GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Fourth Semester – Regular) Examinations, June – 2021

BPCCH4030 / BPCPR4030 – Mass Transfer – I

(Common to Chemical Engg. & PRE)

Time: 3 hrs   Maximum: 50 Marks

Answer ALL Questions
The figures in the right hand margin indicate marks.

PART – A: (Multiple Choice Questions)   **(1 x 10 = 10 Marks)**

Q.1. Answer *ALL* questions   [CO#]   [PO#]

a. The diffusivity (D) in a binary gas mixture is related to the pressure (P) as   CO1   PO1
   (i) $D \propto (P^{0.5})$ (ii) $D \propto (1/P^{0.5})$
   (iii) $D \propto (1/P)$ (iv) $D \propto (1/P^{1.5})$

b. Molecular diffusivity of a liquid   CO3   PO3
   (i) Increases with temperature   (ii) Decreases with temperature
   (iii) Increase or decrease with temperature   (iv) Is independent of temperature

c. Mass transfer co-efficient (K) and diffusivity (D) are related according to film theory as
   (i) $K \propto D$ (ii) $K \propto \sqrt{D}$
   (iii) $K \propto D^{1.5}$ (iv) $K \propto D^{2}$

d. In batch distillation with constant reflux, overhead product composition _____   CO2   PO2
   with time
   (i) Increases   (ii) Decreases
   (iii) does not vary   (iv) may increase or decrease, depends on
                                                   the system

e. In distillation columns, the number of bubble caps per tray primarily depends upon the   CO4   PO1
   (i) Allowable liquid velocity   (ii) Allowable gas velocity
   (iii) Allowable gas and liquid velocities (iv) Feed composition

f. Match the following   CO3   PO1
   1) Hendry's law – a) Ideal solution
   2) Dalton's law – b) Non- Ideal solution
   3) Raoult's law – c) Sum of partial pressure
   (i) 1-(a), 2-(c), 3-(b)   (ii) 1-(a), 2-(b), 3-(c)
   (iii) 1-(c), 2-(b), 3-(a)   (iv) 1- (b), 2-(c), 3-(a)

g. For the Absorber design, the plotting with mole ratio helps to find the   CO4   PO1
   (i) Slope of operating line   (ii) Slope of equilibrium curve
   (iii) Minimum number of trays   (iv) Maximum number of trays

h. Find the rate of non-diffusing solute, if the mole fraction of the gas phase is 0.75 and the   CO1   PO2
   diffusing rate is 80 moles/hr.
   (i) 22 moles/hr   (ii) 24 moles/hr
   (iii) 18.18 moles/hr   (iv) 20 moles/hr

i. Thermometer measurement temperature is   CO2   PO1
   (i) Dry bulb temperature   (ii) Wet bulb temperature
   (iii) Dew point temperature   (iv) Room temperature

j. For an air(A)-water vapour(B) mixture, the partial pressure of the air is 7 pa and the total CO3 PO2
pressure of the system is 17 pa. The molal absolute humidity is

  (i) 0.7   (ii) 1

  (iii) 1.5   (iv) 2

PART – B: (Short Answer Questions)   (2 x 5 = 10 Marks)

Q.2. Answer *ALL* questions   [CO#]   [PO#]

a. State Ficks' law of diffusion and write its salient features?   CO1   PO1

b. What factors should be consider while selecting solvent for gas absorption?   CO2   PO3

c. What happens if a column heated by open steam is operated at total reflux for a long time?   CO4   PO1

d. For distillation of an equimolar binary mixture of A and B, the equations of the operating lines CO2   PO2
are: Rectifying section: y = 0.663 x + 0.32; stripping section: y = 1.329 x – 0.01317. What is
the condition of the feed?

e. Name a few industries that have a large cooling load   CO3   PO3

PART – C: (Long Answer Questions)   (6 x 5 = 30 Marks)

Answer *ANY FIVE* questions   Marks   [CO#]   [PO#]

3. Describe the Stefan tube experiment for estimation of diffusivity   (6)   CO1   PO3

4. Water is evaporating from the placid surface of a lake and the vapour (A) diffuses   (6)   CO4   PO1
through a stagnant film of air (B) of estimated thickness of 3 mm. The water
temperature is 23^OC and the air temperature is 27^OC. The relative humidity of air us
65%. If the diffusivity of water vapour through air is 0.257 cm^2/s at 23^OC and 0.262
cm^2/s at 27^OC, calculate the rate of evaporation. The vapour pressure of water p_v (in
bar) can be calculated using the Antoine equation **ln p_v = 13.8573 - 5160.2/T**, where T
is the temperature in K.

5. Compare gas absorption and distillation   (6)   CO3   PO2

6. 1000 m^3/h of a gas mixture containing 10 mole% solute and rest inert enters an absorber   (6)   CO2   PO1
at 300 K temperature and 106.658 kPa pressure. 90% of the original solute is removed.
Solute-free water used for absorption contains 5 mole% solute when it leaves the
absorber from the bottom. Calculate the solvent flow rate to the absorber.

7. A fractionating column is designed to separate 15000 kg/h of feed containing 60%   (6)   CO1   PO1
toluene and 40% benzene into an overhead product containing 97% benzene and a
waste containing 98% toluene. All % are by weight. Calculate the weights of the
product and waste product per hour.

8. A steam of air (dry bulb temperature = 70^OC; wet bulb temperature = 60^OC) is   (6)   CO2   PO2
dehumidified and cooled in contact with water entering at 26^OC. The outlet air is
essentially at thermal equilibrium with the water. Calculate the wet-bulb temperature of
the outlet air and the moisture removed per kg of dry air.

9. Why does the internal passage for moist air in a crossflow induced draft tower have a   (6)   CO2   PO3
V-shape? Why does such a tower need less fan power than counter flow one for the
same air rate?

10. Derive the equation for overall mass transfer coefficient.   (6)   CO1   PO2

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