

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

(Model Question)

(2013 scheme)

13.601 MASS TRANSFER OPERATIONS I

Maximum-100 marks

Time 3 hours

Part A

*Answer **all** questions. Each question carries 2 marks.*

- 1) Write Fick's law of diffusion and explain the terms.
- 2) State Colburn analogy between heat, mass and momentum transfer and define the dimensionless groups involved
- 3) Write the significance of absorption and stripping factor
- 4) Define wet bulb depression and how it is related to psychrometric ratio
- 5) Distinguish between humidification and dehumidification
- 6) Define absolute humidity and dew point.
- 7) List the factors which affect the zone of unsaturated drying
- 8) Explain $\frac{r}{L}$ law of crystal growth
- 9) Describe Meir's super saturation theory
- 10) Distinguish between bound and unbound moisture. (10 x2 = 20 marks)

Part B

*Answer **one full** question from each module. Each question carries 20 marks*

Module-1

- 11) a) derive the equation to calculate the molar flux under steady state diffusion through a stagnant gas
- b) Describe the salient features of the penetration theory of mass transfer.

OR

12) Chloroform vapor is diffusing from the surface of the liquid contained in a capillary in to ambient air at 298K and 101.3kPa. The diffusivity of chloroform in air at this condition is $9.5 \times 10^{-6} \text{m}^2/\text{s}$. The vapor pressure of chloroform at 298K is 30Kpa. If the length of diffusion path is 70mm from the surface of the liquid, estimate the rate of steady state diffusion in $\text{Kmol}/\text{m}^2\text{s}$. Also estimate the mole fraction of chloroform halfway along the length of the diffusion path.

Module-II

- 13) a. Compare packed c columns versus plate columns for gas absorption
b. Derive kremser equation and describe its applications

OR

14) It is decide to absorb 95% of acetone from an acetone air mixture containing 2 percent (mole) acetone in a counter current packed tower. The gas flow rate is 4000 Kg/hm^2 pure water is used the solvent at a rate of 7000 Kg/hm^2 . The equilibrium solubility of acetone in water is given by $y^* = 2.53 x$ where x and y are the mole fractions of acetone in the liquid and gas phases respectively. The heights of individual transfer units are 0.32 m and 0.53 m respectively for the liquid phases. Assume dilute solutions and calculate the height of the tower

Module-III

- 15) Describe with a neat s sketch the types of cooling towers used in process industries.
(b) Derive Lewis relation and explain its significance

OR

16) Air at a temperature of 30°C and a pressure of 100KPa has a relative humidity of 80%.

- a) Calculate the molar humidity of air
b) Calculate molar humidity of air if its is reduced to 15°C and its pressure is increased to 200KPa, condensing out some water
c) Calculate the weight of water condensed from 100m³ of original wet air in cooling to 15°C and compressing to 200KPa.

Module-IV

17) It takes 9 hours for a porous solid to reduce the moisture content from 45 to 10% when dried in a batch dryer under constant drying conditions. The critical moisture content was found to be 25% and the equilibrium moisture 3%. All moisture contents are on dry basis. Assuming that the rate of drying during the falling rate period is proportional to the free moisture content, how long should it take to dry a sample of the same solid from 35 to 5% under the same drying conditions

OR

18. a) Explain R-L law of crystal growth

b) 200Kg of 15% and 100Kg of 5% solution of Na_2SO_4 by weight are mixed in crystallizer and crystallization takes place. If 50Kg of $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ crystals are formed compute the composition of mother liquor