Exam.Code:0909
Sub. Code: 6710

1079

B.E. (Biotechnology) Fifth Semester
BIO-514: Transport Phenomena

Time allowed: 3 Hours

Max. Marks: 50

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Section.

x-x-x

Q.1a). State the Fick's law of diffusion.

b). Explain the 'no slip boundary condition'.

c). Explain the effect of temperature on the viscosity of liquids.

d). Give the dimensions of viscosity.

e). The Schmidt number is the ratio of _____ and _____.

f). Flow behavior index (n) for dilatants fluid _____.

g). What is newtons law of cooling?

h). What is the significance of Brinkman number?

i). Give an example of "Diffusion Controlled Reaction".

j). Define thermal diffusivity. (10)

SECTION-A

Q.2a). A Newtonian fluid under steady state isothermal conditions is flowing down an inclined flat plate of length L, width W and β as the angle of inclination with the vertical axis. The fluid forms a layer of thickness δ over the surface. Using shell momentum balance derive an expression for the velocity distribution and average velocity of the fluid in the layer. Assume viscous and gravity forces act on the fluid.

b). Viscous fluid is flowing down a vertical wall as a film 2.5 mm thick. The fluid density is 810 kg/m^3 and the kinematic viscosity is 2×10^{-4} m^2/s. Calculate the required mass flow rate per unit width of wall, the Reynolds number and the average velocity. (7,3)

Q.3. In a gas absorption experiment a viscous fluid of density ρ and viscosity μ flows upwards through a small circular tube of radius R and then downward on the outside. Set up a momentum balance over a shell of thickness Δr in the film to find the velocity distribution in the falling film of thickness δ. Neglect end effects. (10)

Q.4a) Discuss the analogy between momentum heat and mass transfer with respect to the transport mechanism and the governing equations.

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b) A Newtonian fluid is flowing between two parallel plates. Calculate the steady-state momentum flux τ, in lbf/ft^3 when the lower plate velocity V is 1ft/s , the plate separation is 0.001 ft, and the fluid viscosity μ is 0.7 cP. (5,5)

SECTION-B

Q.5. A solid catalyzed dimerization reaction $2A \rightarrow B$ is carried out in a catalytic reactor. Each catalytic particle is assumed to be surrounded by a stagnant gas film through which A has to diffuse to reach the catalyst surface where the reaction takes place instantaneously. The product B then diffuses out through the gas film to the main stream composed of A and B. Assuming that the gas film is isothermal, derive an expression for the concentration profile of A in the gas film. The main stream concentration of A and B are given to be x_{A_0} and x_{B_0} respectively and the effective gas film thickness is δ. (10)

Q.6. Obtain an expression for the temperature distribution and the overall heat transfer coefficient for a composite cylindrical pipe wall made up of three materials of different thicknesses and different thermal conductivities. Fluid in the inside of the pipe is at a temperature T_a and the fluid on the outside surface of the pipe is at T_b. The heat transfer at the two surfaces is given by Newton's "law of cooling" with heat transfer coefficients h_o and h_3, respectively. (10)

Q.7. The velocity of fluid flowing through a nozzle has been determined to be a function of diameter of the pipe (D), density (ρ), diameter of nozzle (d), viscosity (μ) and pressure drop (ΔP). Determine the dimensionless numbers using Buckingham method. (10)

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