B.Tech. Sixth Semester (Polymer (Plastic) Tech.) (CGS)

# 11126 : Chemical Engineering Operation - II (Mass Transfer) : 6 PP 01

P. Pages : 2 **AU - 2808**

Time : Three Hours * 0 6 4 0 * Max. Marks : 80

Notes :
1. Answer **three** question from Section A and **three** question from Section B.
2. Assume suitable data wherever necessary.
3. Diagrams and chemical equations should be given wherever necessary.
4. Illustrate your answer necessary with the help of neat sketches.
5. Discuss the reaction, mechanism wherever necessary.
6. Cell phone is not allowed.
7. Use of pen Blue/Black ink/refill only for writing the answer book.

## SECTION – A

**1.** a) Define molecular diffusion. Discuss the role of diffusion in different mass transfer operations. **6**

b) Discuss a diffusion of component 'A' through a stationary gas component B if a surface is introduced for absorbing gas component 'A'. Derive the relationship of Stefan's law. **8**

**OR**

**2.** a) State the comparison of rates of mass transfer in Equimolar counter diffusion and in diffusion through a stationary gas. **4**

b) Describe Stefan tube [Winkelman's] experiment with the help of schematic diagram used for determination of diffusivity of volatile organic solvent such as $ccl_4$ in to air. **10**
The following data is used for calculation of $ccl_4$ diffusivity into air.

i) Slope of curve drawn $\frac{t}{L-L_0} v|s(L-L_0)$ is 0.031k sec/ $mm^2$.

ii) Density of diffusing gas 1540 $kg/m^3$.

iii) Total pressure = 101.3 $kN/m^2$.

iv) Vapour pressure of organic solvent $CCl_4 = 37.6 kN/m^2$.

v) Molecular weight of $CCl_4 = 154$.

vi) Temperature = 321°k.

**3.** a) What is interphase? How does mass transfer takes place across interphase? **5**

b) Write down the salient points of Whitman's two film Theory in brief. **8**

**OR**

**4.** Define film coefficient $k_x$ and $k_y$ for diffusion between two phases and find out its relation with overall mass transfer coefficient on the basis of the relation developed explain the concept of resistance to mass transfer by the phases. **13**

**5.** a) What is a criteria used for selection of good solvent in gas absorption operation? **6**

b) By considering a packed column (Tower) used for gas absorption process. How will you calculate number of transfer unit (NTU) and height of transfer unit (HTU)? **7**

**OR**

6. a) Discuss the condition of equilibrium Liquid-Gas with the example of ammonia-oxygen gas mixture and water as a solvent. 6

b) Ammonia is to be recovered from ammonia-air mixture by absorption in water in a packed column. Calculate the mass flow rate of water assuming equilibrium condition. 7
The data is as under

i) Air flow rate $150\,kg/hr \cdot m^2$.

ii) Liquid phase concentration.
   a) At the top of packing = 0.0000135 kg $NH_3$|kg of water.
   b) At the bottom of packing = 0.000526 kg$NH_3$|kg of water.

iii) Gas phase concentration.
   a) At the top of packing = 0.000568 kg $NH_3$|kg of air.
   b) At the bottom of packing = 0.00957 kg $NH_3$|kg of air.

## SECTION – B

7. a) What is volatility and relative volatility? How will you separate two components having substantially the same volatility? 6

b) Derive Rayleigh's equation for simple or differential distillation of an ideal system. 8

**OR**

8. a) What are different types of distillation methods? Explain their principle. 6

b) What do you mean by minimum boiling and maximum boiling azeotrope. Draw boiling point and equilibrium diagrams for each with an example of system for each type. 8

9. a) A 100kg mole of a feed containing 36 mole % methanol is to be continuously distilled in a fractionating column to get 96.5 mole % methanol as distillate and 10 mole % methanol as a bottom product. Find out molal flow rates of distillate and residue. 6

b) Derive underwood Fenske's equation for minimum reflux ratio. 7

**OR**

10. Explain in detail McCabe Thiele method used for obtaining theoretical stages required for given degree of separation. What are the limitations of McCabe Thiele method? Discuss the above graphical method in detail. 13


11. a) Define following derivations of drying operation 6
   i) Bound moisture ii) Unbound moisture
   iii) Equilibrium moisture iv) Free moisture

b) Discuss in detail the rate of drying curve under constant drying conditions. 7

**OR**

12. a) The moist air at 310° k has a wet bulb temperature of 300° k. If the latent heat of vaporization of water at 300° k. is 2440 kJ/kg. 7
The total pressure is $5kN/m^2$ and the vapour pressure of water vapour at 300° k is $3.6\,kN/m^2$ and $6.33\,kN/m^2$ at 310° k. Calculate the following :-
   i) Humidity of air. ii) Percentage humidity of air.
   iii) Vapour pressure of water vapour.

b) Discuss the natural draught cooling towers with the help of schematic diagram. 6

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