Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – III • EXAMINATION – WINTER • 2013

Subject code: 731602 Date: 28-11-2013

Subject Name: Computer Aided Product and Process Design

Time: 10.30 am – 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)** Discuss Heuristics for designing separation processes. **04**

(b) Explain superstructure with modeling for reactor network synthesis with specific example of your choice. **10**

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

(b) Explain the step-by-step process of selecting best sequence for ternary feed mixture based on minimum vapor rates. **07**

OR

(b) Consider a plant consisting of three stages that manufactures two products, A and B. The demands are 600,000 kg/year for A and 300,000 kg/year of B, and the production time considered is 6000 hours. Data for processing time and size factors are as follows: **07**

	Processing time (hr.)			Size Factors (m^3/kg prod)		
	Stage 1	Stage 2	Stage 3	Stage 1	Stage 2	Stage 3
A	4	2	3	2	5	3
B	3	2	5	1.5	6	2

Assume that both the products have same batch size

Determine the size of vessels of a multi-product batch plant if the production cycle is of 500 hrs consisting of two campaigns: one for A and one for B. Only one vessel is to be used in each stage.

Q.3 **(a)** Explain Geometrical concept for Attainable Regions for van de Vusse reaction. **07**

(b) You are to separate the following relatively ideally behaving mixture of A, B, and C. The feed is at its bubble point of 345.8 K at 1 bar. The Underwood roots for the original feed are 1.116 and 2.826. The minimum vapor flow of the columns are as under: **07**

V_{min}(A/BC) = 828 kmol/hr
V_{min}(AB/C) = 254 kmol/hr
V_{min}(A/B) = 830 kmol/hr
V_{min}(B/C) = 183 kmol/hr

- Which sequence is to be preferred? Why?
- Explain the method of calculating marginal vapor flows. (Very approximate method.)

OR

Q.3 **(a)** Write a generalize MILP model for synthesizing distillation sequences for any mixture of n components that is to be separated into pure components. **07**

(b) For the objective to minimize the investment cost given fixed product demand write MINLP design model for flow shop plants - single product campaigns. **07**

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

(i) Feed gas : 15 kg/h HCl + 15 kg/h Cl_2 + 600 kg/h air

(ii) Solvent : 10% NaOH solution

(iii) Concentration of HCl and Cl_2 in exit gas: 20 mg/m³.

(iv) Chemical Reactions :

$$2NaOH + Cl_2 \text{ ==== } NaOCl + NaCl + H_2O$$

$$\Delta H_R = -24.65 \text{ kcal/mol}$$

$$NaOH + HCl \text{ ==== } NaCl + H_2O$$

$$\Delta H_R = -31.4 \text{ kcal / mol}$$

Calculate :

(a) Amount of solvent required. Tower diameter required for this scrubber is 0.36m.Specific heat of recirculating solvent is 0.9 kcal/ (kg.K). Poly propylene pall rings are selected as packing material for which value of MWR is 4 m^3/ ($h.m^2$).

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

(c) Calculate the height of packing required. Mass transfer coefficient, K_{Ga}=272 kmol/(m³.h)

OR

Q.4 **(a)** Explain the following. **14**
(a) Equation-Tearing Procedure using Tridiagonal matrix algorithm for multicomponent distillation.
(b) Calculation of shell side heat transfer coefficient by Bell's method.

Q.5 **(a)** Discuss the advantages and disadvantages of vacuum distillation over atmospheric distillation. **07**

(b) Discuss Tinker's 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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