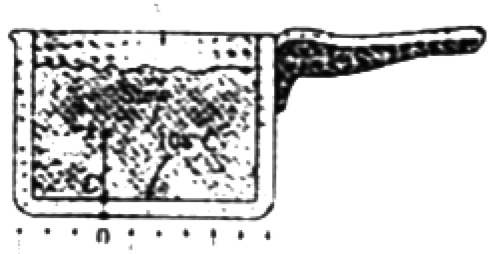
CANKAYA UNIVERSITY
FACULTY OF ENGINEERING
MECHANICAL ENGINEERING DEPARTMENT
ME 313 HEAT TRANSFER

CHAPTER II

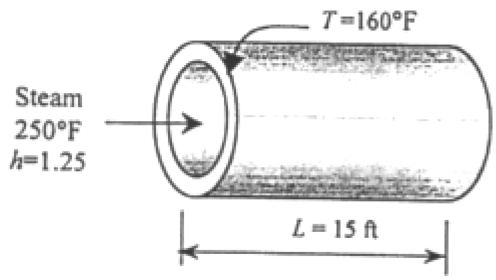
EXAMPLES

1) A cylinder of radius r_o, length L, and thermal conductivity k is immersed in a fluid of convection coefficient h and unknown temperature T_∞. At a certain instant the temperature distribution in the cylinder is $T(r)=a+br^2$, where a and b are constants. Obtain expressions for the heat transfer rate at r_o and the fluid temperature.

2) Consider an aluminum pan used to cook stew on top of an electric range. The bottom section of the pan is L=0.25 cm thick and has a diameter of D=18 cm. The electric heating unit on the range top consumes 900 W of power during cooking, and 90 percent of the heat generated in the heating elements transferred to the pan. During study operation, the temperature of the inner surface of the pan is measured to be 108°C. Assuming temperature-dependent thermal conductivity and one dimensional heat transfer, express the mathematical formulation (the differential equation and the boundary conditions) of this heat conduction problem during steady operation. Do not solve.



3) Consider a steam pipe of length L = 15 ft, inner radius r_1=2 in., outer radius r_2=2.4 in., and thermal conductivity k=7.2 Btu/h.ft^2.^{0}F. Steam is flowing through the pipe at average temperature of 250°F, and the average convection heat transfer coefficient on the inner surface is given to be h=1.25 Btu/h.ft^2.^{0}F. If the average temperature on the outer surfaces of the pipe is T_2=160^{0}F, (a) express the differential equation and the boundary conditions for steady one-dimensional heat conduction through the pipe, (b) obtain a relation for the variation of temperature in the pipe by solving the differential equation, and (c) evaluate the rate of heat loss from the steam through the pipe.



4) The steady state temperature distribution in a one dimensional wall of thermal conductivity 50 W/m.K and thickness 50 mm is observed to be $T(x)=a+bx^2$, where $a=200^oC$, $b=-2000^oC/m^2$ and x in meters.

a) What is the heat generation rate, $\dot{q}$ in wall?

b) Determine heat fluxes at the two wall faces. In what manner are these heat fluxes related to the heat generation rate?

5) The temperature distribution across a wall 0.3 m thick at a certain instant of time is $T(x) = a + bx + cx^2$, where T is in degrees Celsius and x is in meters. $a=200^oC$, $b=-200\ ^oC/m$, and $c = 30\ ^oC/m^2$. The wall has a thermal conductivity of 1 W/m.K.

a) On a unit surface area basis, determine the rate of heat transfer into and out of the wall and the rate of change of energy stored by the wall.

b) If the cold surface is exposed to a fluid at 100^0C, what is the convection coefficient?

6) The temperature distribution in a plate of thickness 20 mm is given by $T(^oC)=10x+6x^2+4$. Assume no heat generation in the plate; calculate heat flux on two sides of the plate. Also calculate the rate of temperature change with respect to time, if $k=300$ W/m.K, $\rho=5800$ kg/m^3 and $c=420$ J/kg.K.