Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – III • EXAMINATION – WINTER • 2014

Subject code: 731602 **Date: 27-11-2014**

Subject Name: Computer Aided Product and Process Design

Time: 02:30 pm - 05:00 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 Distillation column is to be designed for chloromethanes separation. Material balance around distillation column is fixed and the same is shown in following Table. Feed flow rate is 3000 kg/h. **14**

Table : Composition of Distillation Column strems

Component	Vapour pressure at 40°C, atm	Ŭ$_{av}$	Feed, mole %	Distillate, mole %	Bottoms, mole %	
Methyl chloride	8.507	6.296	73.7	99.94	0.94	
Methylene dichloride	1.0	1	20.4	0.06	76.89	
Chloroform	0.465	0.496	4.7	-----	17.62	
Carbon tetrachloride	0.28	0.313	1.2	-------	4.55	

Column must be operated at higher pressure.

(a) It is planned to use cooling water available at 32°C as cooling medium in overhead condenser. Fix the operating pressure at the top of distillation column.

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

Nearly saturated vapour mixture is fed to distillation column.

Gilliland correlation :

$$\frac{N-N_m}{N+1} = 1-\exp\left[\left\{\frac{1+54.4\psi}{11+117.2\psi}\right\} \times \left\{\frac{\psi - 1}{\psi^{0.5}}\right\}\right]$$

$$\text{Where } \psi = \frac{R - R_m}{R+1}$$

Q.2 **(a)** Discuss the criteria of selection of tray tower and falling film absorber as absorber. **07**

(b) Discuss Calculation of shell side heat transfer coefficient by Bell's method. **07**

OR

(b) Discuss the advantages and disadvantages of vacuum distillation over atmospheric distillation. **07**

Q.3 Find the mole fraction of n-butane in distillate and residue by Thieleï Geddes method based on the following data. **14**

Table : Feed Composition

(i) Component	mole %
*n*ï Butane	37
*i*ï Pentane	32
*n*ï Pentane	21
*n*ï Hexane	10

*n*ï Butane is light key component and *i*ï 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

OR

Q.3 Discuss Thiele-Geddes method for multicomponent distillation. **14**

Q.4 Packed tower type scrubber is required for the following duty. **14**

(i) Feed gas : 30 Kg/h HCl + 600 Kg/h air

(ii) Solvent : 10% NaOH solution

(iii) Concentration of HCl : 20 mg/m³

(iv) Chemical Reactions :

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

$$æH_R = -31.4 \text{ Kcal / mol}$$

Calculate : (a)Amount of solvent required. Tower diameter required for this scrubber is 0.36m.

(b) Calculate the number of overall gas phase transfer unit.

(c) Calculate the height of packing required. Mass transfer coefficient, K_{Ga}=200 kmol/(m³.h)

OR

Q.4 Discuss Equation-Tearing Procedure using Tridiagonal matrix algorithm for multicomponent distillation. **14**

Q.5 (a) Discuss the advantages and disadvantages of forced draught fan and induced draught fan for aircooler. Also discuss about criteria of selection. **07**

(b) Discuss Tinkerôs Flow Model and significance of sealing strips. **07**

OR

Q.5 Discuss Lewis-Matheson method for multicomponent distillation. Also explain about how to start the second trial calculation and arrive on final solution. **14**

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