Registration No. :

Total number of printed pages – 2

Fifth Semester Examination – 2013

MASS TRANSFER – I

BRANCH : CHEM

QUESTION CODE : C-387

Full Marks – 70

Time : 3 Hours

*Answer Question No. 1 which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

Assume suitable notations and any missing data wherever necessary.

Use of Humidity Chart is permitted.

1. Answer the following questions : 2×10
    (a) Write the Gilliland's equation and explain each terms used in it. Mention its importance.
    (b) Write and explain Lewis equation.
    (c) Define mass transfer coefficient. Mention its SI units.
    (d) With a suitable plot, discuss the effect of pressure on Txy and xy diagram.
    (e) What do you understand by separation factor ? Mention its values for a greater separation.
    (f) What is minimum reflux ratio ? Mention its importance.
    (g) Mention some essential characteristics of a good adsorbent.
    (h) Discuss about HETP.
    (i) Differentiate between tray efficiency and murphree efficiency.
    (j) How adiabatic saturation temperature is different from adiabatic flame temperature ?

2. (a) Discuss about Taylor-Prandtl modification of Reynolds analogy. 7
    (b) In an oxygen-nitrogen mixture at 12 atm and 20°C, the concentrations of oxygen at two places of 0.3 cm apart are 12 and 24 volume per cent respectively. Calculate the rate of diffusion of oxygen expressed as gm/cm^2.hr for the case of unicomponent diffusion (nitrogen is non-diffusing). Value of diffusivity is 0.18 cm^2/s. 3

3. (a) Discuss, in detail, about positive deviations from ideality. 5
   (b) For a multicomponent distillation system, derive the expressions for equilibrium bubble-point vapour composition and equilibrium dew-point liquid composition. 5

4. A mixture of 30 mole % P and 70 mole % R is to be separated in a distillation column. The concentration of P in the distillate is 90 mole % and 95 % of all product P is in the distillate. The feed is half vapour and the reflux ratio is 4.2. The relative volatility of P to R is 2.1. Calculate the number of theoretical plates in the column and locate the feed plate. 10

5. An ammonia-air mixture containing 2 % by volume ammonia, is to be scrubbed with water at 20°C in a tower packed with 1.3 cm Raschig rings. The water and gas rates are 1200 kg/hr.m² each, based on empty tower cross section. Estimate the height of the tower required if 95 % of the ammonia in the entering gas is to be absorbed. The tower operates at 1 atm pressure. The equilibrium relationship is given by :

   $$y_e = 0.75x$$

   where, y_e = mole fraction of ammonia in air and x = mole fraction of ammonia in solution with water. The height of the transfer unit may be taken as equal to 2 m. 10

6. Fresh air at 20°C in which partial pressure of water vapour is 0.012 atm is blown at the rate of 215 m³/hr first through a pre-heater and then adiabatically saturated in a spray chamber to 100 % saturation and again reheated. This reheated air has a humidity of 0.026 kg water vapour per kg dry air. It is assumed that the fresh air and the air leaving the reheater have the same % humidity. Calculate :
   (i) the temperature of pre-heater, spray chamber, and reheater
   (ii) heat requirements for pre-heating and reheating. 10

7. (a) Describe, in brief, about Ponchon-Savarit method. 5
   (b) Describe the construction and operation of a spray tower with a neat diagram. 5

8. Write short notes on any **two** : 5×2
   (a) Two-film theory
   (b) Optimum reflux ratio
   (c) Minimum irrigation rate
   (d) Sling psychrometer.