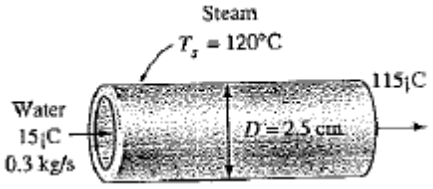
Convection tutorial

Questions

1- Water enters a 2.5 cm internal diameter thin copper tube of a heat exchanger at 15℃ at a rate of 0.3 kg/s, and is heated by steam condensing outside at 120℃. If the average heat transfer coefficient is 800 $\frac{W}{m^2.℃}$, determine the length of the tube in order to heat the water to 115℃ (see the figure).

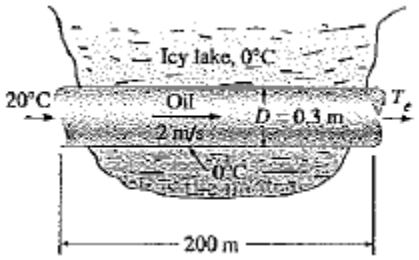


2- Compare the hydrodynamic and thermal entry lengths of mercury (liquid metal) and a light oil flowing at 3.0 mm/s in a 25.0 mm diameter smooth tube at a bulk temperature of 75^0C. The pertinent parameters of the fluids at that temperature are: v_{Hg}=1.0 × 10^{-7} m^2/s, v_{oil}=6.5 × 10^{-6} m^2/s, $Pr_{Hg} = 0.019$, $Pr_{oil} = 85$.

3- For heating water from 20°C to 60°C an electrically heated tube resulting in a constant heat flux of 10 kW/m^2 is proposed. The mass flow rate is to be such that Re_D=2000, and consequently the flow must remain laminar. The tube inside diameter is 25mm. The flow is fully developed (velocity profile). Determine (a) the length of tube required and (b) if thus proposed heating system is feasible with regard to wall temperature.

4- Air at 1.0 atmosphere pressure and 77°C enters a 5.0 mm i.d. tube with a bulk average velocity of 2.5 m/s. The velocity profile is developed and the thermal profile is "developing". The tube length is 1.0 m, and a constant (uniform) heat flux is imposed by the tube surface on the air over the entire length. An exit air bulk average temperature, $T_{h.o}$=127°C, is required. Determine (a) the exit *h* value, $h_{L,}$ (b) the uniform q_s'', and (c) the exit tube surface temperature.

5- Consider the flow of oil at 20^0C in a 30-cm-diameter pipeline at an average velocity of 2 m/s (see the figure below). A 200-m-long section of the horizontal pipeline passes through icy waters of a lake at 0^0C. Measurements indicate that the surface temperature of the pipe is very nearly 0^0C. Disregarding the thermal resistance of the pipe material, determine
   (a) the temperature of the oil when the pipe leaves the lake
   (b) the rate of heat transfer from the oil,
   (c) the pumping power required to overcome the pressure losses and to maintain the flow of the oil in the pipe.



Oil flows in a pipeline that passes through icy waters of a lake at 0℃. The exit temperature of the oil, the rate of heat loss, and the pumping power needed to overcome pressure losses are to be determined.

6- Air at 2 atm and 200℃ is heated as it flows through a tube with a diameter of 25.4 mm at a velocity of 10 m/s. Calculate the heat transfer per unit length of tube if a constant-heat-flux condition is maintained at the wall and the wall temperature is 20℃ above the air temeparture, all along the length of the tube. How much the bulk temperature increase over a 3-m length of the tube?