

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER-V (NEW) EXAMINATION – WINTER 2020****Subject Code:2150501****Date:22/01/2021****Subject Name:Mass Transfer Operation - I****Time:10:30 AM TO 12:30 PM****Total Marks: 56****Instructions:**

1. Attempt any FOUR questions out of EIGHT questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

	MARKS
Q.1 (a) Define: Coning, Stripping factor, Decoction	03
(b) State and explain Fick's Law. Also discuss about N flux and J flux.	04
(c) Explain steady state diffusion in fluid at rest and solve numerical given below: Two large vessels are connected by a tube 5 cm in diameter and 15 cm in length. Vessel 1 contains 80 % N ₂ and 20 % O ₂ and vessel 2 contains 20 % N ₂ and 80 % O ₂ . The temperature is 20 °C and total pressure is 2 atm. Calculate steady state flux and rate of transport of N ₂ from vessel 1 to vessel 2. Also find same quantities for O ₂ . Also calculate total mass flux. Diffusivity is given as 0.23 cm ² /s at 1 atm and 316 K.	07
Q.2 (a) Explain the roles of packing restrainer, entrainment eliminator and packing support as packed column internals.	03
(b) Derive the equation for flux for steady state diffusion of A through non-diffusing B for gas as well as liquid.	04
(c) Discuss classification of mass transfer operation in detail.	07
Q.3 (a) Cite few industrial examples of liquid-liquid extraction with appropriate solvent. Discuss selectivity as selection parameter for solvent and for single stage, find distribution coefficient if feed, pure solvent and extract amounts are 400, 300 and 500 kg respectively. Feed and extract has 45% and 30 % solute respectively.	03
(b) Write a brief note on penetration theory.	04
(c) Explain the fundamental of minimum liquid to gas ratio for absorber and discuss the criteria for solvent selection in the absorber.	07
Q.4 (a) Define nucleation and explain primary and secondary nucleation with respect to crystallization.	03
(b) Classify Gas- Liquid Equipments and explain any one in brief.	04

- (c) Benzene is to be recovered from coal gas by scrubbing it with wash oil as an absorbent. 855 m³ of coal containing 2 % by volume of benzene are to be handled per hour and 95 % removal is required. The operating condition is 299.7 K temperature and 106.658 kPa pressure. The wash oil has an average molecular weight of 260 and contains 0.005 mole fraction benzene as it enters the absorber. Calculate minimum oil circulation rate. Calculate absorption factor if actual oil rate is 1.5 times of minimum rate. Comment on the value of absorption factor. Equilibrium relation is given by

$$\frac{Y}{1+Y} = 0.125 \frac{X}{1+X}$$

Y= moles of benzene/moles of dry coal gas and X= moles of benzene/moles benzene free gas oil.

- Q.5** (a) Define absorption factor and also write its significance. **03**
 (b) What is mass transfer coefficient? Define F-type and k-type mass transfer coefficients. Also derive the relationship for steady state equimolar counter diffusion between F and k type coefficients. **04**
 (c) List various continuous contact liquid extractors. With sketch, explain Rotating Disk Contactor. **07**
- Q.6** (a) Explain Molecular and Eddy diffusion at length. **03**
 (b) Discuss about Meir's super saturation theory. **04**
 (c) 1000 kg of aqueous solution contains 65 % water and remaining Trimethyl Amine (TMA) is to be extracted using Benzene as a solvent. A 3-stage cross current extraction scheme is suggested for the separation. The amount of solvent (98 % Benzene and 2% TMA) to be used in successive stages are 815 kg, 950 kg, 2625 kg. Determine fraction of solute removed if the stages are idea stages. **07**

Water rich phase	x _B	0.004	0.006	0.01	0.02	0.03	0.036	0.07	0.13
	x _C	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40

Benzene rich phase	y _B	0.95	0.90	0.84	0.78	0.71	0.63	0.50	0.26
	y _C	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40

x _c	0.04	0.083	0.13	0.215	0.395
y _c	0.035	0.068	0.09	0.145	0.31

- Q.7** (a) Explain the fundamental of equilibrium by stating proper example. **03**
 (b) Give list of various types of crystallizer and brief about any one. **04**
 (c) Compare tray tower with packed tower. Also list and draw few packings used in industries. **07**
- Q.8** (a) Explain stage and cascade. Discuss briefly about cross flow and counter current cascades. **03**
 (b) Carry out material balance for single stage leaching operation and derive equations for the same. **04**
 (c) Discuss one pair partially soluble system for liquid- liquid extraction and also brief about the effect of temperature and pressure. **07**
