

**GUJARAT TECHNOLOGICAL UNIVERSITY****B E Sem-VI Examination May 2011****Subject code: 160405****Subject Name: Principles of Process Engineering - III****Date: 23/05/2011****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) Answer the followings: 10**

1. State Raoult's law and Dalton's law.
2. Define: Relative volatility and Azeotrope.
3. State true or false: In distillation operation the mass transfer takes place in both the directions.
4. For binary mixture in distillation, calculate the number of degree of freedom.
5. Give the feed conditions for  $q > 1$  and  $0 < q < 1$ .
6. Define: Bound and Unbound moisture.
7. State the types of dryer used for drying of milk powder and wet filter cakes.
8. In boiling point diagram, the saturated vapor curve is also known as \_\_\_\_\_ curve.
9. Give example of minimum boiling and maximum boiling azeotrope.
10. Define: Equilibrium and Driving force in mass transfer.

**(b) Write in brief on flash distillation. 04****Q.2 (a) Derive the equation for q-line. Also, draw the feed line on equilibrium diagram for various values of q. 07****(b) The feed to a distillation unit is 10,000 kg/h of a solution of alcohol and water containing 30% alcohol. The feed is at its boiling point. The distillate contains 80% alcohol. All % are by weights. Total condenser is used. Calculate: (a) the minimum reflux ratio (b) the number of theoretical plates when 1.5 times minimum reflux ratio is used. 07**

|   |       |       |       |      |      |       |      |      |      |
|---|-------|-------|-------|------|------|-------|------|------|------|
| x | 0.05  | 0.1   | 0.2   | 0.3  | 0.4  | 0.5   | 0.6  | 0.7  | 0.8  |
| y | 0.375 | 0.525 | 0.655 | 0.72 | 0.75 | 0.775 | 0.79 | 0.82 | 0.86 |

where x and y is weight fraction of alcohol in liquid and vapor phase respectively

**OR****(b) Liquid mixture containing 40 mole% methanol and 60 mole% water is fed to the differential distillation at atmospheric pressure with 60 mole% of the liquid is distilled. Find the composition of distillate and residue. 07**

|   |      |      |      |      |      |      |
|---|------|------|------|------|------|------|
| x | 0.05 | 0.1  | 0.2  | 0.3  | 0.4  | 0.5  |
| y | 0.27 | 0.42 | 0.57 | 0.66 | 0.73 | 0.78 |

**Q.3 (a) Discuss rate of drying curve in detail. 07****(b) Discuss various moisture movements in the solid during drying. 07****OR****Q.3 (a) Give classification of rotary dryers. Write an account of any one. 07**

- (b) A batch of the solid is to be dried from 25% to 6% moisture under constant conditions. The initial weight of the wet solid is 350 kg and the drying surface is  $1\text{m}^2/8$  kg dry weight. Determine the time of drying. **07**

|         |    |    |    |      |      |      |    |    |     |   |     |     |
|---------|----|----|----|------|------|------|----|----|-----|---|-----|-----|
| X x 100 | 35 | 25 | 20 | 18   | 16   | 14   | 12 | 10 | 9   | 8 | 7   | 6.4 |
| N x 100 | 30 | 30 | 30 | 26.6 | 23.9 | 20.8 | 18 | 15 | 9.7 | 7 | 4.3 | 2.5 |

where X is moisture content in kg moisture/kg dry solid and N is rate of drying in kg moisture/hr, $\text{m}^2$

- Q.4 (a)** Explain super saturation theory. **05**  
**(b)** A colored impurity in an aqueous solution is to be removed by adsorption on a decolorizing carbon. It is desired to reduce the color to 10% of its original value 9.6. Estimate the quantity of fresh carbon required per ton of solution for single stage operation and for a two-stage cross current operation using minimum total amount of carbon. The system obeys Freundlich- equilibrium isotherm: **09**

$$Y^* = 8.91 \times 10^{-5} X^{1.66},$$

where  $Y^*$  is equilibrium color units/kg solution and X is adsorbate concentration unit/ kg carbon. Equation for intermediate concentration c for specified terminal concentration  $Y_0$  and  $Y_2$  for minimum total adsorbent required in case of two stage cross current operation is given by  $(Y_1/ Y_2)^{1/n} - 1/n(Y_0/ Y_0) = 1- 1/n$

**OR**

- Q.4 (a)** Give the effects of impurities on crystal formation. **05**  
**(b)** With special reference to concept of “Adsorption wave” and “Break-through curve” describe unsteady state fixed bed adsorbers in detail with neat diagrams. **09**
- Q.5 (a)** An air-water vapor mixture has dew point of  $35^\circ\text{C}$  and wet bulb temperature of  $39^\circ\text{C}$  at 1 atmospheric pressure. Calculate humidity, % humidity, relative humidity, humid volume, saturation humidity and enthalpy using psychometric chart. **08**  
**(b)** Explain the equilibrium characteristics (Freundlich adsorption isotherm) for adsorption from liquid solution on solids. **06**

**OR**

- Q.5 (a)** Explain different types of cooling towers in humidification operations with neat diagrams. **09**  
**(b)** Explain the theory governing the fundamentals of wet bulb temperature of humidifications in brief. **05**

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