surfaces approach black body behaviour. What is the net exchange of heat between the two spheres?

6. Attempt any one part of the followings: (10×1=10)

a) What do you understand by "Radiation Shield"? If 'n' number of radiation shields are used between two parallel plates, determine the relation for heat transfer using n shields in terms of original heat transfer (without shields). Take emissivities of all surfaces to be $\in$.

b) Write short notes on :
   i) Explain Ficks law of mass diffusion
   ii) Discuss physical significance of Sherwood No. and Schmidt No

7. Attempt any one part of the followings: (10×1=10)

a) Explain Kirchhoff's law. What do you mean by the statement: A perfect absorber of radiant energy is also a perfect emitter?

b) After a long time in service, a counter flow oil cooler is checked to ascertain if its performance has deteriorated due to fouling. In the test a standard oil flowing at 2.0 kg/s is cooled from 420 K to 380 K by a water supply of 1.0 kg/s at 300 K at inlet. If the heat transfer surface is 3.33 m^2 and the design value of the overall heat transfer coefficient is 930 W/m^2 K, how much has it been reduced by fouling? Take Cp of oil as 2330 J/kgK, Cp of water 4174 J/kgK.

(Following Paper ID and Roll No. to be filled in your Answer Books)

Paper ID : 2295032 Roll No.

B.TECH.

Regular Theory Examination (Odd Sem-III), 2016-17

HEAT AND MASS TRANSFER

Time : 3 Hours *Max. Marks : 100*

Note: Attempt all sections. If require any missing data; then choose suitably

SECTION - A

1. Attempt all questions in brief. (10×2=20)

a) What is an isotropic solid?
b) Define one dimensional condition
c) Define fin effectiveness
d) What do you mean by convection?
e) What is aerodynamic heating?
f) What is Laplacian?
g) What is a gray body?
h) Define laminar and turbulent flow?
i) What do you mean by Planck's law?
j) What do you mean by recovery factor?

SECTION - B

2. Attempt any *three* of the followings. (3×10=30)

a) Explain the utility of Heisler chart in transient heat conduction problem.

b) Show that in natural convection heat transfer

$$\breve{N}n = f\left(Gr, \Pr\right)$$

c) Write about :
   i) What is critical thickness of insulation?
   ii) Explain thermal contact resistance

d) A stainless steel fin (k = 20 W/mK) having a diameter of 20 mm and a length of 0.1 m is attached to a wall at 300^0C. The ambient temperature is 50^0C and the heat transfer coefficient is 10 W/m^2K. The fin tip is insulated. Determine :
   i) The rate of heat dissipation from the fin
   ii) The temperature at the fin tip.

e) A steam pipe is covered with two layers of insulation. The inner layer (k = 0.17 W/m) is 30 mm thick and outer layer (k = 0.023 W/mK) is 50 mm thick. The pipe is made of steel (k = 58 W/mK) and has inner diameter and outer diameter of 160 and 170 mm, respectively. The temperature of saturated steam is 300^0C and the ambient air is at 50^0C. If the inside and outside heat transfer coefficients are 30 and 5.8 W/m^2K respectively, calculate the rate of heat loss per unit length of the pipe.

SECTION - C

3. Attempt any one part of the followings: (1×10=10)

a) State and prove Fourier's law of heat conduction. Write the expressions for thermal resistance of a wall, an annular cylinder and a spherical shell.

b) Derive the equation for critical radius of insulation over a cylindrical pipe.

4. Attempt any one part of the following: (10×1=10)

a) A single effect evaporator is to be designed to concentrate 10,000 kg/h of a solution having 20% to 40% solids by weight. Feed enters at 30^0C, saturated steam at 110^0C having 540 kcal/kg latent heat is available. The solution boils at 50^0C (latent heat = 600 kcal/kg). Calculate the steam consumption rate and heat transfer area. Take overall heat transfer coefficient 1800 kcal/h m^2 ^{0}C; specific heat of all solutions can be taken as that of water.

b) Explain the film wise condensation and drop wise condensation with Nusselt's analysis. Why, the higher heat transfer rate experienced in drop wise condensation than in film wise condensation.

5. Attempt any one part of the following: (10×1=10)

a) Define : i) Gray Body and ii) Radiation shape factor and prove reciprocity rule?

b) A small sphere (outside diameter = 60 mm with a surface temperature of 300^0C is located at the geometric centre of a large sphere (inside diameter = 360mm) with an inner surface temperature of 15^0C. Calculate how much of heat emitted from the large sphere inner surface is incident upon the outer surface of the small sphere, assuming that both