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SE-8252

B. E. - III (Sem. V) Examination

May / June – 2011

Mass Transfer Operation - I

(New Syllabus)

Time : **3** Hours] [Total Marks : **50**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. - 3 (Sem. 5)**

Name of the Subject :

☛ **Mass Transfer Operation - 1 (New)**

☛ Subject Code No. : **8 2 5 2** ☛ Section No. (1, 2,.....) : **Nil**

Seat No. :

Student's Signature

(2) Use of scientific calculator Casio Fx 82, Fx 83, Fx 900 or equivalent of other company are allowed.

(3) Assume suitable data wherever necessary and mention it clearly.

(4) Figures to right indicate full marks.

(5) Draw neat and clean figure wherever necessary.

1 Answer the following questions : **9×2=18**

(a) Corresponding to prandtl number in heat transfer we have _____ number in mass transfer.

(b) Stefan's law gives a relation, which describes transfer of mass _____

(i) Bulk diffusion

(ii) Difussion

(iii) Diffusion and Bulk flow

(c) J_D factor for mass transfer is a function of _____

(d) Give the application of molecular diffusion.

(e) Write down Fick's first law.

(f) For leaching vegetable seeds extractor used is _____

(i) Rotocel

(ii) Kennedy extractor

(iii) Bollman

(iv) All

(g) Coarse solids can be leached in _____

(i) Dorr classifier

(ii) Bollman extractor

(iii) Pachuca tank

(iv) Continuous rotary extractor

(h) Define supersaraturation.

(i) Give the methods of supersaturation.

2 Attempt any **two** : **8×2=16**

(a) Oxygen (A) is diffusing through carbon monoxide (B) under steady state conditions with the carbon monoxide non-diffusing. The total pressure is 1×10^5 N/m^2 and the temperature 0°C. The partial pressure of oxygen at two planes 2.00 mm apart is respectively 13000 and 6500 N/m^2. The diffusivity for the mixture is 1.87×10^{-5} m^2/S. Calculate the amount of oxygen diffused in one hour in kg mol through each sq. meter of the two planes $R = 8.314 \left(\frac{N \cdot m}{k\ mol \cdot K} \right)$.

(b) Write a note on mass transfer operations based on phases separated by membranes.

(c) A batch of 500 kg of KCl is dissolved in water to make a saturated solution at 350 K (77°C) where the solubility is 30% by weight KCl in water. The solution is cooled to 293 K (20°C) at which the solubility is 25.4% by weight. Determine the quantity of crystals obtained if 3.5% of the water evaporates on cooling.

3 Write a short notes on any **four** : **4×4=16**

(a) Application of leaching in chemical industries

(b) Penetration theory

(c) Analogies between mass transfer and heat transfer

(d) Swenson-Walker crystallizer

(e) Diffusion through polymers.

4 Answer the following questions : **16**

(a) Define point efficiency. **1**

(b) Define absorption factor. **1**

(c) In the absorption of soluble gas from a gas mixture by a solvent, mass transfer is from _____ phase to _____ phase. (Fill in the blank) **1**

(d) For a ternary system containing two pairs of partially miscible liquids, the number of pluit point is _____. (Fill in the blank) **1**

(e) Define : (1) Weeping (2) Dumping. **2**

(f) Why plate towers are preferred to packed columns when large temperature changes are involved ? **2**

(g) State some common problems of packed columns. **2**

(h) Write a short note on choice of solvent in liquid-liquid extraction operation. **6**

5 Answer the following questions : (any **two**) **16**

(a) Write a short note on choice of solvent for absorption.

(b) Write a short note on packed towers and tower packings.

(c) Write a short note on system of three liquids where one pair is partially soluble in liquid-liquid extraction.

6 (a) Write down significant characteristics of ideal solution. **2**

(b) Solve the following problems : (any **two**) **16**

(i) A gas absorber has to be designed to handle 900 m^3/hr of coal gas containing 2% (by volume) benzene. Coal gas enters at a temperature of 300 K and 805 mm Hg. 95% of benzene should be recovered by the solvent. The solvent enters at 300 K containing 0.005 mole fraction of benzene and has an average molecular weight of 260. Calculate the circulation rate of solvent per second, if the column is to be operated at 1.5 times minimum L_S. Equilibrium data is :

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

Y = mole ratio of benzene to dry gas

X = mole ratio of benzene to solvent.

(ii) A packed tower is to be designed to absorb sulfur dioxide from air by scrubbing the gas with water. The entering gas is 20% SO_2 by volume and the leaving gas is to contain 0.5% SO_2 by volume. The entering water is SO_2 free. The water flow is to be twice the minimum. The air flow rate (SO_2 free basis) is 975 kg/hr-m^2. The temperature is 30°C and total presure is 2 atm. The equilibrium data is governed by $y = 21.8\,x$, where y and x are in mole fraction units. Compute the number of overall gas phase transfer units.

(iii) In order to extract acetic acid from dilute aqueous solution with isopropyl ether, the two immiscible phases are passed counter-currently through a packed column 3.05 m in height and 7.6 cm in diameter. It is found that if 1950 kg/m-m^2 of pure ether is used to extract 975 kg/hr m^2 of 4% acid by weight then the ether phase leaves the column with a concentration of 1% acid by weight. Calculate the number of overall transfer units based on raffinate phase.

The equilibrium relationship is given by weight % acid in ether phase = 0.3 times the weight % acid in water phase.
