

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER-VIII • EXAMINATION – SUMMER 2013

Subject Code: 180505**Date: 09/05/2013****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 (a)** Feed mixture to a distillation column contains 30 % n-hexane, 32 % n-propane, 20 % n-butane and 18 % n-pentane (by mole). Total flow rate of the feed is 100 kmol/h. If butane & pentane are selected as light key & heavy key components, respectively then find the product compositions. Operating pressure at the top of the column is 1600 kPa. Pressure drop in the column is 30 kPa. At dew point temperature 72 °C $K_{Pr} = 1.55$, $K_{Bu} = 0.6$, $K_{Pe} = 0.25$, $K_{He} = 0.11$. At bubble point temperature of residue 180 °C $K_{Bu} = 2.5$, $K_{Pe} = 1.3$, $K_{He} = 0.79$, $K_{Pr} = 4.25$. **10**

- (b)** Write short note on selection of equipment for distillation. **04**

- Q.2 (a)** Define following terms: **07**

Light key component, Heavy key component, Non-key component, Distributed components, Non distributed component, Adjacent keys & Split keys for multi component distillation.

- (b)** Write advantages & disadvantages of vacuum distillation. **OR** **07**

- (b)** Determine the minimum reflux ratio for the binary distillation at standard atmospheric pressure based on the following data. **07**

Feed = 100 kmol/h

Feed mixture: benzene & toluene

Mole fraction of benzene in feed = 0.4

Condition of feed = at 30 °C

Mole fraction of benzene in distillate required = 0.99

Mole fraction of benzene in residue required = 0.02

Average relative volatility = 2.25

$\ln p_{vB} = 15.9008 - 2788.51/(T+652.36)$ for benzene in torr

$\ln p_{vT} = 16.0137 - 3096.52/(T+653.67)$ for toluene in torr

Normal boiling point of benzene = 80.1 °C

Normal boiling point of toluene = 110.6 °C

Property data of benzene & toluene

Component	C_L at 62.65 °C, kJ/(kmol. °C)	at 95.3 °C, kJ/kmol
Benzene	146.96	29391.3
Toluene	173.33	34666.7

- Q.3 (a)** State the algorithm or steps for Lewis Matheson method to calculate theoretical stages in rectification section & also state feed tray identification. **07**

- (b)** State the steps for Theile Geddes method for calculation of theoretical stages in stripping section. **07**

OR

- Q.3** A saturated liquid, consisting of phenol & cresols with some xylenols, is fractionated to give a top product of 95.3 mole % phenol. Metacresol is heavy key & phenol is light key component. Total condenser is used. The compositions of the top product **14**

and of the phenols in the bottoms are given.

- Complete the material balance over the still for a feed rate of 100 kmol/h.
- Calculate the minimum reflux ratio by Underwood's method.
- 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

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

- Q.4 (a)** Distinguish between azeotropic distillation & extractive distillation with suitable examples. **05**
- (b)** Define following terms: **04**
 Homogeneous Maximum Boiling Azeotrope,
 Heterogeneous Minimum Boiling Azeotrope,
 Pressure Swing Distillation,
 Entrainer
- (c)** Write short note on thermally coupled distillation column with diagram. **05**

OR

- Q.4 (a)** Discuss about heat integration & optimum design of distillation column. **07**
- (b)** Discuss batch distillation with rectification. **07**
- Q.5 (a)** 1000 kg of feed containing 30 % by mass ethylene glycol & remaining water is charged to a batch still. Simple batch distillation is carried out at 30.4 kPa absolute pressure to get the residue must contain 95 % by mass ethylene glycol. Find the amount of residue (final product). **07**

VLE data of ethylene glycol- water system at 30.4 kPa are as follow.

Temperature ($^{\circ}\text{C}$)	x	y
69.5	1.00	1.000
76.1	0.77	0.998
78.9	0.69	0.997
83.1	0.60	0.990
89.6	0.46	0.980
103.1	0.27	0.940
118.4	0.15	0.870
128.0	0.10	0.780
134.7	0.07	0.700
145.0	0.03	0.530
160.7	0.00	0.000

- (b)** Define following terms: **04**
 Jet flooding, Down comer flooding, Liquid entrainment, Weeping
- (c)** Write short note on heat pump. **03**

OR

- Q.5 (a)** Write method to find out tower diameter & pressure drop in distillation column. **08**
- (b)** Discuss the parameter for selection of tray in distillation column. **06**
