MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

CHEMICAL AND PROCESSING ENGINEERING DEPARTMENT

ENVIRONMENT POLLUTION CONTROL

CODE: HCHE 525

SESSIONAL EXAMINATIONS
SEPTEMBER 2021

DURATION: 3 HOURS

EXAMINER: MR K. NYENYAYI

INSTRUCTIONS

1. Answer ***all*** questions in Section A
2. Answer any ***three*** questions from Section B.
3. Each question carries 20 marks.
4. Total marks 100

Additional Materials:

Calculator

SECTION A

QUESTION ONE

Table 1 shows selected physical and chemical characteristics of waste from wet scrubber of an incinerator, 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 CaCO3) (mg/L)	9950	-	-	-	-

a) State **two** (2) most likely characteristics of this waste, for purposes of hazardous waste classification, according to the Basel Convention or local coding. [2]

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

c) A steel tanker carrying 30 m^3 of this waste overturned resulting in accidental spillage of its contents onto 500 m^2 of a natural vlei of archaeological significance.

Quantify the theoretical amounts of acidity (as H+) and Pb discharged in kg/ha of the affected area. [Relative atomic masses: H = 1; Ca = 40; C = 12; O = 16] [6]

d) State and justify **one** (1) form of biological treatment that would be necessary for the contaminated site given its significance. [4]

e) Giving examples, compare between *attached growth* and *suspended growth* as applied to wastewater treatment processes. [6]

QUESTION TWO

a. State the three types of forces that act on suspended particles in water. [3]

b. Briefly explain factors that affect flocculation process in water treatment. [5]

c. A water treatment plant treating 10 000 m^3 /d is using 20 mg/L of alum. How much natural alkalinity will be required to react with alum? If there is no natural alkalinity, compute the theoretical dosage of lime in mg/l and kg/d. [5]

d. Outline the major processes that take place in waste stabilisation ponds during wastewater treatment. [5]

e. Important nutrients have natural "Nutrient Cycles" in the receiving stream and within the wastewater treatment plant. Name any **two** (2) of these nutrients. [2]

SECTION B

QUESTION THREE

Describe, with the aid of a flow diagram or otherwise, the source of drinking water in a typical town and the main processes in its treatment. [20]

QUESTION FOUR

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

b. 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 m^3 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]

c. Identify the motivational factors for *reduction*, *recovery*, *reuse* and *recycling* (4Rs) of wastes. [8]

QUESTION FIVE

With aid of a schematic diagram describe all the typical treatment processes and liquid flow paths in an entire conventional municipal wastewater treatment plant using complete-mix activated sludge to provide secondary treatment. Also show and label the residuals produced by certain processes**.** [20]

QUESTION SIX

a) For active treatment of waste(s) of your choice state and justify:
   i. One (1) form of chemical treatment [4]
   ii. One (1) form of physical treatment [4]

b) It is desired to reduce the BOD of the wastewater from 100 mg/L to 20 mg/L in a single stage trickling filter with depth 5 m and 4 m radius. The flow rate of wastewater is 4000 m^3/d with TKN 25 mg/L. Calculate volumetric BOD and TKN loading. [6]

c) Justify why Break point method of chlorination during drinking water disinfection. [6]

THE END