14/05/2025 TE CHEMICAL SEM-VI C-SCHEME MTO-II QP CODE: 10082552

(3 Hours) **Total Marks: 80**

N.B.: 1. Question **No.1** is **compulsory.**

2. Attempt any **three** questions out of the remaining **five** questions.

3. Assume **suitable** data wherever **required.**

4. **Figures** to the **right** indicates **full** marks.

Q.1] Solve any four [20]

(a) Discuss in brief the binodal solubility curve.

(b) In distillation derive the q-line equation.

(c) Explain in detail the Freundlich Adsorption Isotherm

(d) Explain the principle of leaching. Also write the applications of leaching operation.

(e) Write the different types of membrane processes. Also write the applications of membrane processes.

(f) Explain various methods of super saturation.

Q.2] (a) A liquid mixture of benzene and toluene is being distilled in a fractionating column at 101.3 kPa pressure. The feed of 100 kmole/h is liquid and it contains 45 mole% benzene (A) and 55 mole% toluene (B) and enters at 327.6 K. A distillate containing 95 mole% benzene and 5 mole% toluene and a bottoms containing 10 mole% benzene and 90 mole% toluene are to be obtained. The amount of liquid is fed back to the column at the top is 4 times the distillate product. The average heat capacity of the feed is 159 kJ/kgmole K and the average latent heat 32099 kJ/kgmoles.Calculate, 12

i. The kgmoles per hour distillate, kgmole per hour bottoms

ii. No. of theoretical stages at the operating reflux.

iii. The minimum no. of theoretical stages required at total reflux

iv. If the actual no. of stage is 10, what is the overall efficiency increased at operating condition compared to the condition of total reflux?

The equilibrium data:

Temp.(K)	353.3	358.2	363.2	366.7	373.2	378.2	383.8
x_A (mole fraction)	1.000	0.780	0.580	0.450	0.258	0.13	0
y_A(mole fraction)	1.000	0.900	0.777	0.657	0.456	0.261	0

(b) Discuss the single stage leaching and derive the relations for N_{M_1} and y_{M_1}. 08

Q.3] (a) If 100kg of solution of acetic acid (C) and water (A) containing 30% acid is to be extracted three times with isopropyl ether (B) at 20°C,using 40kg of solvent in each stage, determine the quantities and compositions of the various streams. How much solvent would be required if the same final raffinate concentration were to be obtained with one stage? The equilibrium data at 20°C is given below. 12

Water Layer			Isopropyl Ether layer		
Wt % Acetic acid, 100x	Water	Isopropyl ether	Acetic acid, 100y*	Water	Isopropyl ether
0.69	98.1	1.2	0.18	0.5	99.3
1.41	97.1	1.5	0.37	0.7	98.9
2.89	95.5	1.6	0.79	0.8	98.4
6.42	91.7	1.9	1.93	1.0	97.1
13.30	84.4	2.3	4.82	1.9	93.3
25.50	71.1	3.4	11.40	3.9	84.7
36.70	58.9	4.4	21.60	6.9	71.5
44.30	45.1	10.6	31.10	10.8	58.1
46.40	37.1	16.5	36.20	15.1	48.7

(b) Explain minimum boiling azeotrope and maximum boiling azeotrope. 8

Q.4] (a) 360 kg/hr of halibut liver is to be extracted in a counter current cascade with ether to recover oil. The ether which has been used partially contains 2.5 % oil. The fresh liver contains 25 % oil and is to be extracted to composition 2 % (on solvent free basis). 250 kg/hr of solvent is to be used. 12

i) What percentage of oil entering the liver is recovered in the extract?

ii) How many equilibrium stages are required?

The equilibrium data is given in the following table:

kg oil/kg solution	0	0.1	0.2	0.3	0.4	0.5	0.6
kg solution /kg exhausted liver	0.288	0.368	0.44	0.51	0.6	0.71	0.87

(b) Discuss the terms i) Reflux ratio, ii) Optimum reflux ratio (iii) Minimum reflux ratio. 8

Q.5] (a) A salt solution weighing 10000 kg with 30 % Na2CO3 is cooled to 293 K. the salt crystallizes as the decahydrate. What will be the yield of Na2CO3.10H2O crystals if the solubility is 21.5 kg anhydrous Na2CO3/100 kg of total water? 10

Do this for the following cases-

a. Assume that no water is evaporated

b. Assume that 3 % of the total weight of the solution is lost by evaporation of water in cooling.

(b) A batch of water containing residual chlorine at a concentration of 12 ppm is to be treated with activated carbon at 25°C to reduce the chlorine concentration to 0.5 ppm. Estimate the minimum mass of carbon per unit volume of water which can be used. 10

The equilibrium distribution coefficient = c*/X = 0.8 (kg Cl_2/m^3 liquid)/(kg Cl_2/kg Carbon).

Q.6] Solve any four. 20

(a) Derive operating line equation for flash distillation.

(b) Write short note on steam distillation.

(c) Write short note on reverse osmosis.

(d) Explain factors involved in choice of solvent in extraction

(e) Explain in brief Ion exchange process.

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