BOWEN UNIVERSITY

FACULTY OF SCIENCE AND SCIENCE EDUCATION

DEPARTMENT OF CHEMISTRY AND INDUSTRIAL CHEMISTRY

B.SC. Degree 2014/2015, FIRST SEMESTER EXAMINATION

COURSE CODE: ICH 402 COURSE TITLE: PROCESS CHEMISTRY

Date: Jan. 26, 2015 COURCE CREDIT: 3

Time Allowed: 2hours

INSTRUCTIONS: ATTEMPT ANY FOUR QUESTIONS

QUESTION 1: [25MARKS)

a. Give the two (2) major types of cost associated with chemical process and list the main items that make them up. [10Marks]

b. List the five (5) steps involved in initial concept and design of a chemical processing plant. [5Marks]

c. Using appropriate diagram only explain what recycle and by-pass mean in chemical process. [10Marks]

QUESTION 2: [25MARKS)

A liquid mixture contains 60.0 weight per cent ethanol, 5.0 wt % of dissolved solute (s) and the balance water. A stream of this mixture is fed to a continuous distillation column operating at steady state. Product streams emerge at the top and bottom of the column. The column calls for the product streams to have equal mass flow rates and for the top stream to contain 90.0 wt % ethanol and no solute (s).

a. Assume a basis of calculation, draw and fully label a process flowchart and verify that all unknown flows and compositions can be calculated. [10Marks]

b. Calculate: (i) the mass fraction of solute (s) in the bottom stream. [8Marks]

(ii) the fraction of ethanol in the feed that leaves in the bottom product stream (kg ethanol in bottom/kg ethanol in feed) if the process operates as designed. [7Marks].

Question 3: (25Marks)

a. Draw a cash-flow diagram to show the forecast cumulative net cash flow over the life of a project. Identify each section in the diagram.
(15 Marks)

b. There is a proposal for the building of a plant to produce a new product. The estimated investment required for the project is 12.5 million naira and the timing of the investment will be:

year 1 = 1.0 million (design costs)
year 2 =5.0 million (construction costs)
year 3 = 5.0 million (construction costs)

year 4 = 1.5 million (working capital)

The plant will start up in year 4. The forecast sales price, sales volume, and raw material costs are shown in the table below.

End of year	Forecast sales 10^3t	Forecast selling price N/t	Raw material costs N /t product
1	0	-	-
2	0	-	-
3	0	-	-
4	100	150	90
5	105	150	90
6	110	150	90
7	120	150	90
8	130	150	90
9	140	150	90
10	150	145	85
11	165	140	85
12	180	140	85
13	190	140	85
14	200	135	80
15	190	130	75
16	180	120	75
17	170	115	70
18	160	110	70
19	150	100	70

The fixed operating costs are estimated to be:

₦400 000 per year up to year 9

₦500 000 per year up from year 9 to 13

₦550 000 per year from year 13

The variable operating costs are estimated to be:

₦10 per ton of product up to year 13

₦13 per ton of product from year 13

Calculate the net cash flow in the 4th and 8th years **(10 Marks)**

QUESTION 4: [25MARKS]

The oxidation of ethylene (C_2H_4) to produce ethylene oxide proceeds according to the equation:

$$2C_2H_4 + O_2 \rightarrow 2C_2H_4O$$

The feed to a reactor contains 100kmol C_2H_4 and 100kmol O_2.

i. Which reactant is limiting? **[5Marks]**

ii. What is the percentage excess of the other reactant? **[5Marks]**

iii. If the reaction proceeds to completion, (a) how much of the excess reactant will be left (b) how much C_2H_4O will be formed and (c) what is the extent of reaction? **[15Marks]**

QUESTION 5: [25MARKS]

a. Describe the solvay process for manufacturing sodium carbonate.

b. The last stage of manufacturing involves using sulphuric acid to dry the nitric acid. Explain why ordinary distillation process can't be used to achieve this?

c. Draw a simplified diaphragm cell used in the electrolysis of brine.

d. Mention five uses of Chlorine (Cl_2).