मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज–211004 भारत

Motilal Nehru National Institute of Technology Allahabad
Prayagraj-211004 [India]

End Semester Examination 2023-24

Programme Name: B.Tech. Semester: Even

Course Code: CH14107 Course Name: Mass Transfer-I

Branch: Chemical Engineering Student Reg. No.: 2 0 2 2 2 0 6 8

Duration: 1hr 30 minutes (01/03/2024) Max. Marks: 20

Instructions: (Related to Questions)

1. *Figures to the right indicate the full marks.*
2. *Attempt all the Questions and question no 1 should be tried on page 1.*

			Marks	CO
Q 1	a.	What is flux? How different types of fluxes are related with average velocities?	2	
	b.	Explain the diffusion phenomena in porous solids	2	
	c.	Equimolar counter-diffusion of A and B occurs between points 1 (y_{A1}=0.3) and 2 (y_{A2}=0.1) through a distance of 1 cm. Total pressure is 1 atm, temperature is 25^{0}C and diffusivity is 0.2 cm^2/s. What is the "*diffusion velocity*" of "A" halfway in the diffusion path?	4	CO-1
Q 2	a.	Differentiate between the penetration theory and surface renewal theory for inter-phase mass transfer and in both the cases, how mass transfer coefficient, k_c varies with the Diffusivity, D_{AB}?	2	
	b.	Differentiate between the Murphee's tray and point efficiencies with the proper expression for gas-liquid absorption tower.	2	
	c.	Write the possible vapor-liquid flow regimes contacting on a tray and compare the sieve and valve trays with respect to efficiency and pressure drop	2	CO-2
	d.	Write the physical significance of HTU and NTU. In which conditions, HETP will be equal to HTU?	2	
	e.	Sulfur dioxide is absorbed from air into water in a packed absorption column. At a certain location in the column, the mass transfer flux is 0.026 kmol/m^2.h and the liquid phase mole fractions are found to be 0.0025 at two phase interface and 0.0004 in the bulk liquid. If the diffusivity of SO_2 in water is 1.75 x 10^{-5} cm^2/s, determine the mass transfer coefficient, k_c and the film thickness.	4	

**********Best of Luck**********

मोतीलाल नेहरू राष्ट्रीय प्रौद्योगिकी संस्थान इलाहाबाद
प्रयागराज–211004 भारत

Motilal Nehru National Institute of Technology Allahabad
Prayagraj-211004 [India]

End Semester Examination 2023-24

Programme Name: B. Tech. Semester: (IV) Even
Course Code: CHN14107 Course Name: Mass Transfer-I
Branch: Chemical Engineering Student Reg. No.: 2 0 2 2 2 0 6 8
Duration: 2hr 30 minutes (14/05/2024) Max. Marks: 40

Instructions: (Related to Questions)

1. *Figures to the right indicate the full marks.*
2. *Attempt all the Questions and question no 1 should be tried on page 1.*

Q1. **Attempt this question on the initial pages only.** 10 x 1

i. How molecular diffusivity will depend on temperature and viscosity? CO-1 and CO -2

ii. Express the molecular, thermal and momentum diffusivities.

iii. In case of molecular diffusion, correlate the mass transfer coefficient with diffusivity.

iv. In the mass transfer from a gas into a falling liquid film having thickness, δ, what is the value of concentration gradient at $z = \delta$.

v. Write the relation to determine the flux of component *A* using penetration theory.

vi. In the mass transfer of component *A* from gas into a liquid, show the concentration gradient graph using two-resistance concept.

vii Write down the any five dimensionless numbers used in mass transfer?

viii. Write down the any four industrial equipment used for absorption and stripping?

ix. Write the expression for absorption factor and stripping factor.

x. Differentiate between point and tray efficiency.

Q2. A gas flows at the rate of15 kmol/s at 298 K and 1 atm with a H_2S content of 0.10 mol%. Ninety five percent of the hydrogen sulfide is to be removed by absorption with a pure liquid at 298 K. The design liquid flow rate will be 40% higher than the minimum. Under these conditions, The equilibrium line is Y = 10X/(1- 9X) based on solute free basis. **10** **CO-2**

(a) Calculate the operating flow rate of the liquid and the H_2S concentration in the liquid leaving the absorber

(b) Calculate the number of ideal stages required for the specified flow rates and $\%H_2S$ removal.

Q3. a Define the wet bulb temperature (T_w) of the humid air with the proper schematic of gradients. Explain the Psychrometric lines and Lewis relation 6 CO

b A mixture of nitrogen and acetone vapor at 800 mmHg total pressure and saturation pressure 230 at 25°C, has a percentage humidity of 80%. Calculate: 4

i. absolute molal humidity
ii. absolute humidity
iii. partial pressure of acetone
iv. relative humidity

Q4. a A slab with a wet weight of 5 kg originally contains 50% moisture (wet basis). The slab is 600x900x75 (thick) mm. The equilibrium moisture content is 5% of the total weight when in contact with the air of 20 oC and 20 percent humidity. The drying rate is given below for contact with air of above quality at a definite velocity. Drying is from one face. How long will it take to dry the slab to 10 percent moisture content (wet basis)? 6 CO

Wet slab weight, kg	7.2	5.3	4.2	3.3	2.9	2.7
Drying rate, kg/m2.h	4.9	4.4	3.9	3.4	2.0	1.0

b Define the supersaturation in crystallization process. Differentiate between the primary and secondary nucleation. 4

**********Best of Luck**********