UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2004/2005 Academic Session

October 2004

EAP 582/4 – Wastewater Engineering

Duration : 3 hours

Instructions to candidates:

1. Ensure that this paper contains **SIX (6)** printed pages included 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. All questions **MUST BE** answered in English.

4. Each question carry equal marks.

5. All questions **MUST BE** answered on a new sheet.

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

1. (a) What is meant by Cleaner Production (CP)? Discuss the benefits of implementing CP by using several relevant examples.

(10 marks)

(b) A study on the inorganic ammonium cyanate (NH_4OCN) can be converted into the organic compound urea (NH_2CONH_2). The following data were obtained:

t (min)	**0**	**20**	**50**	**65**	**150**
NH_4OCN (mole L^{-1})	0.381	0.264	0.180	0.151	0.086

Determine whether the reaction is zero-, first- or second-order and estimate the reaction rate.

(3 marks)

(c) The characteristic of Vision Park Lake, Kepala Batas, Penang
Area : 100,000 m^2
Mean Depth : 1.5
Inflow = outflow = 5000 m^3/d
Temperature: 28^oC

The Vision Park Lake is a man-made lake and receives the input of a pollutant from several sources. Waste water discharge from residential area has a concentration of 10mg/L BOD. The NPC industrial area discharges of 50 kg/d, atmospheric fallout is counting 0.5g/d/m^2. If the pollutant decays at the rate of 0.5/d at 20^oC ($\theta = 1.05$).

Please state any additional assumptions you made, and show all work.
(Note: $k = \theta^{tn-t20}$; $a = Q + kV$;, $W_{atm}=JA$, $W= W_{NPC} + W_{atm} + W_{inflow}$, $c=W/a$)

i) Determine the inflow concentration
ii) Compute the assimilation factor (a)
iii) Determine the steady-state concentration (c)

(7 marks)

2. (a) Discuss any **TWO (2)** of the following:
(i) Importance of coliform bacteria
(ii) Method of sewer testing
(iii) Daily variation of municipal wastewater generation
(iv) Equivalent weight of compounds

(8 marks)

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2. (b) A 600 mm diameter sewer is built at a grade of 2.5 %. What is depth and velocity of flow in the pipe if the discharge is 200 L/s? Take n = 0.013.

(6 marks)

(c) In a determination of alkalinity experiment, a 100 ml sample of water was titrated with 0.02N H_2SO_4. The total volumes of the acid required to reach the phenolphthalein and methyl orange end-points were 14 ml and 38 ml respectively. Calculate the different forms of alkalinity in the water sample. Report your results in mg/l as $CaCO_3$.

(6 marks)

3. (a) What is the difference between suspended growth and attached growth biological wastewater treatment processes?

(5 marks)

(b) The BOD_5 of a wastewater sample is 250 mg/l. The value of k at 20°C is 0.23 d^{-1}. Calculate the 5-day BOD if the test were run at 25°C?

(5 marks)

(c) A conventional ASP is to be used for the treatment of 12,000 m^3/d of municipal wastewater. The influent BOD to the ASP is 200 mg/l. As per requirements, the BOD of the effluent from the ASP should not exceed 10 mg/l. Assuming:

MLSS = 3,000 mg/L
Mean cell residence time = 10 d
Return sludge from SST = 10,000 mg/L
Yield coefficient = 0.6 kg/kg
Endogenous decay rate constant = 0.05 d^{-1}

Determine:
(i) the volume of aeration tank
(ii) the mass and volume of sludge to be wasted per day
(iii) the recycle ratio
(iv) food-to-microorganism ratio

(10 marks)

4. (a) Explain the air stripping method for ammonia removal. What are its advantages and disadvantages?

(10 marks)

(b) A tannery has to install a wastewater treatment plant.

(i) What would be the expected characteristics of the wastewater? (4 marks)

(ii) Suggest a possible flow diagram for the treatment of the wastewater.

(6 marks)

5. (a) Explain any **TWO (2)** of the following:

(i) Gravity thickening of sludge
(ii) Sludge stabilisation
(iii) Wet air oxidation
(iv) Ultimate disposal of sludge

(10 marks)

(b) The following table shows the results of a column analysis that was used to determine the settling characteristics of an activated sludge suspension.

Concentration, mg/L	1000	2000	3000	4000	5000	6000
Settling velocity, m/h	3.30	1.54	0.55	0.22	0.11	0.08

If the influent to the secondary clarifier is 6000 m^3/d with an MLSS concentration of 3000 mg/l, determine the diameter of the clarifier if the sludge is to be thickened to a concentration of 8 000 mg/l.

(10 marks)

6. (a) Describe the working of a trickling filter. (10 marks)

(b) The average wastewater flow from a community is 6000 and 8000 m^3/d during winter and summer respectively. The average temperature is 8°C for the coldest month and 26°C for the hottest month. The average BOD_5 is 200 mg/l with 70% being soluble. The reaction rate coefficient k is 0.23 d^{-1} at 20°C, the dispersion factor d is 0.5 and temperature coefficient Ø is 1.05. Design a pond system for the community.

(10 marks)

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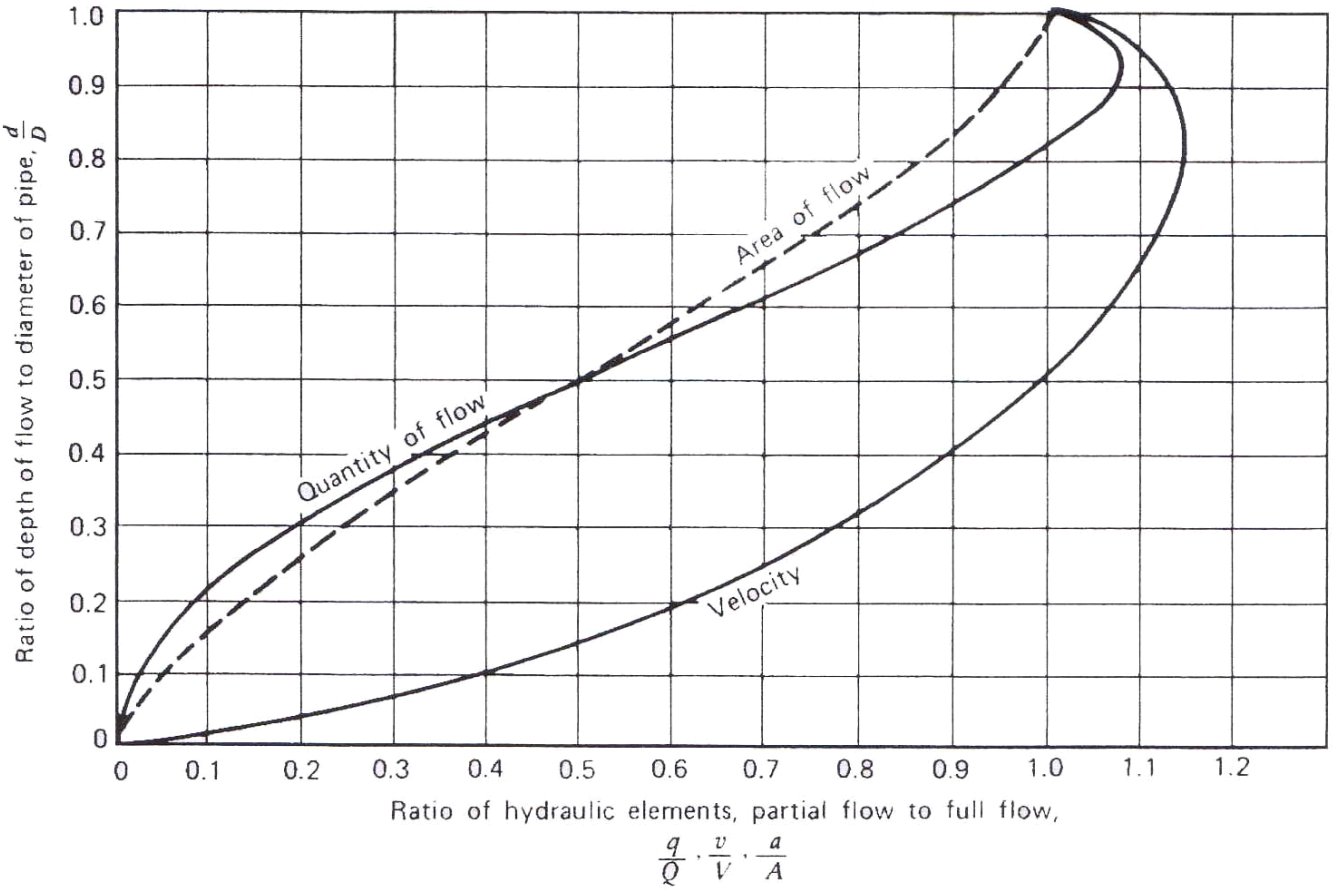

Figure – Partial flow diagram for a circular pipe

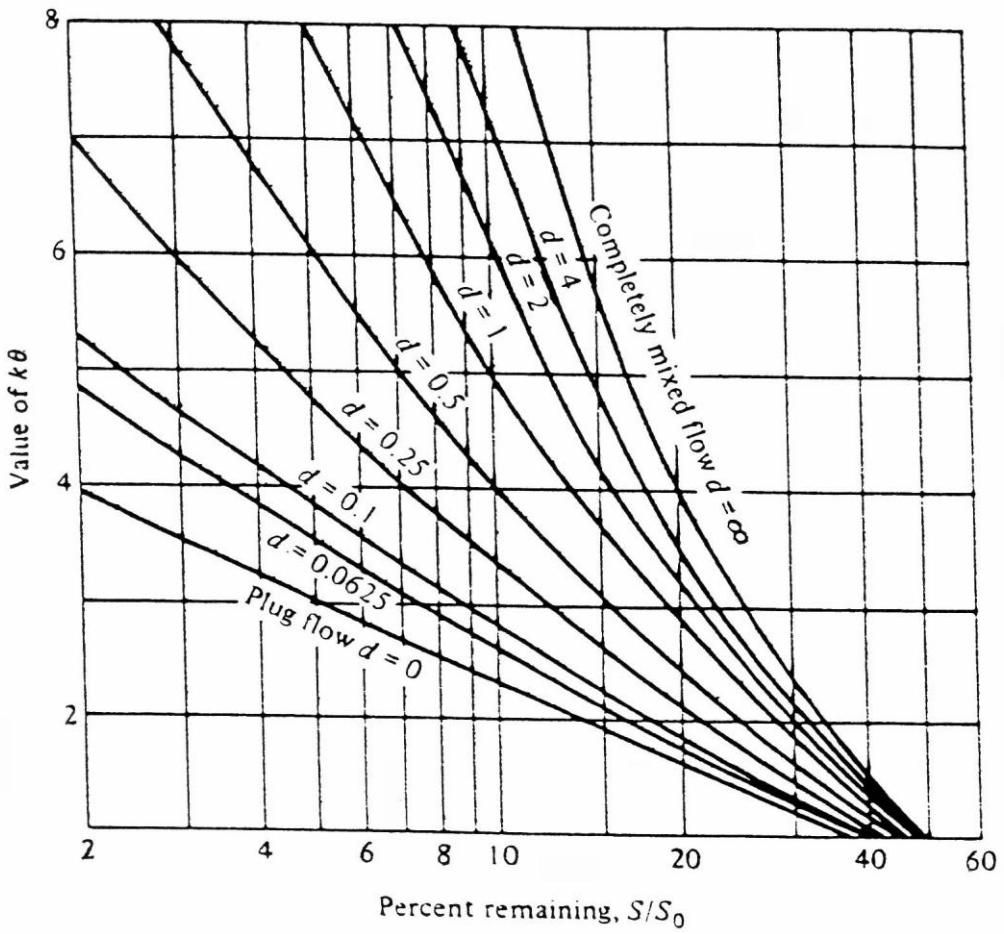

Figure – Relationship between $\frac{S}{S_0}$ (BOD remaining) and kθ