DEPARTMENT OF CHEMICAL ENGINEERING
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Test I

CH2006 HEAT TRANSFER

Duration: 1 hour | Date :13.02.2015 | Maximum Marks: [15]

Instructions: "Answer *all* questions. Any missing data may be suitably assumed"

1. The exterior walls of a building area composite consisting of 10 mm thick plaster board (k = 0.17 W/m. K), 50 mm thick urethane foam (k = 0.026 W/m. K), and a 10 mm thick soft wood (k = 0.12 W/m. K). On a typical winter day the outside and inside air temperature are -15°C and 20°C, respectively, with outer and inner convection coefficients of 15 W/m^2. K and 5 W/m^2. K, respectively,
   (a) What is the heating load for a 1m^2 section of the wall?
   (b) What is the heating load if the composite wall is replaced by a double glazed window (k = 1.4 W/m. K) consisting of two 3 mm thick glass panes separated by a 5 mm thick stagnant air gap (k = 0.0263 W/m. K)? **[3.5]**

2. Saturated liquid oxygen is stored in a spherical container of 500 mm diameter and whose outer surface is at a temperature of -10°C. The container is housed in a laboratory whose air and walls are at 25°C. If the heat transfer coefficient associated with convection at the outer surface of the container is 10 W/m^2. K, what is the rate, in kg/s, at which oxygen vapor must be vented from the system? Latent heat of vaporization of liquid oxygen=214 kJ/kg **[2]**

3. (a) Derive the general solution for temperature distribution in a rectangular straight fin and then obtain the temperature distribution for a fin insulated at the tip. **[1.5+2]**

   (b) One end of a wrought iron rod (k = 59 W/m. K) of 30 cm length and 3 cm diameter is attached to a wall at 300°C, while the other end is insulated. The surface of the rod is exposed to an environment at 25°C and the convective heat transfer coefficient from the surface to the environment is 15 W/m^2. K. Determine the rate of heat transfer from the rod. **[2]**

4. An electric current of 700 A flows through a stainless steel cable of diameter 5 mm generates a heat of 294 Watts per unit length. The cable is in an environment having a temperature of 30°C with a heat transfer coefficient of 25 W/m^2. K.
   (a) If the cable is bare, what is its surface temperature?
   (b) If a very thin coating of electrical insulation is applied to the cable, with a contact resistance of 0.02 m^2. K/W, what are the insulation and cable surface temperature?
   (c) There is some concern about the ability of the insulation to withstand elevated temperatures. What thickness of this insulation (k = 0.5 W/m. K) will yield the lowest value of the maximum insulation temperature? What is the value of the maximum temperature when this thickness is used? **[4]**
   (Rate of heat flow per unit length is constant in all the cases)

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