

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

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

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

$$\text{n-pentane } \ln p_{vNP} = 15.8333 - 2477.07/T - 39.94$$

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

where T in K, p_v in torr

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

Gilliland co relation.

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

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 $P_t = 2$ atm (ab)(d) Reflux Ratio, $R = 3$

(e) Vapour pressure of components :

 $\ln P_v = A - (B/T + C)$, where P_v 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-pentane	32
n-pentane	21
n-hexane	10

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

2. feed flow rate $F = 4750$ mol/hr feed is saturated liquid at its bubble point

3. reflux ratio $R = 3$

4. distillate flowrate $D = 1250$ mol/hr

5. Residue flowrate $W = 3500$ mol/hr

6. operating pressure = 2 atm (ab)

7. assume constant molal overflow. Total condenser is used

8. equilibrium constant values of n-butane are as follows

Tray numbers	Temperature $^{\circ}\text{C}$	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 scrubbed 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°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°C
5. packing material : 25 mm polypropylene pall ring packing factor $F_p = 170\text{ m}^{-1}$
6. Reaction $2\text{NaOH} + \text{Cl}_2 \rightarrow \text{NaOCl} + \text{NaCl} + \text{H}_2\text{O}$
7. heat of reaction $\Delta H_R = -24.65\text{ kcal/mol}$
8. mass transfer coefficient for the absorption of chlorine in 15% NaOH solution $K_{Ga} = 100\text{ kmol/m}^3\text{h}$

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**
