

HW#6 → 8.6 (5e), 8.13 (5e), 8.23a (5e), 8.32 (5e), 8.40 (5e), 8.62 (5e)

Heat Transfer Correlations: Circular Tubes

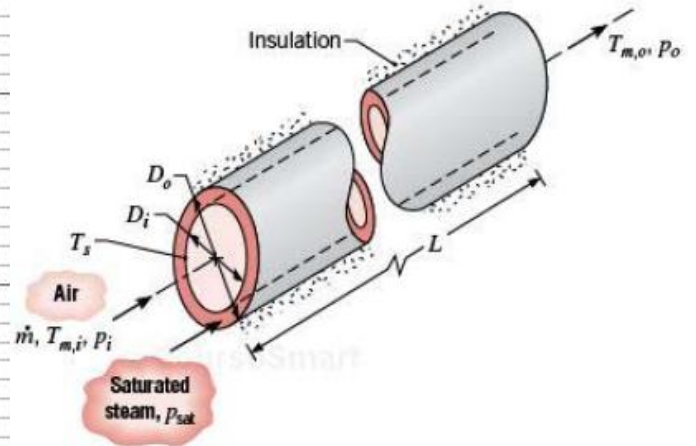
- 8.22 Engine oil is heated by flowing through a circular tube of diameter $D = 50$ mm and length $L = 25$ m and whose surface is maintained at 150°C .
- (a) If the flow rate and inlet temperature of the oil are 0.5 kg/s and 20°C , what is the outlet temperature $T_{m,o}$? What is the total heat transfer rate q for the tube?

A large grid of graph paper for solving the problem, consisting of 10 columns and 20 rows of small squares.

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8.38 An air heater for an industrial application consists of an insulated, concentric tube annulus, for which air flows through a thin-walled inner tube. Saturated steam flows through the outer annulus, and condensation of the steam maintains a uniform temperature T_s on the tube surface.

Consider conditions for which air enters a 50-mm-diameter tube at a pressure of 5 atm, a temperature of $T_{m,i} = 17^\circ\text{C}$, and a flow rate of $\dot{m} = 0.03 \text{ kg/s}$, while saturated steam at 2.455 bars condenses on the outer surface of the tube. If the length of the annulus is $L = 5 \text{ m}$, what are the outlet temperature $T_{m,o}$ and pressure p_o of the air? What is the mass rate at which condensate leaves the annulus?



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8.60 A thin-walled tube with a diameter of 6 mm and length of 20 m is used to carry exhaust gas from a smoke stack to the laboratory in a nearby building for analysis. The gas enters the tube at 200°C and with a mass flow rate of 0.003 kg/s. Autumn winds at a temperature of 15°C blow directly across the tube at a velocity of 5 m/s. Assume the thermophysical properties of the exhaust gas are those of air.

- (a) Estimate the average heat transfer coefficient for the exhaust gas flowing inside the tube.
- (b) Estimate the heat transfer coefficient for the air flowing across the outside of the tube.
- (c) Estimate the overall heat transfer coefficient U and the temperature of the exhaust gas when it reaches the laboratory.