Ref. No. : Ex/FTBE/T/325/2019

BACHELOR OF ENGINEERING (F.T.B.E) EXAMINATION, 2019

(3rd Year -2nd Semester,)

Mass Transfer Operation -I

Time: 3 hrs. Full Marks :50

Part – II (Answer Question 1 and any two questions from the rests; 10 + 20 x 2 = 50)

(a) Find the dimension of diffusivity.

(b) In a gas system molecular diffusion is slow process. How can you make it faster ?

(d) For a two component system (A and B) prove that $D_{AB}=D_{BA}$, where the terms bear normal meaning

(e) What do you mean by 'permeability'? (2+2+4+2)

Derive mathematical expression of molar flux of a gaseous component with respect to its partial pressure difference at two different points in a two-component gas mixture, for the case of equimolar counter diffusion as well as for the case of one diffusing -another non diffusing. (20)

Hydrochloric acid (A) concentration at the opposite walls of a static film (4 mm thick) of non diffusing water (B) are 12% and 4 % (by wt.), respectively. The diffusivity of the acid in the binary mixture of water and acid is 2.5 x 10^{-9}/sec at 20^0C . Density of 12% and 4% acid solution are 1050kg/m^3 and 1020kg/m^3, respectively. Calculate the diffusion flux of the acid at 20^0C . (20)

Oxygen is diffusing through non-diffusing carbon monoxide under steady state condition. The total ambient pressure 10^5N/m^2 and the temperature is 0^0C. The partial pressure of oxygen at two planes 3mm apart is 14,000 and 7000N/m^2, respectively. The diffusivity for the mixture is 1.9 x $10^{-5}$$m^2$/sec. Calculate the rate of diffusion of oxygen in kmol /sec-m^2. (20)

In a tube containing a mixture of methane and helium, the partial pressure of methane is 70kPa and 30kPa at two different positions in the tube. The distance between the positions is 3cm.The ambient pressure and temperature are 1atm and 25^0C , respectively. The diffusivity of methane is 6.75 x 10-5m^2/sec. Calculate (i) the flux of methane at steady state for counter diffusion case and (ii) calculate the partial pressure at a point 1cm apart from the first position. (20)

(a) Hydrogen gas at 2 std. atm. pressure, 25^0Cf lows through a pipe made of unvulcanized rubber , with ID and OD 25 and 50 mm, respectively. The solubility of the hydrogen is reported to be 0.053cm^3(STP)/cm^3.atm. and the diffusivity of hydrogen through the rubber to be 1.8 x 10^{-6} cm^2/s. Estimate the rate of loss of hydrogen by diffusion per meter of pipe length..

(b) Calculate the permeability coefficient of an amorphous PET film to O_2 at 23^0C given that the OTR through a 2.54 x 10^{-3} cm thick film with air on one side and inert gas on the other is 8.8 x 10^{-9} mL cm^{-2} s^{-1}. O_2 partial pressure difference across the film is 0.21 atm (10 + 10)

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Ex/FTBE/T/325/2019

BACHELOR OF FOOD TECHNOLOGY AND BIOCHEMICAL ENGINEERING SUPPLEMENTARY EXAMINATION 2019

(3rd Year, 2nd Semester)

Mass Transfer Operations 1

Time : 3 Hours **Full Marks: 100**

Use a separate answerscript for each part.

PART II (50 Marks)

Answer Question no. 4 and any two Questions from 1.2 and 3.

1. (a) What is the basic difference between liquid- liquid extraction and leaching though both are termed as solvent extraction? What is meant by Distribution Coefficient? What are the factors influencing the rate of leaching? 2+2+6

(b) Deduce an expression for the time needed for batch leaching of a solute with respect to its concentration profile. How are solids prepared before leaching? 5+5

2. A countercurrent extraction process is used for extraction of oil using petroleum ether as solvent from oilseeds which initially contain 22 percent oil by weight. It is desired to extract 90% of the oil from the seeds and the final concentration of oil in the exit solution is 48%. The crushed seeds in the underflow carry with them 40% of the mass of solution (in each stage). Assuming that all the oil in the seeds are extracted in the first stage itself and equilibrium is reached in each stage, find the number of ideal stages required. The overflows and underflows are assumed to be constant. 20.

3. With neat diagrams explain how oil from seeds are extracted by (a) Hildebrant Extractor and (b) Bollman Extractor. 8+12

4. Answer any two: (2×5)

(a) Batch Leaching Equipment

(b) Fields of usefulness in liquid – liquid extraction.

(c) Use of equilateral triangular coordinates in liquid-liquid exrraction.