MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: ENVIRONMENTAL POLLUTION CONTROL

CODE: HCHE525

SESSIONAL EXAMINATIONS
DECEMBER 2022

DURATION: 3 HOURS

EXAMINER: K NYENYAYI (MR)

INSTRUCTIONS

1. *Answer **All** in Section A*
2. *Answer **three** questions in Section B.*
3. *Start a new question on a fresh page*
4. *Total marks 100*

Additional material(s): *Graph Book, Calculator.*

SECTION A

QUESTION 1

a) Table 1 shows selected physical and chemical characteristics of waste from wet scrubber of an incinerator in b), and their permissible limit.

Table 1

Parameter	Value	Permissible limit (SI 6 of 2007)			
		Blue	Green	Yellow	Red
Temperature (°C)	54	< 35	< 40	≤ 40	≤45
Total dissolved solids (mg/L)	5350	≤ 500	≤ 1500	≤ 2000	
pH	3.1	6 - 9	5 - 6	4 - 5	0 - 4
COD (mg/L)	400	≤ 60	≤ 90	≤ 150	≤ 200
Total lead (Pb, mg/L)	1.5	≤ 0.05	≤ 0.1	≤ 0.2	≤ 0.5
Phenol (mg/L)	3	≤ 0.01	≤ 0.04	≤ 0.06	≤ 0.1
Total acidity (as $CaCO_3$) (mg/L)	9950	-	-	-	-

i. State two (2) most likely characteristics of this waste, for purposes of hazardous waste classification. [2]

ii. Justify each of the two (2) characteristics stated in a). [2]

b) For the active treatment of this waste state and justify:

(i) One (1) form of chemical treatment [4]

(ii) One (1) form of physical treatment [4]

c) Gaseous emissions from a cylindrical smokestack of the incinerator in a) was further analysed by gas chromatography and gave 6.5 mg/ml of acid gas (anhydrous HCl). The smokestack had an internal diameter of 0.9 m and a gas exit velocity is 8 m/s. Given that the gas had an average temperature of 42 °C at

0.8 atmospheres, and that the incinerator runs for a total of 9 hours per day: Calculate the total amount of HCl emitted from the smokestack in t/day. [8]

QUESTION 2

a) Outline five of the key system requirements for a bioreactor landfill. [5]

b) Explain the energy recovery principle behind thermal treatment of waste. [8]

c) The anaerobic digestion of 500 kg of sewage sludge (dry weight) changed its chemical oxygen demand from the initial 600 g/kg to 350 g/kg of sludge.

i. Calculate the ultimate CH_4 yield in m3 under normal conditions (0.9 atmospheres and 25 °C). [Relative atomic masses: C=12; H=1, O=16 [5]

ii. State two (2) other parameters that are used to narrow down the range of potential CH_4 producing wastes. [2]

SECTION B

QUESTION 3

a) Name any five (5) parameters regulated under EMA for municipal wasterwater (sewage) discharges. [5]

b) Three physical treatment devices are employed in municipal wastewater treatment control. Outline these control devices and briefly describe each of these devices. [9]

c) List three (3) categories of industrial wasterwater (effluent) treatment. Provide examples from each category. [6]

QUESTION 4

a) Define and discuss the following strategies as used in efforts to reduce the ecological & environmental impacts of industrial activities. .

i. Clean production

ii. Source reduction

iii. Life Cycle Design [6]

b) List and justify parameters that you would consider useful for characterization of the following wastes for biological treatment;

i. Sewage sludge

ii. Citrus waste [6]

c) Using relevant examples, give comparison between *suspended* and *attached* growth media as applied in biological wastewater treatment. [8]

QUESTION 5

a) Flue gases from both mobile and immobile sources must be subjected to:

- Cooling or heat recovery

- Dust separation

- Scrubbing

- Finishing treatments

Giving examples of air pollution control devices or otherwise, briefly explain each of the above processes and how they can be achieved. [20]

QUESTION 6

a) Briefly explain, with the aid of a flow diagram or otherwise, the unit operations

and processes in a typical surface water treatment plant for purposes of urban drinking water supply. [10]

b) The results of a chlorine demand test on a raw water at 20 °C are given in following Table 2:

Table 2

Sample	Chlorine Dosage (mg/L)	Residual chlorine after 10 minutes of contact (mg/L)
1	0.2	0.19
2	0.4	0.37
3	0.6	0.51
4	0.8	0.50
5	1.0	0.20
6	1.2	0.40
7	1.4	0.60
8	1.6	0.80

i. Sketch the chlorine demand curve. [6]

ii. What is the breakpoint chlorine dosage? [2]

iii. What is the chlorine demand at a chlorine dosage of 1.2 mg/L? [2]

END OF EXAMINATION