d) An electrolyte is diffusing at 20°C from 0.1M aqueous solution through a water insoluble membrane of 0.0015 cm thickness into 0.01M aqueous solution. The partition coefficient of the electrolyte between water and membrane is 6.2×10^{-4} and the diffusion coefficient is 1.72×10^{-5} cm²/s. Calculate the flux of electrolyte across the membrane.

OR

The oxygen is diffusing through a rubber membrane of 0.05 mm thickness. The pressure on opposite sides of the membrane are 2 bar and 1 bar, respectively. For oxygen- rubber at 298 K:
$D_{AB}=0.21\times10^{-9}$ m²/s and $s=3.12\times10^{-3}$ kmol/ m² bar. The concentration of oxygen (C_A) on the surface of the membrane is given by $C_A = s.p_A$. Calculate i) Molar diffusion flux of O_2 and ii) Molar concentration of O_2 outside the rubber membrane assuming that the perfect gas law is being obeyed.

5. a) Explain the concept of key component in multi-component distillation.
   b) Write Fenske equation for minimum number of plates for multi- component distillation.
   c) Explain Gilliland equation for multi- component distillation.
   d) A mixture of benzene, toluene and O- xylene is to be separated in a distillation column. The column has a total condenser and a partial reboiler. The feed is at its boiling point as a liquid. It contains 20 mole % benzene, 50 mole % toluene and 30 mole % O-xylene. The bottom have to contain 95% of O- xylene charged as feed. The bottoms contain 99 mole % O-xylene. Calculate the number of stages required at a reflux ratio of 2.0 and a pressure of 1 atm.

OR

Describe the Thiele- Geddes method for

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MECM-101

M.E./M.Tech., I Semester

Examination, December 2014

Separation Process

Time : Three Hours

Maximum Marks : 70

Note: i) Answer five questions. In each question part A, B, C is compulsory and D part has internal choice.
ii) All parts of each questions are to be attempted at one place.
iii) All questions carry equal marks, out of which part A and B (Max.50 words) carry 2 marks, part C (Max.100 words) carry 3 marks, part D (Max.400 words) carry 7 marks.
iv) Except numericals, Derivation, Design and Drawing etc.

1. a) Explain Maxwells law of diffusion.
   b) Describe diffusion as mass flux.
   c) Compare diffusivities in solids, liquids and gases.
   d) A slab of clay 40 mm thick with the four thin edges sealed, is being dried from the two flat faces by exposure to dry air. The initial moisture content is 18%. Drying takes place by internal diffusion of liquid water followed by evaporation at the surface. The surface moisture content is 2.5%. The average moisture content has fallen to 9.75% in 6 hrs.
   Assuming the diffusivity to be independent of moisture content and uniform in all directions, calculate i) The diffusivity in m²/sec. ii) How much time will be required to reduce the average moisture content to 6% under the

OR

Derive an equation for unsteady- state molecular diffusion in a sphere of radius r.

2. a) What are the physical significance of Schmidt and sherwood number?

b) What are the main drawbacks of the two film theory of interphase mass transfer?

c) Explain the significance of prandtl mixing length.

d) It is desired to estimate the value of the mass transfer coefficient k_g for the absorption of ammonia by the wet surface of a streamlined shape placed in a turbulent air-ammonia stream. No data on mass transfer to such a section is available, but experiments under similar conditions indicate the heat transfer coefficient, h to be 65 W/m^2. K. Evaluate k_g by using an appropriate analogy equation.

The air-NH_3 mixture contains only a small amount of ammonia and its properties under the operating conditions are: Density= 1.14 Kg/m^3, Viscosity= 1.85×10^{-5} Kg/ ms, Thermal conductivity= 0.0273 W/mk, Heat capacity = 1002 J/ Kg K, the diffusivity of NH_3 in air may be taken as 2.4×10^{-5} m^2/s and the atmospheric pressure as 101.3 kN/m^2.

OR

Determine the overall mass transfer coefficient in an absorber irrigated with water for which the individual gas phase and liquid phase mass transfer coefficients are 2.76×10^{-3} Kmol/m^2.hr.kPa and 1.17×10^{-4} m/s, respectively. The operating pressure of the absorber is maintained at 1.07 atm (abs). The equation of the equilibrium line in mole fractions is $y^* = 1.02\,x$.

3. a) Explain the transition of the laminar boundary layer flat plate into a fully turbulent boundary layer.

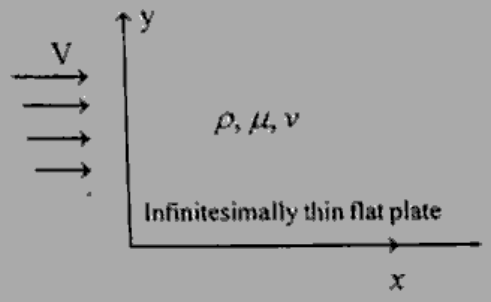
b) Give the common empirical approximation for the averaged velocity profile of a turbulent flat plate boundary layer.

c) "As the fluid viscosity increases, so does the boundary layer thickness". Choose whether the statement is true or false and discuss your answer briefly.

d) Compare flow separation for a laminar versus turbulent boundary layer. Specifically, which case is more resistant to flow separation? Why? Based on your answer, explain why golf balls have dimples.

OR

A uniform free stream of speed V flows parallel to an infinitesimally thin semi- infinite flat plate as given in figure. The coordinate system is defined such that the plate begins at the origin. Since the flow is symmetric about x- axis, only the upper half of the flow is considered. Calculate the boundary layer velocity profile along the plate and discuss.



4. a) What are the two major types of membranes? Give examples.

b) What is permeation? Discuss briefly about its mechanism.

c) Why do diffusivities of gases through membranes get appreciably reduced? Explain.