MindVis GATE 2017 Online Preparation Course

Heat Transfer Questions

1 minute questions

Q1. A furnace is made of red brick wall of thickness 250 cm and conductivity 1.2 W/mK. Determine the thickness of a layer of diatomic earth of conductivity 0.15 W/mK that can be used to replace the brick wall for the same heat loss and temperature drop.

Ans: 3.12 cm

Q2.A 25 cm thick plate of insulation has its two surfaces kept at 350^0C and 225^0C. Thermal conductivity of the wall varies linearly with temperature and its values at 350^0C and 180^0C are 25 W/mK and 15 W/mK, respectively. Determine the steady heat flux through the wall.

Ans: 10 kW

Q3. A steam carrying steam pipe has inner and outer diameter of 85 mm and 110 mm. It is covered with an insulating having a thermal conductivity of 1.8 W/mK. The convective heat transfer coefficient between the surface of the insulation and the surrounding air is 14.5 W/m^2K. Determine the critical radius of insulation.

Ans: 12.41 cm

Q4. A current wire of 18 mm diameter is exposed to air where convective heat transfer coefficient is 25 W/m^2K. The wire is to be laid with an insulating layer of thermal conductivity 0.6 W/mK. Determine the thickness of the insulation for maximum heat dissipation.

Ans: 15 mm

Q5. The temperature distribution in a stainless steel fin of k = 0.2 W/cm-^{0}C of constant cross sectional area of 4 cm^2 and length of 2 cm, exposed to ambient temperature of 25^0C with h = 0.004 W/cm^2-^{0}C is given by

$$T - T_\infty = 6x^2 - 8x + 5$$

where T is in ^{0}C and x is in cm. Base temperature of the fin is 120^0C. Estimate the rate of heat dissipation through the fin surface.

Ans: 6.4 W

Q6. A boundary layer over a flat plate has hydrodynamic boundary layer thickness of 0.75 mm. The fluid has dynamic viscosity of $30\times10^{-6}\ Pa - s$, specific heat is 1.8 kJ/kgK and thermal conductivity 0.05 W/mK Determine the thermal boundary layer thickness.

Ans: 0.73 mm

Q7. Determine the heat transfer coefficient from a 120 mm diameter steel pipe placed horizontally in ambient air at 25^0C. Nusselt number is 30 and thermal conductivity of air is 0.05 W/mK.

Ans: 12.5 W/m^2 K

Q8. Determine the net heat radiation per square meter between two very large plates at temperatures 327^0C and 127^0C. The emissivity of the hot and cold plates are 0.75 and 0.65 respectively. Stefan Boltzmann constant is $5.67\times10^{-8}\ W/m^2K$.

Ans: 3.15 kW/m^2

Q9. Two long parallel surfaces have emissivity of 0.85 each. Determine the number of parallel shields of equal emissivity to reduce the exchange by 80%.

Ans: 4

Q10. A counter flow shell and tube heat exchanger is used to heat water with hot exhaust gases. The water flows at a rate of 2 kg/s while the exhaust gases (c_p = 1030 kJ/kgC) flows at a rate of 5.25 kg/s. If the heat transfer surface area is 32.5 m^2 and the overall heat transfer coefficient is 200 W/m^2C, what is the NTU for the heat exchanger?

Ans: 1.2

Numerical Answer Questions

Q1. A hollow sphere 20 cm in internal diameter and 32 cm external diameter of a material having thermal conductivity 55 W/mK is used as a container for a liquid chemical mixture. Its inner and outer surface temperatures are 325^{0}C and 95^{0}C, respectively. Calculate the thermal resistance and the rate of heat flow through the sphere.

Ans: 5.42^{0}C/kW and 42.39 kW

Q2. The temperature across a 50 cm thick furnace wall are 350^{0}C and 55^{0}C. The thermal conductivity of the furnace material varies with temperature as per the following profile,

$$\kappa = 0.005T - (5\times10^{-6})T^2$$

where T is in ^{0}C. What is the rate of heat loss from the furnace wall.

Ans: 455.01 W/m^2

Q3. The door of a cold storage plant is made from two 5mm thick glass sheets separated by a uniform air gap of 3mm. The temperature of the air inside the room is -25^{0}C and the ambient temperature is 30^{0}C. The heat transfer coefficient between the glass and air is 20 W/m^{2}K on both sides of the door. There is no convective heat transfer in air as air is still. Thermal conductivities of the glass and air are 0.75 W/mK and 0.02 W/mK. What is the rate of leaking of heat into the room. Calculate the percentage increase in the rate of heat loss if the air gap is reduced to 1 mm.

Ans: 61.22%

Q4. A steam boiler furnace is made of a layer of fireclay 15 cm thick and a layer of red brick 40 cm thick. The wall temperature inside the boiler furnace is 1200^{0}C and that of the outside is 50^{0}C. Thermal conductivities of fire clay and red brick are 0.533 W/mK and 0.7 W/mK respectively. Calculate the rate of heat loss per square meter of the furnace wall. Also calculate the thickness of the fireclay layer to reduce the rate of heat loss by 50%.

Ans: 1348.41 W/m^2 and 60 cm

Q5. A sphere made of aluminum weighing 6 kg, initially at a temperature of 300^{0}C, is suddenly immersed in a liquid at 20^{0}C. The convective heat transfer coefficient is 60 W/m^{2}K. The material properties for aluminum are, $\rho = 2700\frac{kg}{m^3}, c = 900\frac{j}{kgK}, \kappa = 205\ W/mK.$ Lumped capacity method is applied for the analysis. What is the time required by the sphere to reach 36.8% of the initial temperature difference? How much time it would take in cooling upto a temperature of 100^{0}C?

Ans: 1092.53 s and 1376.7 s

Q6. A gray surface is maintained at a temperature of 927^0C. The maximum spectral emissive power at that temperature is $2.74 \times 10^{10}\ W/m^2$. Calculate the emissivity of the gray surface and the wave length corresponding to the maximum spectral intensity of radiation.

Ans: 0.842 and 2.408μm