludges are:

Treatment plant:
Diameter of primary sedimentation tank = 25 m
Volume of aeration tank = 3500 m^3
Mixed liquor suspended solids in aeration tank = 3000 mg/l

Wastewater:
Influent suspended solids = 200 mg/l
Influent BOD = 250 mg/l
Effluent BOD = 20 mg/l
Flow = 30 000 m^3/d

Sludge solids:
Primary sedimentation tank = 4.5%
Secondary sedimentation tank = 1.0%
Gravity thickener = 8%

Determine:
(i) the mass and volumetric loading rates to the thickener. (8 marks)
(ii) the percent volume reduction by the gravity thickener. (2 marks)

5. (a) Explain the working of a facultative pond with the help of a diagram.

(10 marks)

(b) Design a two-stage trickling filter for the treatment of 7000 m^3/d of municipal wastewater with a BOD of 250 mg/l. Assume effluent BOD, recirculation ratio and temperature as 20 mg/l, 2:1 and 20°C respectively.

(10 marks)

6. (a) What is alkalinity? How are different forms of alkalinity in wastewater samples determined?

(10 marks)

(b) There are three lakes connected in series as shown in Figure 2 and have the following characteristics:

Figure 2

	Lake 1	Lake 2	Lake 3
Volume, 10^6 m^3	2	3	5
Mean depth, m	2	2.5	3
Surface area, 10^6 m^2	0.5	0.75	1.00
Loading, kg yr^{-1}	2000	4000	1000
Flow, 10^6 m^3 yr^{-1}	1.0	1.0	1.0

Note: (Q1 = Q2 = Q3 = Q4).

i. Calculate the steady-state concentration in each of the reactors.
ii. Determine how much of the concentration in the third reactor is due to the loading to the second reactor.

(10 marks)

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APPENDIX

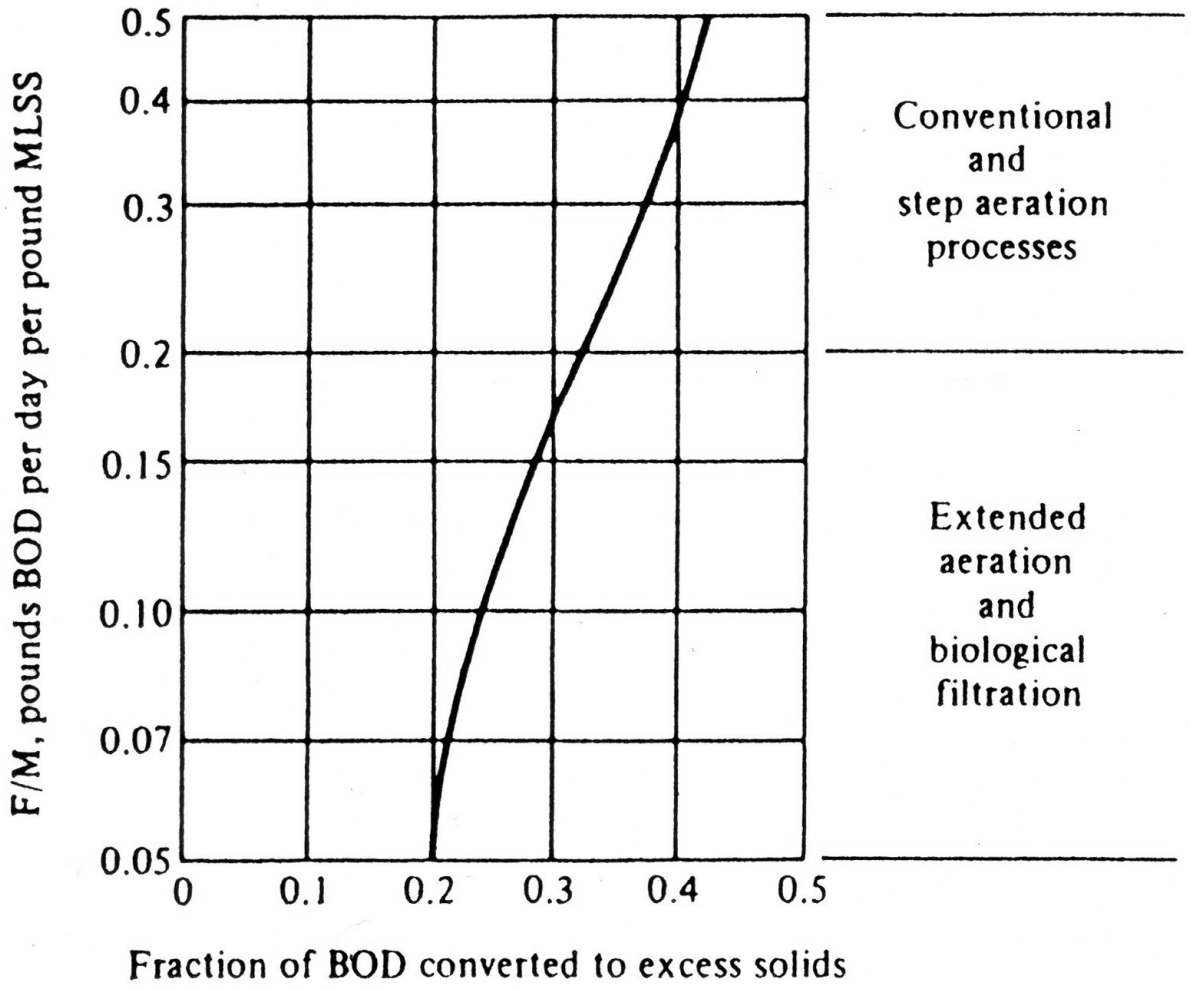

Figure 1 – Excessive sludge production v. F/M ratio

APPENDIX

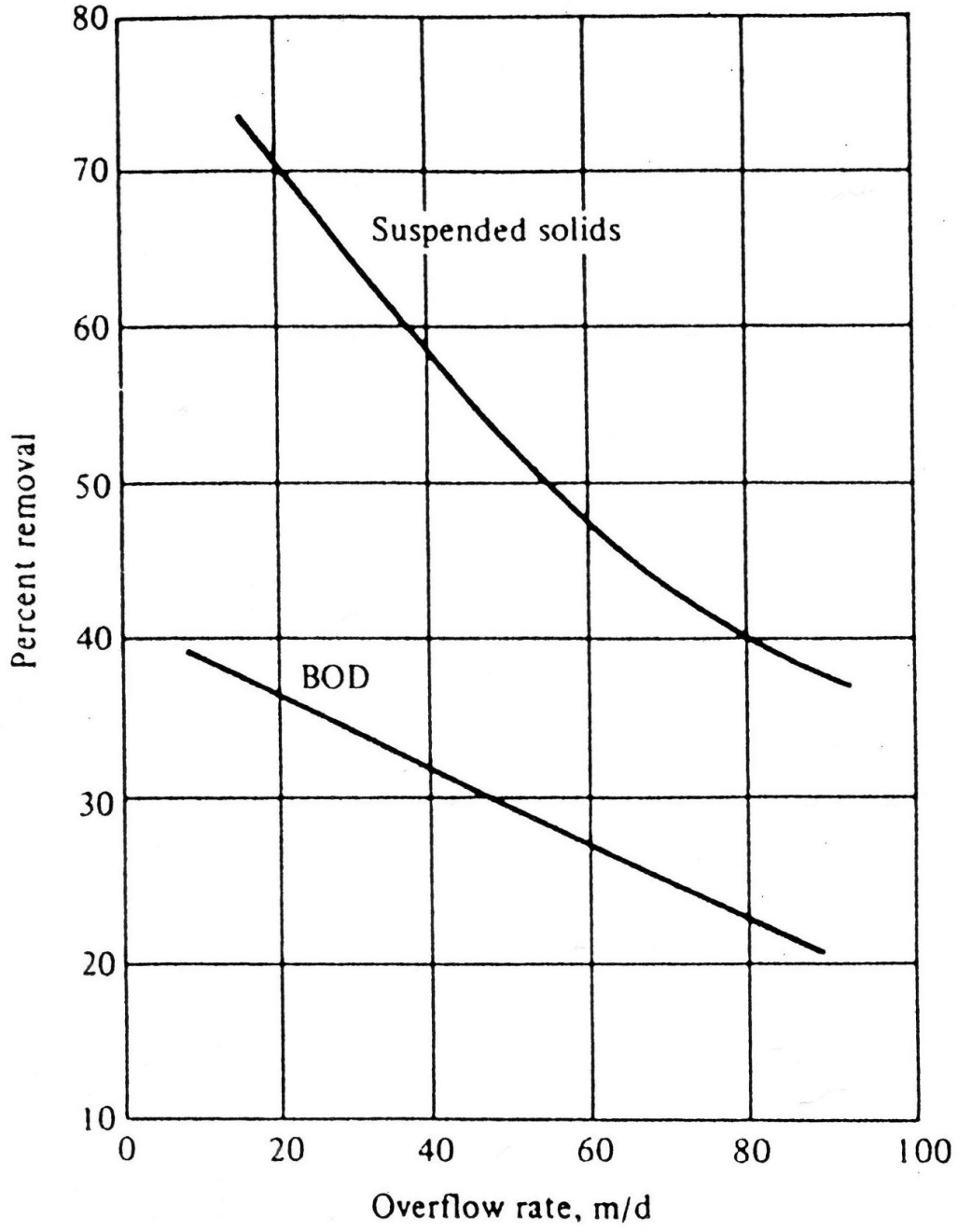

Figure 2 – Suspended solids and BOD removal as a function of surface overflow rate