BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION MO/2023)

CLASS: B.TECH. **SEMESTER : V**
BRANCH: CHEMICAL ENGG. **SESSION : MO/2023**

SUBJECT: CL301 MASS TRANSFER OPERATION-II

TIME: 02 HOURS **FULL MARKS: 25**

COURSE OUTCOMES:

1. Solve design calculation problems on liquid-liquid and solid-liquid extraction.
2. Solve problems related to humidification and drying.
3. Explain the various adsorption isotherms and solve problems related to adsorption.
4. Explain the mechanisms of crystallization and solve related problems.

Apply the knowledge of membrane-based separation processes like ultrafiltration, electrodialysis, pervaporation, reverse osmosis, and membrane distillation.

INSTRUCTIONS:

1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**
5. Solve the Q. 2a) by using LLE equilibrium graph attached. Mention the roll no. and submit the graph along with answer sheet.

		FM	CO	BL
Q.1(a)	Isopropyl alcohol(C) and water(A) can be separated by extraction with ethylene tetrachloride(B). A 100 kg of feed containing 30 wt% isopropyl alcohol and the 70 wt% water is mixed with the pure solvent ethylene tetrachloride. The raffinate phase contains 71% water, 28.1% isopropyl alcohol and 0.9% ethylene tetrachloride and the extract phase contains 94% ethylene tetrachloride, 5.2% isopropyl alcohol, and rest water. Calculate i) the amount solvent, ii) the quantities of raffinate and extract phases and iii) the percent of the solute extracted.	[5]	1	3
Q.2(a)	Acetone is to be extracted from a solution containing 46 wt % acetone and 54 wt% water by using pure chlorobenzene as solvent in a multistage counter current operation. The final raffinate should not contain more than 6% of solute. Compute the no. of ideal stages required. The feed and solvent rate are 1000 kg/hr and 1300 kg/hr, respectively. The equilibrium diagram is attached. The equilibrium data is also given as follows:	[5]	1	3

xA	xB	xC	yA	yB	yC
0.9989	0.0011	0	0.0018	0.9982	0
0.8979	0.0021	0.1	0.0049	0.8872	0.1079
0.7969	0.0031	0.2	0.0079	0.7698	0.2223
0.6942	0.0058	0.3	0.0172	0.608	0.3748
0.5864	0.0136	0.4	0.0305	0.4751	0.4944
0.4628	0.0372	0.5	0.0724	0.3357	0.5919
0.2741	0.1259	0.6	0.2285	0.1508	0.6107
0.2566	0.1376	0.6058	0.2566	0.1376	0.6058

Q.3(a)	Define Dew point temperature and Wet bulb temperature? At which condition both temperatures will be same?	[2.5]	2	1
Q.3(b)	From the definition of wet bulb temperature derive the expression of wet bulb depression.	[2.5]	2	5
Q.4(a)	It is planned to cool water from 43.3 °C to 29.4 °C in a packed counter current water-cooling tower using entering air at 29.4 °C with a wet bulb temperature of 23.9 °C. The water flow is 9700 kg/h.m^2 and the air flow is 6800 kg/h.m^2. The overall mass transfer coefficient is $K_Y' a = 2500 \text{ kg/m}^3\text{h } (\Delta Y')$. Calculate (a) minimum air rate that can be used and (b) tower height needed if air flow of 6800 kg/h.m^2 is used.	[5]	2	5

Given: Height of transfer unit, $H_{toG} = \dfrac{G_S}{K_Y' a}$. Tie lines are vertical.

Enthalpies of saturated air-water vapor (Base temperature: 0 ºC)

Temperature (ºC)	H' (kJ / kg dry air)	H_*' (kJ / kg dry air)	Temperature (ºC)	H' (kJ / kg dry air)	H_*' (kJ / kg dry air)
15.6		43.68	37.8	122.4	148.2
26.7		84.0	40.6	139.4	172.1
29.4	71.7	97.2	43.3	154.8	197.2
32.2	88.4	112.1	46.1		224.5
35.0	105.4	128.9	60.0		461.5

Q.5(a) Draw the drying rate curve mentioning the different rate zone with different moisture zone. [2] 3 3

Q.5(b) A porous solid is dried in a batch dryer under constant drying conditions. Six hours are required to reduce the moisture content from 30 to 10 %. The critical moisture content was found to be 16 % and the equilibrium moisture 2 %. All moisture contents are on the dry basis. Assuming that the rate of drying during falling rate period is proportional to the free moisture content, how long should it take to dry a sample of same solid from 35 to 6 % under the same drying conditions? [3] 3 4

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