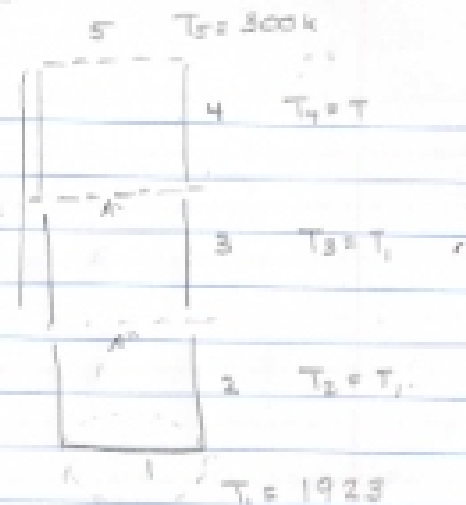


13.2 Blackbody Radiation exchange

Example 13.3

$$q_{1 \rightarrow 2} = q_{1 \rightarrow 3} = q_{1 \rightarrow 4} = q_{1 \rightarrow 5}$$

$$q_{1 \rightarrow 2} = A_1 F_{1 \rightarrow 2} \sigma (T_1^4 - T_2^4)$$



$F_{1 \rightarrow 2}$

$$R_1 = \frac{r}{L} = \frac{0.25}{.15} = 0.167$$

$$R_2 = \frac{r}{L} = 0.167$$

$$S = 1 + \frac{1 + (0.167)^2}{0.167^2} = 38$$

$$F_{1 \rightarrow 2} = \frac{1}{2} \left\{ 38 - [38^2 - 4]^{1/2} \right\} = 0.0263$$

$$A_1 = \frac{\pi D^2}{4} = \frac{\pi (0.05 \text{ m})^2}{4} = 0.00196$$

$$q_{1 \rightarrow 2} = (0.00196)(0.0263)(5.67 \times 10^{-8}) (1923^4 - 300^4) = 40.07 \text{ Watts}$$

Black Body

$$q_{i \rightarrow j} = A_i F_{i \rightarrow j} \sigma (T_i^4 - T_j^4)$$

$$A_i F_{i \rightarrow j} = A_j F_{j \rightarrow i}$$

$$\sum_j F_{i \rightarrow j} = 1$$

$F_{1 \rightarrow 2}$

$$q_{1 \rightarrow 2} = A_1 F_{1 \rightarrow 2} \sigma (T_1^4 - T_2^4)$$

$$F_{1 \rightarrow 2} = F_{2 \rightarrow 1} + F_{2 \rightarrow 3} + 1$$

$$0.0263 = \frac{r}{L} = \frac{0.025}{0.05} = 0.5$$

$$S = 1 + \frac{1 + (0.5)^2}{(0.5)^2} = 6$$

$$F_{1 \rightarrow 2} = \frac{1}{2} \left\{ 6 - [6^2 - 4]^{1/2} \right\} = 0.1716$$

$$F_{2 \rightarrow 1} = 0.8284$$

$$A_2 F_{2 \rightarrow 1} = A_1 F_{1 \rightarrow 2} \quad \therefore A_2 = \frac{\pi D^2}{4} \quad A_1 = \pi D^2$$

$$F_{1 \rightarrow 2} = \frac{1}{4} F_{2 \rightarrow 1} = 0.2071$$

$$q_{1 \rightarrow 2} = A_1 F_{1 \rightarrow 2} \sigma (T_1^4 - T_2^4) \rightarrow (\pi (0.05 \text{ m})^2)(0.2071)(5.67 \times 10^{-8})(1923^4 - 300^4)$$

$$q_{1 \rightarrow 2} = 1260.4 \text{ Watts}$$