Thermal Conductivity

19.15 (a) The steady-state heat flux through the plate may be computed using Equation 19.5; the thermal conductivity for brass, found in Table 19.1, is 120 W/m-K. Therefore,

$$q = -k \frac{\Delta T}{\Delta x}$$

$$= -(120 \text{ W/m-K}) \left[\frac{(50 + 273 \text{ K}) - (150 + 273 \text{ K})}{22 (7.5 \text{ x } 10^{-3} \text{ m})} \right]$$

$$= 1.60 \times 10^6 \text{ W/m}^2$$

(b) Let dQ/dt represent the total heat loss such that

$$\frac{dQ}{dt} = qAt$$

where A and t are the cross-sectional area and time, respectively. Thus,

 $\frac{dQ}{dt} = (1.60 \text{ x } 10^6 \text{ J/s} \text{ - m}^2)(0.5 \text{ m}^2)(60 \text{ s/min})(60 \text{ min/h})$

=
$$2.88 \times 10^9$$
 J/h (2.73 x 10⁶ Btu/h)

(c) If soda-lime glass is used (k = 1.7 W/m-K, Table 19.1),

$$\frac{dQ}{dt} = -kAt\frac{\Delta T}{\Delta x}$$

$$= - (1.7 \text{ J/s} - \text{m} - \text{K})(0.5 \text{ m}^2)(3600 \text{ s/h}) \left(\frac{-100 \text{ K}}{7.5 \text{ x} 10^{-3} \text{ m}}\right)$$

$$= 4.08 \text{ x } 10^7 \text{ J/h} (3.9 \text{ x } 10^4 \text{ Btu/h})$$

(d) If the thickness of the brass is increased to 15 mm, then

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