UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

SUBJECT NAME	: DESIGN OF WASTEWATER ENGINEERING
SUBJECT CODE	: BFA 4043
COURSE	: 4BFF
EXAMINATION DATE	: NOVEMBER 2009
DURATION	: 3 HOURS
INSTRUCTION	: ANSWER FIVE (5) QUESTIONS ONLY

THIS PAPER CONSIST OF SEVEN (7) PAGES ONLY

Q1 (a) State the significant physical, chemical and biological parameters to characterize wastewater.

(6 marks)

(b) Discuss the design criteria used to calculate the reactor volume and to evaluate the performance of biological processes.

(8 marks)

(c) A diameter of clarifier is 18.0m and an average wastewater flow rate is 40.0 MLD. Calculate the hydraulic detention time and surface loading rate of a clarifier having a wastewater depth of 2.5 m in the clarifier.

(6 marks)

Q2 (a) Discuss the effect of temperature on the biological reaction rate.

(4 marks)

(b) With a diagram enlist the step of operating Sequencing Batch Reactor (SBR).

(6 marks)

(c) Determine the volume of a reactor to carry out 95% removal of reactant A, when the flow condition is completely mixed flow. It is given that wastewater flow rate is $300m^3/d$ and first order reaction rate constant is 1.2/h. Removal takes place in the reactor at steady state condition.

(10 marks)

Q3 (a) Draw a flow diagram of a typical preliminary treatment system.

(3marks)

(b) Explain the following types of chamber for wastewater treatment.

(i) Rectangular horizontal flow
(ii) Detritus tanks
(iii) Aerated grit chamber
(iv) Square horizontal flow
(v) Vortex flow

(10 marks)

(c) It is proposed to provide a grit chamber for a treatment plant expecting an average of $2000m^3/h$ flow of domestic wastewater. Assuming suitable design criteria, determine the effective and overall dimension of the grit chamber.

(7 marks)

Q4 (a) The biological processes for wastewater treatment have been classified according to operational condition dan microbial maintenance. Describe the following operational condition:

(i) Aerobic process
(ii) Anaerobic process
(iii) Anoxic process
(iv) Facultative process

(8 marks)

(b) Discuss the significant factors that are normally considered in the design of aerobic biological process.

(12 marks)

Q5 (a) Define the following kinetic rate constants developed for aerobic biological processes:

(i) Specific Growth rate, μ
(ii) Yield Coefficient, Y
(iii) Maximum Substrate Utilization Rate Constant, K
(iv) Endogenous Decay Coefficient, K_d

(8 marks)

(b) An activated sludge is to be designed for 10 MLD domestic wastewater flow to operate at 10 days of SRT and 6 hours of HRT. Assuming BOD_5 (20°C) as 175 mg/L in influent to the aeration tank, sludge wasting flow equal to 70 m^3/d and retuned sludge concentration equal to 8000 mg/L. Determine:

(i) The concentration of MLVSS to be maintained in the aeration tank to achieve effluent DOB_5 of 30 mg/L.
(ii) The food to microorganism ratio
(iii) The recirculation ratio at which plant should be operated.

(Assume the kinetic coeffients Kd = 0.06 d^{-1}, Y = 0.6)

(12 marks)

Q6 (a) Discuss briefly the design concepts of anaerobic biological treatment processes.

(8 marks)

(b) For a proposed Up-Flow Anaerobic Sludge Blunket (UASB) reactor to remove 85% COD from 2 MLD flow of wastewater, determine the size of the reactor , hydraulic retention time and reactor MLSS in the sludge zone. Assuming the following data:

Soluble influent COD	=	1000 mg/L
Up-flow velocity	=	2.0 m/h
Organic loading rate	=	12 kg soluble BOB/m^3.d
Solids retention time	=	15 d
Volume effective factor	=	0.85

(12 marks)

Q7 (a) Describe the methods normal used to process the sludge before its final disposal.

(5 marks)

(b) The anaerobic sludge digestion is one of the most widely used method to decompose and stabilize the organic and inorganic content of the sludge. Discuss briefly the digestion processes occur in the system in stages of hydrolysis, acidogenesis and methanogenesis.

(6 marks)

(c) The sludge production having 96% moisture content from a wastwater treatment plant is 1000 kg on dry solid basis. The solid contain 70% volatile matter with a specific gravity of 1.02 and 30% mineral matter with a specific gravity of 2.5. Determine the volume of raw and digested sludge if reduction in volatile solid is 55% during digestion and moisture content of digested sludge is 92%.

(11 marks)

S1 (a) Nyatakan parameter fizikal, kimia dan biologi yang utama untuk mencirikan air sisa.

(6 markah)

(b) Bincangkan kriteria rekabentuk yang digunakan untuk mengira isipadu reaktor dan menilai prestasi proses biologi.

(8 markah)

(c) Diameter tangki enap cemar ialah 1.8 m dan kadar alir purata air sisa adalah 40.0 MLD. Kira masa tahan (HRT) dan kadar beban permukaan untuk tangki enap cemar yang mempunyai kedalaman air sisa 2.5 m.

(6 markah)

S2 (a) Bincangkan kesan suhu ke atas kadar tindakan biologi.

(4 markah)

(b) Dengan bantuan gambarajah, nyatakan langkah-langkah pengoperasian Reaktor SBR.

(6 Markah)

(c) Tentukan isipadu suatu reaktor yang boleh menyingkirkan 95% reaktan A, apabila dalam keadaan aliran campuran sempurna. Diberi kadar alir air sisa ialah 300 m^3/d dan angkatap tindakbalas darjah pertama ialah 1.2/h. Penyingkiran berlaku dalam reaktor semasa keadaan mantap.

(10 markah)

Q3 (a) Lukiskan gambarajah aliran tipical system olahan preliminari.

(3 markah)

(b) Terangkan jenis kebuk untuk olahan air sisa berikut:

(i) Aliran ufuk empat segi tepat
(ii) Tangki Detritus
(iii) Kebuk grit pengudaraan
(iv) Aliran ufuk empat segi tepat
(v) Aliran vorteks

(10 markah)

(c) Kebuk grit bagi logi olahan dengan jangkaanaliran purata 2000 m3/h air sisa domestik dicadangkan. Dengan andaian kriteria rekabentuk yang sesuai, tentukan dimensi berkesan dan dimensi keseluhan untuk kebuk grit tersebut.

(7 markah)

Q4 (a) Proses biologi untuk olahan air sisa telah dikelaskan menurut keadaan pengoperasian dan penyelenggaraan mikrobial. Huraikan keadaan pengoperasian berikut:

(i) Proses aerobik
(ii) Proses anaerobik
(iii) Proses anosik
(iv) Proses fakutatif

(8 markah)

(b) Bincangkan faktor utama yang biasa dipertimbangkan dalam rekabentuk proses biologi aerobik.

(12 markah)

Q5 (a) Takrifkan angkatap kadar kinetik berikut yang telah dibangunkan untuk proses biologi aerobik:

(i) Kadar tumbuhan spesifik, μ
(ii) Pekali pembiakan, Y
(iii) Angkatap kadar penggunaan substrat maksimum, K
(iv) Pekali kematian endogenus

(8 markah)

(b) Enap cemar teraktif telah direkabentuk untuk 10 MLD aliran air sisa domestik yang beroperasi selama 10 hari SRT dan 6 jam HRT. Dengan andaian BOD_5 (20°C) sebanyak 175 mg/L dan influen ke dalam tangki berudara, aliran buangan enap cemar bersamaan dengan 70 m^3/d dan kepekatan enap cemar kembali bersamaan dengan 8000 mg/L. Tentukan:

(i) Kepekatan MLVSS yang perlu dikekalkan dalam tangki pengudaraan supaya effluen BOD_5 ialah 30 mg/L
(ii) Nisbah Makanan kepada mikroorganisma
(iii) Nisbah kitar semula operasi loji tersebut.

(Andaian pekali kinetik $K_d = 0.06\ d^{-1}$, Y = 0.6)

(12 markah)

Q6 (a) Bincangkan konsep rekabentuk proses olahan biologi anaerobik.

(8 markah)

(b) Tentukan saiz reaktor, masa tahanan dan MLSS reaktor di dalam zon enap cemar untuk reaktor UASB yang boleh menyingkir 85% COD dengan aliran air sisa 2 MLD,. Dengan mengandaikan data-data berikut:

Influen COD terlarut	=	1000 mg/L
Halaju aliran menaik	=	2.0 m/h
Kadar beban organik	=	12 kg BOD terlarut/m^3.d
Umur enap cemar (SRT)	=	15 d
Faktor berkesan isipadu	=	0.85

(12 markah)

Q7 (a) Huraikan kaedah lazim yang digunakan untuk memproses enap cemar sebelum pelupusan terakhir.

(5 markah)

(b) Penguraian enap cemar anaerobik merupakan salah satu kaedah yang digunakan secara meluas untuk penguraian dan pengstabilkan bahan kandungan organik dan bukan organik di dalam enap cemar. Bincangkan proses penguraian yang berlaku di dalam sistem di peringkat hidrolisis, asidogenesis and metanogenesis.

(6 markah)

(c) Penghasilan enap cemar yang mengandungi sebanyak 96% kandungan lembapan daripada logi olahan air sisa ialah 1000 kg berdasarkan pepejal kering. Pepejal mengandungi 70% bahan meruap dengan graviti tentu 1.02 dan 30% bahan mineral dengan graviti tentu 2.5. Tentukan isipadu enap cemar yang belum terurai dan yang telah terurai jika pengurangan pepejal meruap ialah 55% semasa penguraian dan kandungan lembapan enap cemar terurai ialah 92%.

(9 markah)