1T00535 - T.E.(Chemical Engineering)(SEM-V)(Choice Base Credit Grading System) (R-20-21) (C Scheme) / 31721 - Mass Transfer Operations -I

QP CODE: 10013829 DATE: 22/11/2022

[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 for the case of gas A diffusing in non-diffusing gas B when driving force is mole fraction difference. [05]

b. Discuss the mechanism of diffusion through porous solids [05]

c. A wet solid is containing 76 % moisture and it is dried to reduce the moisture content to 18 %. Calculate the moisture removed per 950 kg of the dried product [05]

d. 1250 $kmole/hr$ of a gas mixture containing 4 $volume$ % of solute is contacted with 5000 $kmole/hr$ of pure water in a counter-current absorption operation. What is the slope of the operating line? [05]

Q. No. 2

a. Derive an equation for the steady state molar flux for molecular diffusion of gas A in a non-diffusing gas B [08]

b. Ethanol is diffusing through a stagnant water film of thickness 2 mm at 293 K. The concentrations of ethanol at the two ends of the film are 16.8 wt % and 6.8 wt %, respectively. The diffusion coefficient of ethanol in water at 293 K is $0.740 \times 10^{-9}\ m^2/s$. Find the rate of diffusion of ethanol in $kmole/m^2s$. The densities of 16.8 wt % and 6.8 wt % ethanol solution are 972.8 kg/m^3 and 988.1 kg/m^3 respectively [12]

Q. No. 3

a. For the interphase transfer across the interface between gas and liquid phases, obtain a relation between individual and overall mass transfer coefficients. Also, discuss the following.

i. The case when gas phase resistance is the controlling resistance

ii. The case when liquid phase resistance is the controlling resistance [12]

b. Considering various aspects, compare tray towers with packed towers [08]

Q. No. 4

a. Discuss the criteria for selecting a solvent for gas absorption [08]

b. Light oil vapors (benzene) present in a coal gas are to be removed by scrubbing it with a wash oil in a counter-current absorption column. The gas is entering at a rate of $0.3\ m^3/s$ at 26^OC and $1.07 \times 10^5\ N/m^2$ pressure. The entering gas contains 1.5 % by volume of the light oil vapors. The wash oil used is a recovered solvent and it contains a 0.0025-mole fraction of the light oil and has an average molecular weight of 260. Calculate the wash oil rate if it is equal to 1.5 times the minimum liquid rate and when 95 % removal of the solute is required. At 26^OC, the vapor pressure of benzene is $13330\ N/m^2$. The gas mixture and the liquid solution may be assumed to be ideal [12]

Q. No. 5

a. Derive the relation between mass absolute and molal absolute humidity [05]

b. $220\ kg$ of wet solid is to be dried from an initial moisture content of 28 % to a final moisture content of 4 %. Drying tests show that the rate of drying is constant at $3 \times 10^{-4}\ kg/m^2s$ in the region $0.2 - 0.4 \frac{kg\ water}{kg\ solid}$. The drying rate falls linearly in the range of $0.01 - 0.2 \frac{kg\ water}{kg\ solid}$. If the equilibrium moisture content is $0.01 \frac{kg\ water}{kg\ solid}$, calculate the time of drying. The drying surface is $\frac{1\ m^2}{40\ kg\ dry\ solid}$ [10]

c. Write a short note on the wetted wall column [05]

Q. No. 6

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

a. Diffusion through polymers

b. The minimum liquid-to-gas ratio in gas absorption

c. Various types of moisture contents

d. Types of packings used in a packed tower

e. Humid heat and humid volume

*****