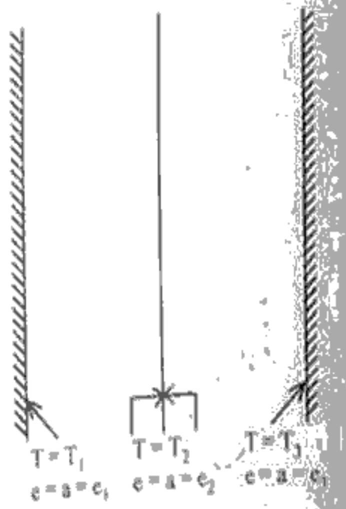
high thermal conductivity is placed between them as shown in figure 2.



5. a) Define the mixing length expression of Prandtl and Taylor.

b) Carbon dioxide and nitrogen counterdiffuse in a circular tube (1 m long, diameter 50 mm) at 25°C and 1 atm. The tube ends are connected to large chambers where the species concentrations are kept at fixed values. Partial pressures of carbon dioxide are 0.132 and 0.066 atm at each tube end. What is the carbon dioxide mass transfer rate through the tube.

Or

a) Define the time smoothing of the equation of continuity of A.

b) Ammonia gas diffuses at a constant rate through 1 mm of stagnant air. Ammonia is 50 percent (by volume) at one boundary. The gas diffusing to the other boundary is rapidly absorbed. Concentration of ammonia at the second boundary is negligible. Ammonia diffusivity is 0.18 cm²/sec at the system conditions (295K, 1 atm). Determine the rate of diffusion of the ammonia.

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MECM-102

M.E./M.Tech. I Semester

Examination, December 2014

Advanced Transport Phenomenon

Time : Three Hours

Maximum Marks : 70

Note: Attempt all questions. All questions carry equal marks, draw neat sketch and assume suitable data wherever you required.

1. a) Differentiate between eddy viscosity and eddy diffusivity.

b) A fluid that is very nearly described by the Bingham model is flowing through a vertical tube as the result of a pressure gradient and/or gravitational acceleration. The radius and length of the tube are R and L respectively. Develop a relation between the volume rate of flow Q and the combined pressure and gravity forces acting on the fluid.

$$\tau_{rz} = \tau_0 - \mu_0 \frac{dv_z}{dr} \; if \; |\tau_{rz}| > \tau_0$$

$$\frac{dv_z}{dr} = 0 \; if \; |\tau_{rz}| < \tau_0$$

Or

a) Differentiate between absolute viscosity kinematic viscosity.

b) In a Gas absorption experiment a viscous fluid of density ρ and viscosity μ flows through a small circular tube of radius R and then downward on the outside. Show that the velocity distribution in the falling film of thickness δ (neglecting end effects) is given by

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b) Spherical particles of [illegible] of radius R = 1mm are [illegible] by an SO_2-O_2 [illegible] at 400°C and 1 atm. The stoichiometry of the reaction $2SO_2 + O_2 \rightarrow 2SO_3$.

4. a) Explain [illegible] model for porous catalyst and give electrical analog of a pore.

b) Show that the selectivity of two concurrent first order reactions occurring in flat shaped porous catalyst is independent of the effect of either heat or mass transfer if the activation energies of both reactions are equal.

OR

a) What is effectiveness factor? Explain.

b) In a fluidized bed catalytic reactor under isothermal conditions a first order reaction is carried out in the bubbling regime. Given overall mass transfer coefficient between bubbles and the dense phase $K_{BE} = 0.7\ sec^{-1}$, catalytic first order reaction rate constant $K = 0.07\ m^3/Kg\text{-}sec$, bubbles superficial velocity $U_b = 0.13\ m/sec$, bed reactor height $Z = 0.55$ m, Fraction of the fluidized bed reactor occupied by the dense phase $\epsilon_d = 0.76$ and the density of catalyst particles in dense phase $P_d = 15\ Kg/m^3$. Calculate fractional conversion in the fluidized bed.

5. a) Explain Trickle-Bed Reactor based on the following points:

i) Flow Regimes: the flow regime may be trickle flow, pulsing flow, bubble flow, or spray flow, depending on [illegible] properties of the fluids and solid.

ii) Pressure Drop: The pressure drop for cocurrent down flow of gas and liquid in packed bed.

iii) Liquid holdup and wetted area

iv) The external mass transfer coefficients

b) Show that the general energy balance for non-isothermal batch reactor can simplify to an appropriate form for either adiabatic or isothermal reactor operation.

OR

a) Discuss how the steady state reactor temperature varies as a function of the steady state jacket temperature.

b) Consider the liquid-phase reaction $A + B \rightarrow C$, $\Delta H_R = -5$ kJ/mol, $C_{pA} = ?$ J/mol-K, $C_{pB} = 3$ J/mol-K, $C_{pC} = 10$ J/mol-K $C_{pj} \neq f(T)$. This reaction occurs in a well-cooled CSTR ($V = 10\ dm^3$), with UA = 10 W/K and $T_a = T_0$. The inlet stream is an equimolar mixture of A and B entering at $v_0 = 100 dm^3/min$ and $F_{T0} = 10$ mol/s. Use the G(T) plot to answer the following question: Determine the extinction and ignition temperatures (provide numbers) when the coolant is shut off and the reactor becomes adiabatic. On the plot, Draw and label the R(T) curves for ignition and extinction and circle the bifurcation points.

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