

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER-VIII • EXAMINATION – SUMMER 2014

Subject Code: 180505**Date: 27-05-2014****Subject Name: Multi Component Distillation****Time: 10:30 am TO 01:00 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 Find the distribution (or mol/h) of *n*-Butane in distillate and in residue by Thiele – **14**
 Geddes method based on the following data.

Table : Feed Composition

(i) Component	mole %
<i>n</i> -Butane	37
<i>i</i> -Pentane	32
<i>n</i> -Pentane	21
<i>n</i> -Hexane	10

n-Butane is light key component and *i*-Pentane is heavy key component.(ii) Feed flow rate $F = 4750$ mol/h. Feed is saturated liquid at its bubble point.(iii) Reflux ratio, $R = 3$ (iv) $D = 1250$ mol/h, $W = 3500$ mol/h(v) Operating pressure, $p = 2$ atm a

(vi) Assume constant molal overflow. Total condenser is used.

Equilibrium Constants Data for *n*-Butane

Tray number	Temperature, °C	K_{C4}
1	22	1.086
2	24	1.156
3	28	1.308
4 (Feed)	32	1.474
5	41	1.904
Reboiler	48	2.303

Q.2 (a) Discuss the use of heat pump with auxiliary heat transfer medium (or use of Vapour Compression Refrigeration Cycle) for saving the energy consumption of distillation column. **07**

(b) Discuss “Sequencing of multi component distillation columns”. **07**

OR

(b) Discuss Thermally coupled distillation columns. **07**

Q.3 Nitric acid water mixture forms maximum boiling azeotrope at 1atm a and at 122°C, **14**
 with a composition of 64.1% by mass of HNO₃. Distillate contains 99.9% HNO₃ (by mass) and residue contains 1% HNO₃ (by mole). Separation is achieved from the azeotropic mixture by extractive distillation using concentrated sulphuric acid (99% by mass) as solvent. Residue of this extractive distillation column is 80% by mass H₂SO₄ and remaining water. Extractive distillation is carried out in glass packed tower type distillation column at 180 Torr a pressure. Glass Raschig rings are used as a packing material. Determine height of packing required for the desired separation in this extractive distillation column. Average relative volatility of nitric acid-water mixture in presence of large amount of sulphuric acid is 95. Assuming that feed is saturated liquid.

OR

- Q.3** (a) Explain the working principle of Azeotropic Distillation with flow sheet of one industrial application. **07**
 (b) Discuss the advantages and disadvantages of Extractive Distillation over Azeotropic Distillation. **07**

- Q.4** Discuss Lewis-Matheson method for multicomponent distillation. Also explain about how to start the second trial calculation and arrive on final solution. **14**

OR

- Q.4** (a) Discuss Equation-Tearing Procedure using Tridiagonal matrix algorithm for multicomponent distillation. **10**

- (b) Define Light key component, heavy key component, and adjacent key and split key components. **04**

- Q.5** A saturated liquid, consisting of phenol and cresols with some xylenols, is fractionated to give a top product of 95.3 mole% phenol. Metacresol is heavy key and phenol is light key components. Total condenser is used. **14**

The composition of the top product and of the phenols in the bottoms is given.

(a) Complete the material balance over the column for a feed rate of 100 kmol/h.

(b) Calculate the minimum reflux ratio by Underwood's method.

(c) For $R = 3R_m$, calculate the composition of vapour entering to the top most tray by Lewis–Matheson method.

Distillation Column Data and Relative Volatilities values are given in following Table.

Component	α_{av}	Feed, mole %	Top product, mole %	Bottom product, mole %
Phenol	1.98	35	95.30	5.24
<i>o</i> – Cresol	1.59	15	4.55	?
<i>m</i> – Cresol	1.00	30	0.15	?
Xylenols	0.59	20	–	?
		100	100.00	

OR

- Q.5** Discuss the stepwise procedure for process design of multicomponent batch distillation with rectification and with constant overhead composition. **14**
