RADIATION HEAT TRANSFER: BLACK SURFACES

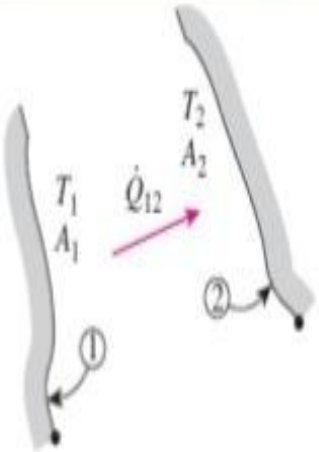

FIGURE 13–18
Two general black surfaces maintained at uniform temperatures T_1 and T_2.

When the surfaces involved can be approximated as blackbodies because of the absence of reflection, the *net* rate of radiation heat transfer from surface 1 to surface 2 is

$$\dot{Q}_{1\to 2} = \begin{pmatrix}\text{Radiation leaving}\\ \text{the entire surface 1}\\ \text{that strikes surface 2}\end{pmatrix} - \begin{pmatrix}\text{Radiation leaving}\\ \text{the entire surface 2}\\ \text{that strikes surface 1}\end{pmatrix}$$

$$= A_1 E_{b1} F_{1\to 2} - A_2 E_{b2} F_{2\to 1} \quad \text{(W)}$$

$A_1 F_{1\to 2} = A_2 F_{2\to 1}$ reciprocity relation

$E_b = \sigma T^4$ emissive power

$$\dot{Q}_{1\to 2} = A_1 F_{1\to 2} \sigma (T_1^4 - T_2^4) \quad \text{(W)}$$

A negative value for $Q_{1\to 2}$ indicates that net radiation heat transfer is from surface 2 to surface 1.

The *net* radiation heat transfer *from* any surface i of an N surface enclosure is

$$\dot{Q}_i = \sum_{j=1}^{N} \dot{Q}_{i\to j} = \sum_{j=1}^{N} A_i F_{i\to j} \sigma (T_i^4 - T_j^4) \quad \text{(W)}$$

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