

15-77 A furnace shaped like a long equilateral-triangular duct is considered. The temperature of the base surface is to be determined.

Assumptions 1 Steady operating conditions exist 2 The surfaces are opaque, diffuse, and gray. 3 Convection heat transfer is not considered. 4 End effects are neglected.

Properties The emissivities of surfaces are given to be $\varepsilon_1 = 0.8$ and $\varepsilon_2 = 0.5$.

Analysis This geometry can be treated as a two surface enclosure since two surfaces have identical properties. We consider base surface to be surface 1 and other two surface to be surface 2. Then the view factor between the two becomes $F_{12} = 1$. The temperature of the base surface is determined from

$$\dot{Q}_{12} = \frac{\sigma(T_1^4 - T_2^4)}{\frac{1-\varepsilon_1}{A_1\varepsilon_1} + \frac{1}{A_1F_{12}} + \frac{1-\varepsilon_2}{A_2\varepsilon_2}}$$

$$800 \text{ W} = \frac{(5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4)[(T_1)^4 - (500 \text{ K})^4]}{\frac{1-0.8}{(1 \text{ m}^2)(0.8)} + \frac{1}{(1 \text{ m}^2)(1)} + \frac{1-0.5}{(2 \text{ m}^2)(0.5)}}$$

$$T_1 = \mathbf{543 \text{ K}}$$

Note that $A_1 = 1 \text{ m}^2$ and $A_2 = 2 \text{ m}^2$.

