[3 Hours] **[Total Marks: 80]**

Instructions to the candidates if any: -

1. Question No 1 is compulsory
2. Attempt any three questions from the remaining five questions
3. Assume suitable data wherever necessary
4. The figures to the right indicate full marks

Q. No. 1

a. Derive the relation between K-type and F-type mass transfer coefficients when liquid A diffuses in stagnant liquid B, and the driving force is the mole fraction difference. [05]

b. Write a short note on diffusion through porous solids [05]

c. A wet solid is containing 78 % moisture and it is dried to reduce the moisture content to 18 %. Calculate the moisture removed per 1000 kg of the dried product [05]

d. Discuss the requirements for a solvent that can be used in gas absorption [05]

Q. No. 2

a. Derive the equation for the area for mass transfer for radial diffusion through a sphere. [08]

b. An open circular tank $10\,m$ in diameter contains benzene at $22^{O}C$ exposed to the atmosphere in such a manner that the liquid is covered with a stagnant air film estimated to be 7 mm thick. The concentration of benzene beyond stagnant film is negligible. The vapor pressure of benzene at $22^{O}C$ is 100 $mm\ of\ Hg$. If benzene is worth ` 44 per liter, what is the value of loss of benzene from this tank in ` per day? The diffusion coefficient of benzene in the air at the prevailing conditions is 277.7 cm^2/hr and the density of benzene at $22^{O}C$ is 0.88 g/ml. [12]

Q. No. 3

a. Discuss the mechanism of interphase mass transfer and derive the relation between overall and individual mass transfer coefficients. [15]

b. State and explain Raoult's law. [05]

Q. No. 4

a. Discuss the following- [08]

1. Drying curve
2. The typical rate of drying curve.

b. A batch of solid for which the following table applies is to be dried from 28 wt % to 9 wt % on a wet basis. The drying is carried out under conditions that are identical to those for which the data was generated. The initial weight of the wet solid is 320 kg and the drying surface is 1 $m^2/10\ kg\ dry\ solid$. Determine the total time of drying.

X	0.35	0.25	0.2	0.18	0.16	0.14	0.12	0.10	0.09	0.08	0.064
N	0.3	0.3	0.3	0.266	0.239	0.208	0.180	0.15	0.097	0.07	0.025

In this table-

X is $kg\ moisture/kg\ dry\ solid$

N is $kg\ moisture\ evaporated/(m^2)(hr)$ [12]

Q. No. 5

a. Discuss different types of cooling towers [08]

b. A gas mixture is contacted with a hydrocarbon oil for a sufficiently long time so that there is equilibrium between them. The equilibrium is achieved at a temperature of 24^OC and pressure of $1 \times 10^5\ N/m^2$. At equilibrium, the gas mixture contains 60 % methane, 20 % ethane, 8 % propane, 6 % n-butane, and 6 % n-pentane. All the compositions are in $mole$ %. Calculate the composition of the liquid solution at equilibrium. The vapor pressures of the components at 24^OC are given in the following table. [12]

Component	Vapor pressure $[N/m^2]$
Methane	Insoluble
Ethane	42.05×10^5
Propane	8.96×10^5
n-Butane	2.36×10^5
n-Pentane	0.66×10^5

Q. No. 6

Write short notes on the following (Any four)- (20)

a. Penetration theory for mass transfer in a turbulent flow.
b. Minimum liquid to gas ratio in gas-absorption
c. Fick's first law of molecular diffusion
d. Ideal liquid solutions
e. Psychrometric charts

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