Total No. of Questions : 10]

SEAT No. :

P2902

[Total No. of Pages : 4

[4958]-1095
T.E. (Chemical Engg.)
MASS TRANSFER - I
(2012 Course) (Semester - I)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Neat diagrams must be drawn wherever necessary.***
2) ***Figures to the right indicate full marks.***
3) ***Use of logarithmic tables slide rule, Mollier charts, electronic pocket Calculator and steam tables is allowed.***
4) ***Assume suitable data, if necessary.***

Q1) a) A gas mixture containing one fifth hydrogen and four fifth methane by volume is prepared, through which oxygen is allowed to diffuse. The total pressure is 1×10^5 N/m^2 and temperature is 2°C. Estimate the rate of diffusion of oxygen through a film of gas mixture, 3 mm thick when the concentration change across the film is 12 to 7% by volume. The diffusivity are, $D_{O2\text{-}H2} = 7.1\times10^{-5}$ m^2/sec. $D_{O2\text{-}CH2}=1.88\times10^{-5}$ m^2/sec. **[5]**

b) State Fick's First law of diffusion. Derive an expression for steady state equimolar counter current Diffusion. **[5]**

OR

Q2) a) Ammonia gas is diffusing through a layer of stagnant air, 2.5mm thick at constant rate. Conditions are fixed so that gas contains 50% ammonia by volume a one boundary of stagnant layer. Ammonia is quickly absorbed on other side and its concentration is negligible at that plane. The temperature is 20°C and pressure is atmospheric. The diffusivity for ammonia-air system is 0.18 cm^2/sec. Calculate the rate of diffusion of ammonia through air in gm. mole/hr.cm^2 **[5]**

b) Write short note on Chilton-Colburn Analogy and Reynolds Analogy. **[5]**

P.T.O.

Q3) a) Define absorption factor and stripping factor. **[2]**

b) Ammonia is absorbed by water in wetted wall column using operating temperature of 20°C and 1 atm pressure. The overall coefficient is 2.72×10^{-4} kmol/m^2 atm. At one point in the column the gas contained 10mol% ammonia and the liquid phase concentration was 6.42×10^{-2} kmol ammonia per m^3 of solution. Temperature is 20°C and 1 atm pressure. 85% of the resistance to mass transfer lies in a gas phase. If Henry's law constant is 9.35×10^{-3} atm m^3/kmol, calculate the individual film coefficient and the interfacial composition. **[8]**

OR

Q4) A mixture of Acetone vapor and air contain 5% by volume of acetone is to be freed from acetone content by scrubbing it with water in a absorption column. The flow rate of gas mixture is 700 m^3/hr of acetone free air measured at NTP and that of water is 1500 kg/ hr. the absorber operates at an average temperature of 20°C and a pressure of 101 KPa. The scrubber absorbs 98% acetone. The equilibrium relation for the acetone-water system is Y* = 1.68 X, where Y = Kmol of acetone/kmol of dry air, X=Kmol of acetone/kmol of water, calculate

a) mean driving force for absorption,

b) mass transfer area if overall mass transfer coefficient is K_G = 0.4 kmol of acetone/m^2. hr **[10]**

Q5) a) 30000 m^3 of gas at 298°K and 101.3 kN/m^2 saturated with water vapor is compressed to 340 kN/m^2, cooled to 289°K and condensed water is drained off. Subsequently the pressure is reduced to 170 kN/m^2 and the gas is distributed at this pressure and temp. What is % humidity. The vapor pressure of water at 289°K is 1.8 kN/m^2. **[8]**

b) Define:

i) adiabatic saturation temperature,

ii) enthalpy,

iii) humid heat,

iv) humid volume. **[4]**

c) What are different types of cooling tower? Discuss spray chamber in brief. **[4]**

OR

Q6) a) Acetone is evaporated in to a steam of nitrogen gas and this mixture of acetone vapor and nitrogen flows through a duct of cross section $0.08m^2$. The pressure and dry bulb temperature at one point in the duct are 800mms. Hg and 45°C. At this point the average velocity is 4 m/s, the wet bulb temperature is 28°C. Calculate the mass flow rate of acetone vapor carried by duct. The data given: latent heat of vaporization for acetone = 403000 J/kg, h_G/K_y = 1700 J/kg°K, vapor pressure of acetone = 50mms. Hg. **[8]**

b) Define wet bulb temperature and psychometric ratio. Derive an expression relating wet bulb temp with absolute humidity and psychometric ratio. **[8]**

Q7) a) Define

i) Murphree tray efficiency,

ii) Overall tray efficiency,

iii) Coning,

iv) Weeping. **[8]**

b) What are different types of trays used in column? Explain working of any one. **[4]**

c) Explain the end effects of axial mixing. **[4]**

OR

Q8) a) With neat sketch explain

i) Wetted Wall Column,

ii) Mechanically Agitated Vessels **[8]**

b) Compare packed and plate columns. **[6]**

c) What is pressure drop in column? Brief about positive and negative effects of pressure drop. **[2]**

Q9) a) Under constant drying conditions, a wet solid is dried from 30% to 4%. The time taken is 4 hours. All are on dry basis. The equilibrium moisture content is 2%. Critical moisture content is 10%. How long it takes to dry to 7%? Assume falling rate period is linear. **[10]**

b) Give classification of drying equipments and working of fluidized bed dryer. **[6]**

c) What are the factors affecting the rate of drying? **[2]**

OR

Q10)a) Data on drying rate curve of a particular solid is given below. The weight of the dry material in the solid is 48 kg/m^2. Calculate the time required to dry the material from 25% to 8% moisture (dry basis) **[10]**

kg/kg dry solid (X)	0.30	0.20	0.18	0.15	0.14	0.11	0.07	0.05
kg/hr.m^2 (N)	1.22	1.22	1.14	0.90	0.80	0.56	0.22	0.05

b) Explain rate of drying curve with neat sketch. **[6]**

c) What are the uses of drying operation? **[2]**

x x x