opposite sides of the film are 9 and 3% weight acid. The diffusivity of acetic acid in the solution is 0.95×10^{-9} m^2/s. Density of 9 and 3% solutions are 1012 and 1003.2 kg/m^3 7

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M. Tech Odd Semester Examination, February, 2023

Agricultural Engineering

(1st Semester)

Course No.: 1AE202

(Transport Processes in Food Engineering)

Full Marks: 70
Pass Marks: 28

Time: 3 hours

Note:
1. Attempt 05 (Five) questions by taking one form each unit.
2. Begin each answer in a new page.
3. Answer parts of a question at a place.
4. Assume reasonable data wherever required.
5. The figures in the right margin indicate full marks for the question.

UNIT-I

1. (i) What is Fick's law? Briefly explain the three modes of heat transfer. 5

   (ii) Derive the expression for heat transfer in cartesian coordinates. 9

2. (i) Define thermal emissivity. Write down the equation for heat transfer through composite pipes or cylinder. 5

   (ii) Write short notes on

   (a) Fourier's law

   (b) Unsteady state heat transfer

   (c) Convective heat transfer coefficient 9

UNIT-II

3. (i) What is molecular diffusion? Briefly explain with formula. 7

3. (ii) Oxygen in diffusing through Carbon monoxide under steady state condition with carbon monoxide nondiffusing. The total pressure is 1 bar and the temperature is 30^0. The partial pressure of oxygen at two planes 2 mm apart are 0.13 bar and 0.065 bar respectively. The diffusivity for the mixture is 2×10-5 m2/s. Calculate the rate of diffusion of oxygen. 7

4. (i) Derive the expression of molecular diffusion in solid. 7

(ii) Water vapour is diffusing at 40°C through air in a pore whose Knudsen number is unity. Find the molar flux if absolute humidity at the beginning and at the end of the pore are 0.045 and 0.02 kg/kg dry air respectively. The pore length is 3 mm. 7

UNIT-III

5. (i) What is fluidization? Elaborate an equation for pressure drop and minimum fluidizing velocity for flow in fluidized beds. 9

(ii) Peas having an average diameter of 6 mm and density of 880 kg/m^3 are to be dried in a fluidized bed dryer. The minimum voidage is 0.4 and the cross sectional area of bed is 0.25 m^2. Calculate the minimum air velocity needed to fluidize the bed if the air density is 0.96 kg/m^3 and the air velocity is 2.15 ×10^{-5} N.s/m^2. 5

6. (i) Write short notes on (any two)

(a) Heat and mass transfer analogy.

(b) Ergun's Equation

(c) Continuity Equation. 4+4

(ii) Derive the Bernoulli's Equation from Euler's equation with necessary assumption. 6

UNIT-IV

7. (i) What are the different types of transport mechanisms? 6

(ii) What is viscosity? A mixture of air and water vapour is contained in a pipe at 25°C and 1 atm total pressure. At one end of the pipe the partial pressure of water vapour is 0.6 atm and at the other end 0.2 m away the same is 0.2 atm. Calculate the flux of water vapour from one end to the other.[Diffusivity of air-water vapour = 0.26×$10^{-4}$$m^2$/s] 2+6

8. (i) What is mass transfer coefficient? Enlist the types of mass transfer coefficient? 6

(ii) Derive the expression of steady state diffusion. 8

UNIT-V

9. (i) Define Laminar and Turbulant flow. Derive the expression for rate of flow through venturimeter. 2+7

(ii) What is interphase in mass transfer? Write the transfer steps of interphase mass transfer. 5

10. (i) What are the different loses of energy in pipes? Derive the expression for flow through orifice. 2+5

(ii) Calculate the rate of diffusion of acetic acid (A) across a film of non-diffusing water (B) 1mm thick when the concentrations of acetic acid on