MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: MASS TRANSFER PROCESSES 1B

CODE: CHEP223

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 and explain the following adsorption isotherms

i) Langmuir isotherm [5]

ii) Freundlich isotherm [4]

iii) Brunauer-Emmett-Teller (BET) [4]

(b) Explain the following terms used in humidity

i) Humid heat [2]

ii) Humid volume [2]

iii) Dew point [2]

(c) Give an explanation of operation of the following towers

i) atmospheric tower [3]

ii) mechanical draft tower [3]

QUESTION 2

a) Define the following terms

i) Moisture content on dry basis [2]

ii) Moisture content on wet basis [2]

b) Explain the concept of drying equilibria [3]

c) Why is drying an important mass transfer process? [3]

b) A wet solid is dried from 22 to 7 per cent moisture under constant drying conditions in 16 ks (4.44 h). If the critical and the equilibrium moisture contents are 14 and 3 per cent respectively, how long will it take to dry the solid from 29 to 7 per cent moisture under the same conditions? [15]

$$t = \frac{Q}{R_c A}\left[\frac{f_1 - f_c}{f_c} + ln\left(\frac{f_c}{f}\right)\right]$$

$$f_1 = (w_1 - w_e)$$

$$f_c = (w_c - w_e)$$

$$f = (w - w_e)$$

QUESTION 3

Acetone (*C*) is to be extracted from an aqueous solution (500 kg/h, 50 mass % acetone) using TCA (trichloroethane-*B*) as a solvent in a single stage counter-current extraction. It is desired to reduce the acetone in the feed to 1 % in the final raffinate. The solvent rate is 800 kg/h and has a composition of 98 % TCA and 2 % acetone. Given the following LLE data:

Raffinate arm (mass fraction**)**			**Extract arm (**mass fraction**)**		
x	x_B	x	y	y	y
0.3	0.1	0.55	0.13	0.27	0.60
0.4	0.07	0.50	0.04	0.46	0.50
0.5	0.03	0.40	0.03	0.57	0.40
0.6	0.02	0.30	0.02	0.68	0.30
0.7	0.01	0.20	0.015	0.78	0.20
0.895	0.005	0.1	0.01	0.89	0.10

i) Determine the values of the following F, S, $x_{C,F}$, $x_{B,F}$, $y_{C,S}$,$y_{B,F}$ [10]

ii) Draw the raffinate and extract arms. [15]

QUESTION 4

(a) Define

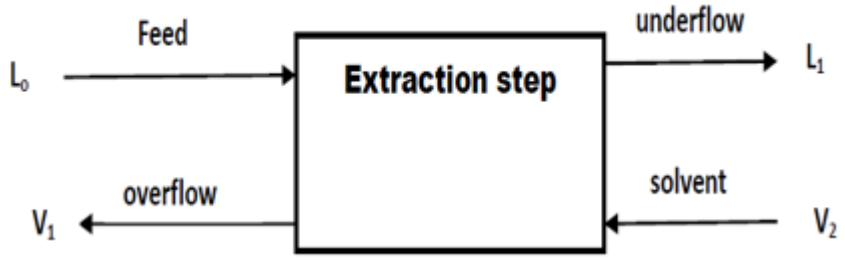
i) Feed

ii) Solvent

iii)Extract [3]

b) Extraction is in many ways complementary to distillation. In which cases is extraction preferable to distillation? Give four (4) cases. [4]

c) In a single step solid-liquid extraction cotton oil is to be extracted from cotton seed flakes using hexane as solvent.



200kg of the flakes with an oil content of 18 wt% are contacted with 200kg fresh hexane. 1.5kg of inert material holds back a constant value of 1kg solution. Determine the amount (wt%) and composition of the flows leaving the extraction plant. [18]

Hint: Calculate W_{am}, W_{bm}, W_{cm}, W_{aL1}, L_1, V_1, W_{BV1}, W_{CV1}, W_{BL1}, W_{CL1}

END OF EXAMINATION