NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

Environmental Process Engineering 1B
TCE 5204
Final Examination Paper

April 2025

This examination paper consists of **three** pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: Dr. Fortune Nkomo

INSTRUCTIONS

1. Answer **ALL** questions in **SECTION A**
2. Answer **ANY TWO** questions in **SECTION B**
3. Each question carries 25 marks

MARK ALLOCATION

QUESTION	MARKS
A1	**25**
A2	**25**
B1	**25**
B2	**25**
B3	**25**
TOTAL ATTAINABLE MARK	**100**

SECTION A: Answer ALL questions in this section.

QUESTION A1

i. Explain the term collection efficiency of a gas cleaning device **[5]**

ii. Given the following inlet loading and outlet loading of an air pollution particulate control unit, determine the collection efficiency of the unit. Inlet loading = 2 gr/m3 Outlet loading = 0.1 gr/m^3 **[5]**

iii. A cyclone is used to collect participates with an efficiency of 60%. A venturi scrubber is used as a second control device. If the required overall efficiency is 99.0%, determine the minimum operating efficiency of the venturi scrubber. **[5]**

iv. A proposed incineration facility design requires that a packed column and a spray tower be used in series for the removal of HCl from the flue gas. The spray tower is to operate at an efficiency of 65% and the packed column at an efficiency of 98%. Calculate the mass flowrate of HCl leaving the spray tower, the mass flowrate of HCl entering the packed tower, and the overall efficiency of the removal system if 76.0 kg of HCl enters the system every hour. **[10]**

QUESTION A2

Discuss 10 factors that should be considered when choosing a solvent for a gas absorption column that is to be used as an emission control device. **[25 Marks]**

SECTION B: Answer any TWO (2) questions in this section.

QUESTION B1

Discuss in detail any five methods of used to treat gaseous industrial waste. **[25]**

QUESTION B2

i. As a consulting engineer, you have been contracted to modify an existing control device used in fly ash removal. The standards for emissions have been changed to a total numbers basis. Determine if the unit will meet an effluent standard of $10^{5.7}$ particles/m^3. Data for the unit are given below. Average particle size, d_p = 10 um; assume constant Particle specific gravity = 2.3, Inlet loading = 3.0 gr/m^3 Efficiency (mass basis), E = 99% **[5]**

ii. Define and discuss the differences among the following terms: pollution prevention, pollution control and waste minimization **[20]**

QUESTION B3

A cyclone on a cement plant suddenly malfunctions. By the time the plant shuts down, some dust has accumulated on parked cars and other buildings in the plant complex. The nearest affected area is 700m from the cyclone location, and the furthest affected area measurable on plant grounds is 2500m from the cyclone. What is the particle size range of the dust that has landed on plant grounds? On this day, the cyclone was discharging into a 6km/hr wind. The specific gravity of the cement is 1.96. The cyclone is located 175 m above the ground. Neglect effects of turbulence. **[25]**

END OF QUESTION PAPER