Code No: NR310803 **NR**

III B.Tech I Semester Supplementary Examinations, November 2006
HEAT TRANSFER
(Chemical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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1. A 15mm dia steel sphere ,k = 42W/m^{0}C, is exposed to cooling airflow at 20^{0}C resulting in the convective coefficient h = 120 W/m2.C. Determine
   (a) Time required to cool the sphere from 550 to 90^{0}C
   (b) Instantaneous H T rate 2 min. after the start of the cooling
   (c) Total energy transferred from the sphere during the first 2 min.
   Data: Density = 7850 kg/m^3, C_p = 475 J/kg^{0}C and α=0.045 m^2/h [8+4+4]

2. (a) Derive an equation for temperature distribution in a hollow sphere. [8]
   (b) Hot gas at a constant temperature of 400^oC is contained in a spherical shell (2000mm 1D, 50mm thick) made of steel. Mineral wool insulation (k=0.06 w/m-k) of thickness 100mm is wrapped all around it. Calculate the steady rate at which heat will flow out if the outside air is at a temperature of 30^oC. HTC on the inner surface of the steel shell and on the outer surface of the insulation is 15 w/m^2K. [8]

3. (a) Explain the mechanism of natural convection. [8]
   (b) Show by dimensional analysis that data for convection may be correlated by an equation of the form: Nu= ϕ (Re, Gr, Pr)where Nu is Nusselts Number., Re is Reynolds number. pr is product/no.-and Gr is grashoft number. [8]

4. (a) Determine the hydraulic radius for the following cross sections:
      i. Circular tube of diameter D
      ii. Square tube of dimensions s × s. [4+4]
   (b) Estimate the heat transfer from a 40 W incandescent bulb at 125^0C to 25^0C in quiescent air. Approximate the bulb as a 0.05 m diameter sphere. What percentage of the power is lost by free convection? The appropriate correlation for the free convection coefficient is Nu=0.60$(GrPr)^{0.25}$ where the different parameters are evaluated at the mean film temperature and the characteristic length is diameter of the sphere. The properties at mean temperature are
   Thermal conductivity is 0.03 W/(m.K)
   Kinematic viscosity is 20.55 × 10^{-6} m^2/s
   Pr = 0.693. [5]

5. (a) Explain about film boiling. [6]
   (b) Discuss the merits and demerits of film wise and drop wise condensation. [10]

6. State and explain the following laws relating to thermal radiation and temperature of a radiating body:
   (a) Plank's law [5]
   (b) Stefan Boltzman law [5]
   (c) Wien's displacement law [6]

7. (a) With neat diagram explain 2-4 shell and tube heat exchanger and indicate the various parts. [8]
   (b) Discuss the operation and advantages of a multiple effect evaporator. [8]

8. A double effect evaporator has to concentrate 1000 kg/hr of caustic soda solution from 9% to 45% solids(concentration by wt). Backward feed is used. The feed enters the evaporator at 30^oC. Process steam at 7 kg/cm^2 (g) is available and in the second effect vacuum of 65 mm Hg is maintained. Design a suitable forced circulation evaporator system with equal heating surface in both the effects. Calculate the steam consumption and evaporation in each effect. Neglect boiling point rise. Overall heat transfer coefficients in the first and second effects are 8375 and 6270 kJ/hrm^{2o}C respectively. C_p value for all caustic stream is 3.77 kJ/kg^oC.[16]

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