Exam Date & Time: 30-Dec-2022 (02:30 PM - 05:30 PM)

AK

MANIPAL ACADEMY OF HIGHER EDUCATION

V Semester Make Up Examination
MASS TRANSFER II (CHE 3152)

MASS TRANSFER- II [CHE 3152]

Marks: 50 **Duration: 180 mins.**

Descriptive Questions

Answer all the questions. Section Duration: 180 mins

1) Derive an expression to theoretically calculate the minimum number of trays if the relative volatility remains reasonably constant throughout the column (provided x_D, x_W and α are known). (3)

A)

B) A binary mixture (A and B) are fractionated using a fractionator which has 3 ideal plates. The feed enters between 2nd and the 3rd trays. The feed is a saturated vapor with mole fraction 0.005. The condenser used is a total condenser and the reflux is at its bubble point. The molar rate of reflux is 1.3 moles/mole of feed and rate of vaporization in reboiler is 0.6 moles/mole of feed. The equation for equilibrium line is given as $y = 12.6\ x$. Calculate the volume and concentration of distillate and the residue. (5)

C) Compare and contrast Azeotropic and Extractive distillation. (2)

2) 100 moles of benzene and toluene containing 50 mole% benzene is subjected to a differential distillation at atmospheric pressure till the composition of the benzene in the residue is 33% by mole. Calculate the total moles of the mixture distilled. Assume α = 2.4 (3)

A)

B) 1000 kg of crushed oil seeds (19.5% oil, 80.5% meal) is extracted in a three-stage cross-current unit using 500 kg of pure hexane in each stage. The equilibrium data are as follows:

(5)

Overflow (100 kg) solution			Underflow (100 kg) slurry		
W_A (kg)	W_B (kg)	W_C (kg)	W'_A (kg)	W'_B (kg)	W'_C (kg)
0.3	99.7	0	67.2	32.8	0
0.45	90.6	8.95	67.1	29.94	2.96
0.54	84.54	14.92	66.93	28.11	4.96
0.70	74.47	24.83	66.58	25.06	8.36
0.77	69.46	29.77	66.26	23.62	10.12
0.91	60.44	38.65	65.75	20.9	13.35
0.99	54.45	44.56	65.33	19.07	15.6
1.19	44.46	54.35	64.39	16.02	19.59
1.28	38.50	60.22	63.77	14.13	22.10
1.28	34.55	64.17	63.23	12.87	23.90
1.48	24.63	73.89	61.54	9.61	28.85

Calculate the fraction of oil extracted using PS method.

C) Consider two binary mixtures of C and D with concentration 0.6 and 0.8 and enthalpies 500 kcal/mole and 10,000 kcal/mole respectively. When the two mixtures are mixed together. The resulting solution has a concentration of 0.68. Compute the enthalpy of the mixture. (2)

3) A mixture of 35 mole % A and 65 mole % B is to be separated in a distillation column. 96% of the component A from the feed is in the distillate. The concentration of A in the distillate is 93 mole %. The feed is half vapor and reflux ratio is 4. The relative volatility is 2.5. How many equilibrium stages are required in each section of the column? (5)

A)

B) Determine the minimum reflux ratio for the conditions given in question 3A. (2)

C) Nicotine in a water solution containing 1% nicotine is to be extracted with kerosene at 20°C. Water and kerosene are essentially insoluble. Determine the % extraction of nicotine if 100 kg of feed solution is extracted once with 150 kg solvent.

X' (kg nicotine/kg water)	0	0.001011	0.00246	0.00502	0.00751	0.00998	0.0204
y*' (kg nicotine/kg kerosene)	0	0.000807	0.001961	0.00456	0.00686	0.00913	0.01870

(3)

4) A feed of 1000 kg aqueous solution of pyridine per hour (50% by mass) is to be extracted with pure benzene to reduce the solute content in the raffinate to 2%. Determine the minimum solvent rate. (Use rectangular coordinate system) (5)

A)

Water layer		Benzene layer	
Pyridine (mass %)	Benzene (mass %)	Pyridine (mass %)	Benzene (mass %)
1.17	0	3.28	94.54
3.55	0	9.75	87.46
7.39	0	18.35	79.49
13.46	0.15	26.99	71.31
22.78	0.25	31.42	66.46
32.15	0.44	34.32	64.48
42.47	2.38	36.85	59.35
48.87	3.99	39.45	56.43
49.82	4.28	39.27	55.72
56.05	19.56	48.39	40.05

B) Consider Ponchon-Savarit method. Derive the theoretical expressions to determine heat load on condenser, reboiler and the hypothetic stream with a neat schematic diagram (marking all the streams). Also discuss about the significance of the hypothetic stream. (3)

C) Write a short note on Type 1 and Type 2 systems of three liquids for extraction process with a sample representation of triangular coordinates. (2)

5) Discuss about spiral wound membranes and bundle of hollow fibers with schematic representation. Which among these is generally used in RO systems? (4)

A)

B) Write a short note on any two pressure driven membrane types with their applications. (2)

C) Write a short note on any two solid-liquid contacting equipment which operates in counter-current mixing with a neat schematic diagram. (4)

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