MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: MASS TRANSFER PROCESSES 1A

CODE: CHEP213

SESSIONAL EXAMINATIONS
DECEMBER 2022

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) Define mass transfer [2]

b) Discuss the following operations as used in mass transfer

i) Leaching

ii) Liquid-liquid extraction

iii) Distillation

iv) Gas adsorption

v) Crystallization [10]

c) List and explain five (5) factors that affect mass transfer processes [15]

QUESTION 2

a) Define the following models

i) Maxwell Stefan model [5]

ii) Lewis-Sorel method [5]

ii) Ponchon Savarit method [5]

b) List differences between Ponchon- Savarit method and McCabe-Thiele method. [10]

QUESTION 3

The feed to a distillation column consists of ethanol and water. The feed enters the column at its boiling point and the vapour leaving the column which is condensed but not cooled, provides reflux and product. The distillate product should contain 95 mol % ethanol and the bottoms product 5 mol %. A reflux ration of 3 is applied to obtain the desired enrichment. The feed has a mole fraction of 0.6 ethanol and the feed rate is 100 kmol/hr.

Table 1

x	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
y	0	0.35	0.49	0.57	0.64	0.71	0.78	0.85	0.91	0.95	1.0

Determine the following:

(i) Compositions of distillate and bottoms [5]

(ii) The operating line for the rectifying section [5]

(iii) The operating line for the stripping section [5]

(iv) The number of theoretical plates [5]

(v) Locate the feed plate [5]

QUESTION 4

A liquid mixture of benzene-toluene is to be distilled in a fractionating tower at 101.3 kPa pressure. The feed of 100 kg mol/h is liquid and it contains 45 mol % benzene and 55 mol % toluene and enters at 327.6 K. A distillate containing 95 mol % benzene and 5 mol % toluene and a bottoms containing 10 mol % benzene and 90 mol % toluene are to be obtained. The reflux ratio is 4. The average heat capacity of the feed is 159 *kJ/kg*·mol·K and the average latent heat 32099 kJ/kg·mol. Equilibrium data for this system are given in the table below.

Equation for feed line is given by:

$y = 7x - 2.65$

Table 2

x	0	0.13	0.26	0.41	0.58	0.78	1.0
y	0	0.26	0.46	0.63	0.76	0.90	1.0

Calculate

i)	kg moles per hour distillate	[4]
ii)	kg moles per hour bottoms	[4]
iii)	rectifying section operating line	[5]
iv)	stripping section operating line	[5]
v)	number of theoretical trays needed	[5]
vi)	Locate feeding plate.	[2]

END OF EXAMINATION