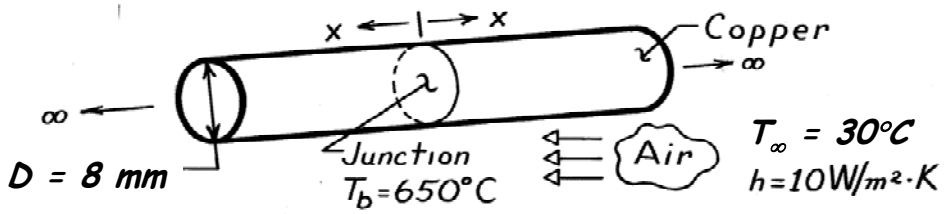
PROBLEM 3.136

KNOWN: Melting point of solder used to join two long copper rods.

FIND: Minimum power needed to solder the rods.

SCHEMATIC:



ASSUMPTIONS: (1) Steady-state conditions, (2) One-dimensional conduction along the rods, (3) Constant properties, (4) No internal heat generation, (5) Negligible radiation exchange with surroundings, (6) Uniform h, and (7) Infinitely long rods.

PROPERTIES: *Table A-1:* Copper $\bar{T} = (650 + 25)^\circ C \approx 600K$: $k = 379\ W/m \cdot K$.

ANALYSIS: The junction must be maintained at 650°C while energy is transferred by conduction from the junction (along both rods). The minimum power is twice the fin heat rate for an infinitely long fin,

$$q_{min} = 2q_f = 2(hPkA_c)^{1/2}(T_b - T_\infty).$$

Substituting numerical values,

$$q_{min} = 2\left[10\frac{W}{m^2 \cdot K}(\pi \times 0.008m)\left[379\frac{W}{m \cdot K}\right]\frac{\pi}{4}(0.008m)^2\right]^{1/2}(650 - 30)^\circ C.$$

Therefore,

$$q_{min} = 85.8\ W. \quad <$$

COMMENTS: Radiation losses from the rods may be significant, particularly near the junction, thereby requiring a larger power input to maintain the junction at 650°C.