Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME – SEMESTER III (NEW) – EXAMINATION – WINTER-2016**

**Subject Code:** 2731602 **Date:25/10/2016**

**Subject Name: Computer Aided Product and Process Design**

**Time:02:30 pm to 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** | **(a)** | Explain PROS and CONS of vacuum distillation with industrial examples. | **07** |
| | **(b)** | Discuss Tinkers flow model and importance of sealing strips and dummy Tubes in the design of shell and tube heat exchanger. | **07** |
| **Q.2** | **(a)** | Discuss the criteria of selection of tray tower and ventury scrubber as absorber. | **07** |
| | **(b)** | Explain the stepwise procedure for the process design of falling film absorber. | **07** |
| | | **OR** | |
| | **(b)** | Explain stepwise procedure for the process design of vertical and horizontal Spray tower. | **07** |

**Q.3** A saturated liquid, consisting of phenol and cresols with some xylenols, is fractioned 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 are 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 $\boldsymbol{R = 3R_m}$, calculate the composition of vapour entering to the top most tray by Lewis–Matheson method.

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

| Component | $\alpha_{av}$ | 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 | 100.00 | |

**OR**

**Q.3** Discuss the step wise procedure for the process design of multicomponent batch distillation with rectification and with constant overhead composition. **14**

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

(i) Feed gas : 45% $CO_2$ + 3% $H_2S$ + 52% $CH_4$ (by mole)
(ii) Feed gas flow rate = 900 $Nm^3/h$ at 1.2 bar a and 40°C
(iii) Solvent : 10% NaOH solution
(iv) Specific heat of solvent : 0.9 kcal/(kg.°C)
(iii) Concentration of $CO_2$ and $H_2S$ in exit gas : 100 ppm
*(iv) Chemical Reactions :*

$$2\ NaOH_{(aq)} + CO_{2(g)} = Na_2CO_{3(aq)} + H_2O_{(l)}$$
$$\Delta H_R = -104.67\ kJ/mol$$

$$2\ NaOH_{(aq)} + H_2S_{(g)} = Na_2S_{(aq)} + 2\ H_2O_{(l)}$$
$$\Delta H_R = -52.73\ kJ/mol$$

( Atomic mass : Na 23,O 16,H 1,C 12,S 32)

Calculate :

(a) Amount of solvent required. Tower diameter required for this scrubber is 0.95 m. 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, $K_{Ga}$=38 kmol/($m^3$.h).

**OR**

**Q.4 (a)** Calculation of shell side heat transfer coefficient by Bell's method **07**

**(b)** Discuss the criteria of selection between horizontal position and vertical position of condenser and significance of 'Inverted U-Seal' in design of multi component condenser. **07**

**Q.5** Discuss Thiele-Geddes method for multicomponent distillation. Also write about the method for verifying stage wise temperatures for the same. **14**

OR

**(a)** Discuss the advantages and disadvantages of induced draught fan over Forced draught fan for air cooler. Explain also various design conditions of atmospheric air for the different applications of air cooler. **07**

**(b)** Discuss the step wise procedure for the process design of air cooler. **07**

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