Duration: -03 Hrs. **Total marks assigned to the paper: - 80**

Instructions to the candidates if any: -

1. Question No 1 is compulsory
2. Attempt any three questions from the remaining five questions
3. Assume suitable data wherever necessary
4. Figures to the right indicates full marks

Q. No. 1

a. Discuss the requirements of a solvent that can be used in liquid-liquid extraction. [05]

b. The relative volatility for a Benzene-Toluene system is 2.34. Generate the VLE data for this system and plot the same on a x-y plot. [05]

c. Discuss the need for membrane separation operations in chemical engineering and list some of the important operations. [05]

d. Discuss various methods of creating supersaturation during crystallization process. [05]

Q. No. 2

a. A salt solution weighing $15000\,kg$ with $25\,\%$ Na_2CO_3 is cooled to $293\,K$. The salt crystallizes as $Na_2CO_3.10H_2O$. Find the yield of crystals if there is no loss of water by evaporation. The solubility of Na_2CO_3 at $293\,K$ is $21.5\,kg$ of Na_2CO_3 in $100\,kg$ of water. [10]

b. A mixture of 30 mole % of A and 65 mole % of B is to be separated in a distillation column. The concentration of A in the distillate should be $96\,mole$ % and 97 % of all A is in the distillate. The feed is half vapor and the reflux ratio is 3.5: 1. How many equilibrium stages are required? The relative volatility is 2.51 [10]

Q. No. 3

a. If $150\,kg$ of solution (A+C) containing $28\,\%\,C$ is to be extracted 3 times using $40\,kg\ of\ pure\ B$ in each stage, in a three stage cross current operation. Determine

quantities and compositions of various streams. The equilibrium data in wt % is given below. R indicates raffinate phase and E indicates extract phase

R	C	0.69	1.41	2.89	6.42	13.30	25.50	26.70	44.30	46.40
	A	98.1	97.1	95.1	91.7	84.4	71.1	58.9	45.1	37.1
	B	1.2	1.5	1.6	1.9	2.3	3.4	4.4	10.6	16.5
E	C	0.18	0.37	0.79	1.93	4.82	14.40	21.60	31.10	36.20
	A	0.5	0.7	0.8	1.0	1.9	3.9	6.9	10.8	15.1
	B	99.3	98.9	98.4	97.1	93.3	84.7	71.5	58.1	48.7

[10]

b. One liter flask is containing air and acetone at 1 atm and 303 K with a relative humidity of 30 % of acetone. 2.5 g of fresh activated carbon is introduced into the flask and the flask is sealed. Compute the final vapor composition and final pressure neglecting adsorption of air. The equilibrium data is given below

$g\ adsorbed/g\ carbon$	0	0.1	0.2	0.3	0.35
Partial pressure of acetone [mm of Hg]	0	2	12	42	92

[10]

Q. No. 4

a. Oil is to be extracted from meal by means of benzene, using a continuous counter current extractor. The unit is to treat 1200 kg of meal (based on completely exhausted solids) per hour. The untreated meal contains 360 kg of oil and 35 kg of benzene. The exhausted solids are to contain 60 kg of unextracted oil. The fresh solvent stream contains 16 kg oil and 595 kg benzene.

Experiments carried out under conditions identical with those of the projected battery, show that the solution retained depends upon the concentration of the solution as follows

$kg\ oil/kg\ solution$	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
$kg\ solution/kg\ solid$	0.5	0.505	0.515	0.530	0.550	0.571	0.595	0.620

[10]

b. Discuss any two ion exchange equipments. [10]

Q. No. 5

a. Derive Fenske's equation for calculating minimum number of stages in a distillation column. [08]

b. Discuss break through curve in unsteady state adsorption. [08]

c. Explain why the VLE curve lies above the diagonal line when vapor phase composition is plotted on Y-axis and liquid phase composition is plotted on X-axis. [04]

Q. No. 6

Write short notes on the following. [Any four]

a. Ultra-filtration.

b. Minimum boiling azeotropes.

c. $\Delta\, L's$ law of crystal growth

d. Binodal solubility curve

e. Reverse Osmosis.

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