Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E –IIst SEMESTER–EXAMINATION – JULY- 2012

Subject code: 1723001 **Date: 06/07/2012**

Subject Name: Advance Mass Transfer Operation

Time: 10:30 am – 13:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 A distillation column is to separate 4750 mol/h of feed composed of 37% n-butane, 32% iso-pentane, 21% n-pentane and 10% n-hexane. The column operates at an average pressure of 2 atm and will produce a distillate product containing 95% n-butane and 5% iso-pentane. The bottom product is allowed to contain no more than 570 mol/h of n-butane. Feed is 25% (by mole) vapor. Assume ideal vapor-liquid equilibrium. All compositions are mole%. **14**

Antoine equations

n-butane $\ln p_{vnB} = 15.6782 - 2154.9/T - 34.42$

iso-pentane $\ln p_{viP} = 15.6338 - 2348.67/ T - 40.05$

n-pentanr $\ln p_{vnP} = 15.8333 - 2477.07/T—39.94$

n-hexane $\ln p_{vnH} = 15.8366 - 2697.55/ T - 48.78$

where T in K, p_v in torr

Determine the number of theoretical stages required for desired separation by FUG method.

Gilliland co relation.

$N - Nm / N+1 = 1 - \exp ((1 + 54.4\psi / 11 + 117.2 \psi) * (\psi - 1 / \psi^{0.5}))$

Where $\psi = R -- R_m / R + 1$

Q.2 **(a)** Discuss the advantages and disadvantages of vacuum distillation in detail **07**

(b) Discuss various types of membrane module in detail. **07**

OR

(b) Write note on Ultra filtration. **07**

Q.3 By using Lewis Matheson method, calculate the composition of liquid leaving the second tray from the top of the column for following case. **14**

(a) Distillation column details:

Component	Feed, Mole%	Distillate mole %	Residue mole %
n- Butane	37	95	16.3
i- Pentane	32	5	41.6
n- Pentane	21		28.5
n- hexane	12		13.6
	100	100.00	100.00

(b) F= 4750 kmol/hr , D= 1250 kmol/hr and q = 1

(c) Operating Pressure Pt = 2 atm (ab)

(d) Reflux Ratio, R = 3

(e) Vapour pressure of components :

$\ln Pv = A - (B/T+C)$, where Pv is in mmHg & Temp. in K

Component	A	B	C
n-butane	15.6782	2154.9	-34.42
i- pentane	15.6338	2348.67	-40.05
n-pentane	15.8333	2477.07	-39.94
n-hexane	15.8366	2697.55	-48.78

OR

Q.3 Find the mole fraction of n-butane in distillation and also in residue by Thiele Geddes method based on following method. **14**

1. Feed Composition

Component	mole%
n-butane	37
i-pantane	32
n- pantane	21
n- hexane	10

n- butane is light key component and i- pantane is heavy key component

2. feed flow rate F = 4750 mol/hr feed is saturated liquid at its bubble point
3. reful ratio R = 3
4. distillate flworate D = 1250 mol/ hr
5. Residue flowrate W = 3500 mol/hr
6. opersting pressure = 2 atm (ab)
7. assume constsnt molal overflow. Total condenser is used
8. equilibrium constant values of n butane are as follows

Tray numbers	Temperature ^{0} C	K
1	22	1.086
2	24	1.156
3	28	1.308
4 = feed	32	1.474
5	41	1.904
Reboiler	48	2.300

Q.4 **(a)** Discuss the criteria of selection for different towers used in absorption **07**

(b) Explain the method of selection of operating pressure in distillation column. Also define light key and heavy key components. **07**

OR

Q.4 Chlorine is to be sc rubbed by 15% NaOH solution (by mass) in packed tower type absorber. Following data are available. **14**

1. feed flowrate = 80 kg/hr of chlorine plus 320 kg/hr of air. Air is added for dilution.
2. feed gas temperature and pressure = 40^0 C and atmosphere
3. solvent : 15% NaOH solution , density of solution = 1100 kg/m^3 viscosity of 15% NaOH solution = 5 cp
4. temperature of solution = 15 to 20 ^{0} C
5. packing material : 25 mm polypropylene pall ring packing factor Fp = 170 m^{-1}
6. Reaction $2NaOH + Cl_2 \rightarrow NaOCl + NaCl + H_2O$
7. heat of reaction ΔH_R = --24.65 kcal/mol
8. mass transfer coefficient for the absorbtion of chlorie in 15% NaOH solution K_{Ga} = 100 kmol/ m^3h

Determine the following

a. actual amount of solvent required or circulation rate of NaOH solution required
b. Height of packing required
c. Heat duty of chilled water cooler required

Q.5 **(a)** Write a note on osmotic distillation. **07**

(b) Write a note on reactive and catalytic distillation. **07**

OR

Q.5 Explain the concept of energy conservation in distillation in detail. **14**

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