ME 353 M.M. Yovanovich

Radiative Conductance

The radiative conductance is defined as

$$h_{\text{rad}} = \frac{Q_{12}}{A_1\,(T_1 - T_2)}$$

The radiative exchange between two isothermal gray surfaces is obtained from

$$Q_{12} = \frac{E_{b1} - E_{b2}}{R_{\text{total}}}$$

where $E_{b1} = \sigma\,T_1^4$, $E_{b2} = \sigma\,T_2^4$, and the total radiative resistance consists of three resistances in series:

$$R_{\text{total}} = R_{s1} + R_{12} + R_{s2} = \frac{1-\epsilon_1}{A_1\epsilon_1} + \frac{1}{A_1\,F_{12}} + \frac{1-\epsilon_2}{A_2\epsilon_2}$$

For the general case the radiative conductance is complex because it depends on the geometry and spatial placement: A_1, A_2, F_{12}, the emissivities: ϵ_1, ϵ_2, and the temperatures: T_1, T_2 in a non-linear manner.

For the case of a small object A_1 in a much larger enclosure $A_2 >> A_1$, $F_{12} = 1$, the radiative conductance can be obtained from:

$$h_{\text{rad}} = \epsilon_1\,\sigma\,(T_1^2 + T_2^2)\,(T_1 + T_2)$$

Calculation of radiative conductance

The radiative conductance will be calculated for a small black-body $\epsilon_1 = 1$ at temperature $T_1 = T_2 + \Delta T$ where $T_2 = 300\,K$. Let $\Delta T = 1, 10, 100\,K$.

$$h_{\text{rad}} = 5.67 \times 10^{-8} \left[(300 + \Delta T)^2 + (300)^2)\right] \left[(300 + \Delta T) + 300\right]$$

For $\Delta T = 1, 10, 100\, K$, the corresponding radiative conductances are found to be: $h_{\text{rad}} = 6.15, 6.44, 9.92\, W/m^2 \cdot K$, respectively. These are the maximum values of the radiative conductance for the given temperatures. For gray surfaces, the radiative conductances will be smaller according to the emissivity of the smaller object.