Code No: 07A52301 **R07** **Set No. 2**

III B.Tech I Semester Examinations,May 2011
TRANSPORT PHENOMENA IN BIO PROCESSES
Bio-Technology

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. What are the various steps involved in the transport of gas from gas bubble to the bulk liquid and to the active site in the cell cluster? [16]

2. (a) Compare the plate and cone viscometer with coaxial cylindrical viscometer.
   (b) Describe with a neat sketch, explain the working principle of the coaxial viscometer. [8+8]

3. (a) Explain Skin Friction and Form friction.
   (b) What is the significance of friction factor chart in design? [8+8]

4. A tube or bridge of a gel solution of 1.05 wt% agar in water at 298K is 0.04m long and connects two agitated solutions of urea in water. The urea concentration in the first solution is 0.2g mol urea per liter solution and is 0 in the other. Calculate the flux of urea in kg mol/s.m^2 at steady state. [16]

5. A laboratory furnace wall is constructed of 0.2 m thick fireclay brick (k = 1.0 w/m^0C). This is covered on the outer surface with a 0.03m thick layer of insulating material (k = 0.07 w/m^0C). The furnace inner brick surface is at 1250^0k and the outer surface of the insulation material is at 310^0k. Calculate the steady state heat transfer rate through the wall. [16]

6. A genetically engineered strain of yeast is cultured in a bioreactor at 30^0C for production of heterologous protein. The oxygen required is 80 mol L^{-1} h^{-1}. The critical oxygen concentration is 0.004 mM. The solubility of oxygen in the fermentation broth is estimated to be 10% lower than in water due to solute effects.
   (a) What is the minimum mass transfer coefficient necessary to sustain this culture if the reactor is sparged with air at approximately 1 atm pressure? Assume that the molar composition of air is 21% oxygen.
   For solution of oxygen in water at 30^0C, the Henrys constant is:
   $H = 0.86\frac{\text{atm}}{\frac{\text{mmoles}O_2}{\text{L}}}$ [16]

7. (a) Draw the temperature profile of heat transfer across a tube with fouling deposits on both surfaces
   (b) Derive the equation for LMTD by drawing the temperature profiles of parallal and counter current flows. [8+8]

8. Write short notes on

(a) Equilibrium Stage Operations

(b) Gas-Liquid Mass Transfer Operations [8+8]

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Code No: 07A52301 **R07** **Set No. 4**

III B.Tech I Semester Examinations,May 2011
TRANSPORT PHENOMENA IN BIO PROCESSES
Bio-Technology

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Determine the rate of mass transfer in Liquid- liquid mass transfer. [16]

2. (a) Show schematically the switch from the soluble carbon source limited growth to dissolved oxygen limited growth in steady state continuous culture using plots of cell concentration against the dilution rate. Indicate on your graph, what the most efficient operating conditions will be.
   (b) Write a general energy balance for an operating bioreactor. [10+6]

3. What is the expansion of LMTD? Why is it calculated? When can we use arithmetic mean instead of LMTD? Write the equation for LMTD. What are the limitations of LMTD? [16]

4. An Aluminium pipe (k = 45.0 w/m^{0}k) having a 6.0 cm O.D. is covered with a 4.2 cm thick layer of magnesia (k = 0.07 w/m^{0}k)which in turn is covered with a 2.4 cm layer of fiber glass insulation (k = 0.048 w/m^{0}k). The pipe wall outside temperature is 370^{0}K and the outside surface temperature of the fiber glass is 305^{0}K. What is the interfacial temperature between the magnesia and the fiber glass? [16]

5. (a) Distinguish between Eddy and Molecular Diffusion.
   (b) Explain Penetration Theory versus Two Film Theory. [8+8]

6. Write short note on power requirements for
   (a) Ungassed Newtonian fluids.
   (b) Ungassed Non Newtonean fluids. [8+8]

7. What is momentum transfer explain in detail about the importance of momentum transfer in bioprocessing? [16]

8. Oxygen (A) is diffusing through carbon monoxide (B) under steady-state, with the carbon monoxide non-diffusing. The total pressure is 1×10^5 N/m^2 , and the temperature 0^{0}C. The partial pressure of oxygen at two planes 2.0 mm apart is ,respectively, 13,000 and 6,500 N/m^2 . The diffusivity for the mixture is 1.87×10^{-5}m^2/s. Calculate the rate of diffusion of oxygen in kmol /s through each square meter of the two Planes. [16]

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Code No: 07A52301 **R07** **Set No. 1**

III B.Tech I Semester Examinations,May 2011
TRANSPORT PHENOMENA IN BIO PROCESSES
Bio-Technology

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Yeast is being grown in a 48 ltr capacity standard aerobic fermenter in a pilot plant experimentation. The fermentation broth is agitated with a turbine impeller. The dimensions of the bio reactor and the liquid height in the vessel are as per standard dimensions. Air is being blown into the fermenter at the rate of 12 lpm . The gas hold-up is estimated to be 18%. The turbine impeller is operated with 0.1 HP motor, out of which only 10% of the power is being used for agitating the impeller. Estimate the mass transfer rate(K_L^a). [16]

2. Solve fundamental problems involving mass transfer between two phases with either individual or overall mass transfer coefficients. [16]

3. Write short notes on the following
   (a) Diffusion as a mass flux
   (b) Characteristics of Mass Transfer [8+8]

4. Discuss the phenomena of boundary layer separation and wake formation. [16]

5. A one square meter 6mm thick steel furnace door (k = 30 w/m^{0}k) is insulated on the inside by a 2cm thick layer of ceramic fiber matting (k = 0.05 w/m^{0}k) and a 10 cm thick layer of refractory brick (k = 1.0 w/m^{0}k). If the temperature of the brick surface in the furnace is 700^{0}C and the outside steel surface of the door is at 50^{0}C, what is the heat loss by conduction through the door? [16]

6. It is required to reduce the heat loss from a furnace wall by doubling the thickness of the insulating brick work. Initially the temperatures of the inner and outer surfaces of the insulating brick are 480^{0}C and 180^{0}C, respectively. The atmospheric air is at 30^{0}C. Calculate the % decrease in heat loss because of doubling of the thickness of insulating brick. [16]

7. Discuss about general case for gas-phase mass transfer in a binary mixture. [16]

8. Write short note on
   (a) Operating conditions for turbulent shear damage.
   (b) Velocity distribution in turbulent flow. [8+8]

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Code No: 07A52301 **R07** **Set No. 3**

III B.Tech I Semester Examinations,May 2011
TRANSPORT PHENOMENA IN BIO PROCESSES
Bio-Technology

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. What are the various steps involved in the transport of gas from gas bubble to the bulk liquid and to the active site in the cell cluster? [16]

2. Write short notes on the following
   (a) Equimolar counter diffusion
   (b) Diffusion of A through stagnant non diffusing B [8+8]

3. Define mass transfer coefficients. Explain mass transfer coefficients in turbulent flow. [16]

4. Discuss about molecular diffusion in liquids and write equations for diffusion in liquids. [16]

5. (a) What is the significance of heat transfer coefficient? Write the units of heat transfer coefficient.
   (b) Hot oil is used to heat water, flowing at the rate of 0.1 kg/s from 40^0C to 80^0C in a counter flow double pipe heat exchanger. For an overall heat transfer coefficient of 300 w/m^2 ^{0}K, find the heat transfer area if the oil enters at 105^0C and leaves at 70^0C. [8+8]

6. The thermal contact conductance at the interface of two 1 cm thick aluminium plates is measured to be 10000 w/m^2 ^{0}C. Determine the thickness of the aluminium plate whose thermal resistance is equal to the thermal resistance of the interface between the plates. [16]

7. (a) What is meant by shear thinning and shear thickening fluids?
   (b) Explain in detail about the working of any viscosity measuring instrument. [8+8]

8. (a) Explain the relationship between pressure and density of a compressible fluid for:
      i. Isothermal process and
      ii. Adiabatic process.
   (b) A fermentation broth with viscosity 10^{-3} PaS and density 1100 kg/m^3 is agitated in a 4/ m^3 baffle tank using a Ruston turbine with diameter 0.8 m and stirrer speed of one revolution per second. Estimate the mixing time. [8+8]

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