Solutions

2.1

- $R = L/(kA) = 0.25/(1.4 \times 10) = \mathbf{0.01786}$ K/W.
- $q = \Delta T/R = 25/0.01786 = \mathbf{1400}$ W.

2.2

- $R_i = 1/(h_i A) = 1/80 = 0.0125$; $R_{wall} = 0.0179$; $R_{ins} = L/(kA) = 0.06/(0.035 \times 10) = 0.1714$; $R_o = 1/200 = 0.0050$ K/W.
- $\sum R = \mathbf{0.2068}$ K/W; $q = 25/0.2068 = \mathbf{120.9}$ W.
- $\Delta T_{ins} = qR_{ins} = 120.9 \times 0.1714 = \mathbf{20.7}$ K, 83% of the whole drop.

2.3

- $r_c = k/h = 0.2/10 = 0.020$ m $= \mathbf{20}$ mm.
- The wire is below r_c: a coating up to 20 mm radius adds outer area faster than resistance, so it *increases* the loss, useful for cooling cables.

3.1

- $R_i = 1/(h_i 2\pi r_1) = 1/(1000 \times 2\pi \times 0.025) = 0.0064$; $R_s = \ln(r_2/r_1)/(2\pi k) = \ln(28/25)/(2\pi \times 50) = 0.0004$ K/W.
- $R_{ins} = \ln(58/28)/(2\pi \times 0.04) = 2.8976$; $R_o = 1/(10 \times 2\pi \times 0.058) = 0.2744$ K/W.
- $q = \Delta T/\sum R = 60/3.1787 = \mathbf{18.9}$ W/m.
- $T_{surface} = 20 + qR_o = 20 + 18.9 \times 0.2744 = \mathbf{25.2}$ °C.
- Bare: $q = 60/(0.0064 + 0.0004 + 1/(10 \times 2\pi \times 0.028)) = 104.3$ W/m, so insulation saves about 82%.

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