

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-V (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2150501

Date: 05/05/2017

Subject Name: Mass Transfer Operation - I

Time: 02:30 PM to 05:00 PM

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1 Short Questions 14**
- 1 Name methods of conducting mass transfer operations.
 - 2 Define molecular diffusion.
 - 3 Specify the order and unit of diffusivity of gases and liquids.
 - 4 Name theories of mass transfer coefficients.
 - 5 What is the difference between N_i and J_i ?
 - 6 Relate k_x and k_y for gas-phase controlled interphase mass transfer.
 - 7 What is the driving force of mass transfer within a phase and at interphase?
 - 8 What is weir and down comer?
 - 9 Name types of packings used in packed tower.
 - 10 Define absorption factor.
 - 11 Define selectivity of solvent used in liquid extraction.
 - 12 How to prepare solids for leaching?
 - 13 Define Tray efficiency.
 - 14 Define nucleation and growth of crystals.
- Q.2 (a) Define F and k-type mass transfer coefficients and mention their units. 03**
(b) Classify mass transfer operations with examples. 04
(c) Differentiate between direct and indirect mass transfer operations with examples. 07
- OR**
- (c) Starting from Fick's first law of diffusion for unidirectional binary gas phase, derive the equation to calculate N_A for steady state molecular diffusion of A through non-diffusing B. 07**
- Q.3 (a) What is minimum liquid – gas ratio in case of gas absorption? 03**
(b) Name the equipments used for gas – liquid operations and write a short note on any one of them. 04
(c) Explain any one theory of explaining meaning of mass transfer coefficients. 07
- OR**
- Q.3 (a) Explain the effect of temperature, pressure etc. on diffusivity of gases and liquids. 03**
(b) Explain Swenson-Walker crystallizer with neat sketch. 04
(c) Explain “two-resistance theory” for overall mass transfer coefficient in case of interphase mass transfer. 07
- Q.4 (a) Define: (i) Weeping (ii) Dumping (iii) Flooding 03**
(b) Explain Shanks system in leaching. 04
(c) State the selection criteria between Tray tower and Packed tower and also differentiate between them. 07

OR

- Q.4** (a) Explain Equilateral Triangular Co-ordinates in liquid extraction. **03**
 (b) Explain briefly the system of three liquids with one pair partially soluble in case of liquid extraction. **04**
 (c) A solution of nicotine in water containing 1% nicotine is to be extracted with kerosene at 20 K. Water and kerosene is essentially insoluble. The equilibrium relation is $y' = 0.9 x$, where y' and x' are mole ratio. **07**
 1) Determine the % extraction of nicotine if 100 kg of feed solution is extracted with 150 kg solvent.
 2) Repeat for three theoretical stages using 50 kg solvent each
- Q.5** (a) Outline the industrial applications of leaching. **03**
 (b) A hot solution containing 2000kg of MgSO_4 and water at 57°C and with a concentration of 30 weight% MgSO_4 is cooled to 30°C and $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ crystals are removed. The solubility at 30°C is 35.5 kg MgSO_4 per 100 kg water. Calculate the yield of crystals. Assume that no water is vaporized. Atomic weight: Mg=24, S=32, O=16, H=1 **04**
 (c) Explain selection criteria for choice of solvent in case of gas absorption. **07**
- OR**
- Q.5** (a) Name equipments used in leaching. **03**
 (b) Explain Meir's super saturation theory of crystallization with neat sketch. **04**
 (c) A packed tower is to be designed to absorb sulfur dioxide from air by scrubbing the gas with water. The entering gas is 18.6% SO_2 by volume. The water flow is to be 2.3 times the minimum. The air flow rate (SO_2 free basis) is $1100 \text{ m}^3/\text{hr}$. The temperature is 30°C and the total pressure is 2 atm. The equilibrium data is governed by $y=21.8x$ where y and x are in mole fractions units. 95% solute removal is necessary. Compute the number of overall gas phase transfer units. **07**
