15-96 The temperature of air in a duct is measured by a thermocouple. The radiation effect on the temperature measurement is to be quantified, and the actual air temperature is to be determined.

Assumptions The surfaces are opaque, diffuse, and gray.

Properties The emissivity of thermocouple is given to be ε=0.6.

Analysis The actual temperature of the air can be determined from

$$T_f = T_{th} + \frac{\varepsilon_{th}\sigma(T_{th}^{\,4} - T_w^{\,4})}{h}$$

$$= 850\,\text{K} + \frac{(0.6)(5.67 \times 10^{-8}\ \text{W/m}^2 \cdot \text{K}^4)[(850\,\text{K})^4 - (500\,\text{K})^4]}{60\ \text{W/m}^2 \cdot {}^\circ\text{C}}$$

$$= \mathbf{1111\,K}$$

Air, T_f

$T_w = 500$ K

Thermocouple
$T_{th} = 850$ K
$\varepsilon = 0.6$