



UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

B.Sc. DEGREE IN: ENVIRONMENTAL MANAGEMENT &
OCCUPATIONAL SAFETY AND HEALTH
- ENVIRONMENTAL MANAGEMENT AND WATER
RESOURCES

MAIN EXAMINATION PAPER 2019

TITLE OF PAPER : WASTEWATER MANAGEMENT
COURSE CODE : EHM 418
DURATION : 2 HOURS
MARKS : 100

INSTRUCTIONS :

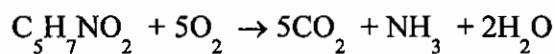
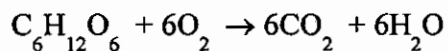
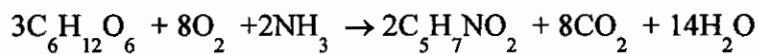
- : READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
- : ANSWER **ANY FOUR** QUESTIONS
- : EACH QUESTION **CARRIES 25** MARKS.
- : WRITE NEATLY & CLEARLY
- : NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM.
- : BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR.

QUESTION ONE (5 marks each)

1A. A wastewater effluent from a sugar processing industry has a theoretical COD of 1250 mg/L. using the chemical reactions provided below answer the following questions:

- i. What is the mass of glucose present ($C_6H_{12}O_6$) in the waste in mg/L
- ii. What is the mass of sludge produced (MLVSS) in mg/L



1B. Show the outlet tracer test profile diagram using salt tracer for the following flow conditions:

- i. Plug flow tank[2 ½ marks]
- ii. Completely mixed flow tank.[2 ½ marks]

Assume that 100 gm of salt is added to the inlet and the volume of the tank in each case is $4 m^3$. The wastewater flow rate is $2 m^3/hr$.

1C. Give examples of treatment processes for the removal of:

- i. Colloidal solids
- ii. Dissolved solids
- iii. Volatile organic compounds
- iv. Odours

1D. Describe the following types of settlement of solids in wastewater treatment processes:

- i) Discrete particle settling
- ii) Flocculent settling
- iii) Hindered (zone) settling

1E. It is suspected that a ground water supply may have been contaminated by industrial wastewater containing arsenic.

- i. Estimate the incremental risk of Arsenic toxicity for an adult associated with drinking 2L per day of ground water containing 0.2 mg/L arsenic. Arsenic has a potency factor of $1.5(\text{mg/Kg.day})^{-1}$ for oral route exposure.

- ii. To limit arsenic exposure to acceptable risk of 1 in 1,000,000, determine the concentration of arsenic that can be allowed in the extracted groundwater.

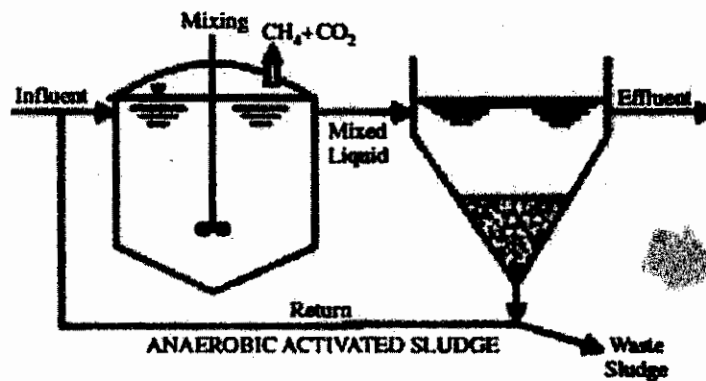
QUESTION TWO (5 marks each)

- 2A.** A sludge settleability test indicated that the sludge volume index was 100 ml/mg. The initial MLSS concentration of the sludge before settlement was 3000 mg/L. Estimate the return sludge concentration in mg/L. Assume that all the solids occupy the settled position and that no solid is left in the supernatant water after settlement.
- 2B.** Define the following terms used in relation to chemical unit processes:
- i. Extinction coefficient [1 mark]
 - ii. Gas stripping ...[1 mark]
 - iii. Advanced oxidation[1 mark]
 - iv. Photolysis[1 mark]
 - v. Reverse osmosis[1 mark]
- 2C.** Describe the possible causes of sludge bulking in activated sludge processes.
- 2D.** Draw a diagram of the contact stabilization activated sludge process. Indicate the advantage of such process and the kind of wastewater that can be treated.
- 2E.** Describe the three basic steps taking place in anaerobic reaction indicating in detail the process taking place in each step.

QUESTION THREE (5 marks each)

3A. The diagram below shows anaerobic activated sludge process with sludge recirculation. A designer decided to remove the sludge recirculation. In relation to this decision answer the following questions.

- i. What will happen to the hydraulic retention time and solids retention time as a result?
- ii. How will the performance of the reactor change?



- 3B.** Draw a diagram of the A²O process. What do the terms A² and O represent? What are the major constituents removed in the A²O process?
- 3C.** Describe with the help of a diagram the sequencing batch activated sludge reactor process. What type of wastewater is suitable for treatment with a sequencing batch reactor?
- 3D.** What are the parameters that are routinely monitored for the process control of activated sludge processes?
- 3E.** List possible chemical treatment methods employed for the removal of phosphorus from wastewater

QUESTION FOUR (5 marks each)

- 4A.** Describe with the help of a diagram the following processes of denitrification in activated sludge:
- i. The pre-anoxic process
 - ii. Post-anoxic process
- 4B.** What is the purpose of recirculation of recycled effluent to trickling filters?
- 4C.** State whether each of the following reactions are homogenous or heterogeneous reactions. Give reasons for your choice.
- i. Fluidized bed reactor
 - ii. Packed bed reactor
 - iii. Ammonia stripping
 - iv. Chemical precipitation
 - v. Ion exchange
- 4D.** Describe with the help of a sketch the following methods of equalization:
- i. Flow equalization
 - ii. Constituent equalization
- 4E.** State the advantages of reducing the rotational speed of the distributor in percolating filters.

QUESTION FIVE (5 marks each)

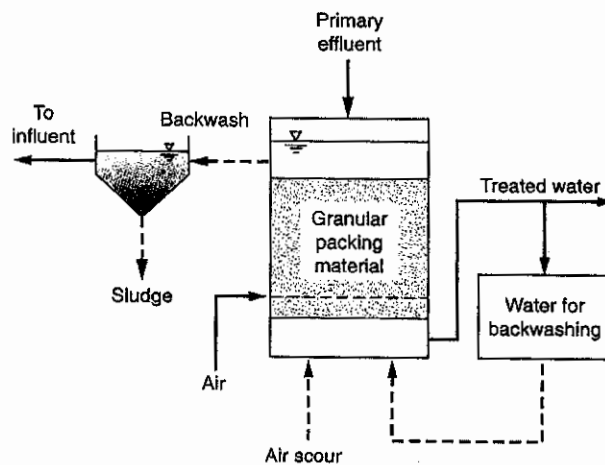
5A. Compare the potentials of the following oxidation processes for treating wastewater

- i. Ozone/UV
- ii. UV/Hydrogen peroxide
- iii. Ozone/Hydrogen peroxide

5B. Describe briefly the four discrete steps used in environmental risk analysis

5C. Describe the sources of odours in wastewater treatment plants and the mechanism that can be placed to minimize odours.

5D. Draw a diagram of submerged attached growth process labelling the essential components.



5E. Draw a diagram of the activated bio filter and indicate the particular advantage of this set up compared to conventional activated sludge processes.