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,

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

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

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

(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,

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

$$= 2.88\ \text{x}\ 10^{9}\ \text{J/h} \quad (2.73\ \text{x}\ 10^{6}\ \text{Btu/h})$$

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

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

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

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

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