CODE NO : NR 310803 N6

2005 JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

III B.TECH I SEMESTER SUPPLEMENTARY EXAMINATIONS
HEAT TRANSFER
(CHEMICAL ENGINEERING)

NOVEMBER 2005

TIME – 3 HOUR
MARK – 80

Answer any FIVE Questions
All Questions carry equal marks

1. In order to measure the effective k of a powder, the material is packed in the annulus between two aluminium spheres. The OD of inner sphere is 60 mm and the ID of outer sphere is 80 mm. The core of the assembly is electrically heated. In a experiment, the power supply to the core is 100W when the temperatures of the aluminium surfaces are found to be 210 and 600C. What is the k of the sample? [16]

2. The outside and inside surface temperatures of a 20cm outer diameter and 18cm inner diameter pipe (k=40W/mK) are 400oC and 460oC respectively. Calculate the reduction in heat loss if a 5cm layer of insulation (k=0.06 W/mK) is put on the pipe. Assume that the inner and outer surface temperature of insulation is 390Oc and 140oC . What is the inside surface temperature of this pipe in this case? [16]

3. (a) Discuss the various analogy equations relating skin friction and heat transfer.

(b) Write about the effect of tube length on inside film coefficient when heat transfer takes place by forced convection in turbulent flow of fluids through tubes. [4+4+8]

(c) Discuss the effect of roughness on heat transfer coefficient in turbulent flow of fluids in tubes.

4. Air flowing at 4.75 m/s through a pipe of inner diameter of 0.025 m is used for cooling a nuclear reactor. Air enters the pipe at 150C and the surface temperature of the pipe is maintained at 1500C. Find the following:

(a) the exit temperature of air, and

(b) the total heat transfer rate for a pipe length of 5 m using Colburn analogy.

The average fluid properties may be taken as:
Thermal conductivity is 0.03 W/(m.K)
Viscosity is 2.03 × 10-5 PaS
Density is 1.00 kg/m3.
Specific heat 1.01 kJ/(kg.K)
The skin friction may be computed from f = 0.0014 + 0.125 Re-0.32 [6+10]

5. (a) Explain about film boiling.

(b) Discuss the merits and demerits of film wise and drop wise condensation. [10+6]

6. The sun may be considered as a black body with a surface temperature of 5600 K at a mean distance of 15×1010 m from the earth. The diameter of the sun is 1.4 ×109 m. Make calculations for

(a) The total energy radiated by the sun

(b) The energy received per m2 just outside the earth's atmosphere.

(c) The total energy the earth would receive if no energy were blocked by the earth's atmosphere, and

(d) The energy received by a 1.25 M × 1.25 M solar collector whose perpendicular is inclined at 35 deg. to the sun. The energy loss through the stmosphere is 35 % and the diffuse radiation is 15 % of direct radiation. *[4*4]*

7. (a) Derive an expression for LMTD for a parallel flow double pipe heat exchanger

(b) Explain the method of correcting LMTD for a multipass shell and tube heat exchanger.

(c) Why is a counter current flow heat exchanger more suitable than a parallel flow heat exchanger. *[4+4+8]*

8. A solution is concentrated from 20 % to 65% solids. (Specific heat of feed 0.3) Steam at 2 atm is used. Pressure in the condenser is 100 mm Hg absolute. Feed enters at 25oC, overall heat transfer coefficient is 1800 W/m2oC. The evaporator must evaporate 20,000 kg/hr of water as vapour. Calculate the steam needed, economy and heat transfer area required. ⅄ s = 2197 kJ/kg, ⅄ = 2375 kJ/kg. *[16]*