MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: MASS TRANSFER PROCESSES 1A

CODE: CHEP213

SESSIONAL EXAMINATIONS
JUNE 2023

DURATION: 3 HOURS

EXAMINER: ENG P. SIGAUKE

INSTRUCTIONS

1. *Answer **All** questions.*
2. *Start a new question on a fresh page*
3. *Show all your steps clearly in your calculations.*
4. *Total marks 100*

Additional material(s): *Graph papers, Calculator*

QUESTION 1

a) List and explain five (5) factors affecting mass transfer. [5]

b) Explain the following models as used in mass transfer

i) Lewis- Sorel method [5]

ii) Maxwell Stefan model [5]

iii) Ponchon Savarit method [5]

iv) McCabe- Thiele method [5]

QUESTION 2

a) Distillation operations involve use of different equipments. List and explain five (5) distillation equipments and their uses. [10]

b) 200 mol/hr of a mixture containing 53 mole % benzene and 47 mole% toluene is fed to a continuous distillation column. The feed is at its boiling point. The reflux ratio is 1.5. The distillate must contain 93 mole % benzene and the bottoms 7 mol % benzene. The equilibrium data is given in the table below;

x	0	0.2	0.4	0.6	0.8	1.0
y	0	0.433	0.65	0.80	0.90	1.0

Determine the following:

i) The operating line for the rectifying section

ii) The operating line for the stripping section

iii) The number of theoretical plates [15]

QUESTION 3

A distillation column is fed with a mixture of benzene and toluene, in which the mole fraction of benzene is 0.35. The column is to yield a product in which the mole fraction of benzene is 0.95, when working with a reflux ratio of 3.2, and the waste

from the column is not to exceed 0.05 mole fraction of benzene. If the plate efficiency is 60 per cent, estimate the number of plates required and the position of the feed point. The relation between the mole fraction of benzene in liquid and in vapour is given by:

Mole fraction of benzene in liquid	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Mole fraction of benzene in vapour	0.2	0.38	0.51	0.63	0.71	0.78	0.85	0.91	0.96

[25]

QUESTION 4

Methanol and water are separated using a distillation column with a partial condenser and partial reboiler. 200 kmol/h of a sub-cooled liquid feed containing 43 mole percent methanol and 57 mole percent water enters the column and condenses 1 mole of vapour for every 6 moles of feed. The products of separation are a distillate containing 94 mole percent methanol and bottoms liquid containing 93 mole percent water. The reflux is returned from the condenser to the column as a saturated liquid and the operation is run at $R = 1.8R_{min}$. Using the McCabe-Thiele method

i. Calculate the flow rates of the distillate and bottoms. [4]

ii. Determine the number of ideal plates. [20]

iii. Determine the optimal feed location. [1]

The equilibrium data of the methanol-water system is shown in table below.

x	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
y	0.0	0.417	0.579	0.669	0.729	0.780	0.825	0.871	0.915	0.959	1.0

Hint: q = 7/6

END OF EXAMINATION