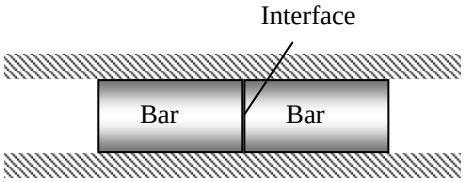
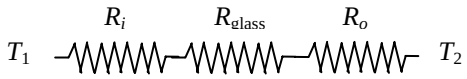
10-48 Two cylindrical aluminum bars with ground surfaces are pressed against each other in an insulation sleeve. For specified top and bottom surface temperatures, the rate of heat transfer along the cylinders and the temperature drop at the interface are to be determined.

Assumptions **1** Steady operating conditions exist. **2** Heat transfer is one-dimensional in the axial direction since the lateral surfaces of both cylinders are well-insulated. **3** Thermal conductivities are constant.

Properties The thermal conductivity of aluminum bars is given to be k = 176 W/m·°C. The contact conductance at the interface of aluminum-aluminum plates for the case of ground surfaces and of 20 atm ≈ 2 MPa pressure is h_c = 11,400 W/m^2·°C (Table 10-2).





Analysis (*a*) The thermal resistance network in this case consists of two conduction resistance and the contact resistance, and they are determined to be

$$R_{\text{contact}} = \frac{1}{h_c A_c} = \frac{1}{(11{,}400\ \text{W/m}^2 \cdot \text{°C})[\pi(0.05\ \text{m})^2/4]} = 0.0447\ \text{°C/W}$$

$$R_{\text{plate}} = \frac{L}{kA} = \frac{0.15\ \text{m}}{(176\ \text{W/m} \cdot \text{°C})[\pi(0.05\ \text{m})^2/4]} = 0.4341\ \text{°C/W}$$

Then the rate of heat transfer is determined to be

$$\dot{Q} = \frac{\Delta T}{R_{\text{total}}} = \frac{\Delta T}{R_{\text{contact}} + 2R_{\text{bar}}} = \frac{(150 - 20)\text{°C}}{(0.0447 + 2 \times 0.4341)\ \text{°C/W}} = \mathbf{142.4\ W}$$

Therefore, the rate of heat transfer through the bars is 142.4 W.

(*b*) The temperature drop at the interface is determined to be

$$\Delta T_{\text{interface}} = \dot{Q} R_{\text{contact}} = (142.4\ \text{W})(0.0447\ \text{°C/W}) = \mathbf{6.4°C}$$

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