CEN 3311 HEAT TRANSFER

Radiation: Radiaton is the transfer of energy through space by electromagnetic waves.

Thermodynamic considerations show that 'a black body' will emit energy at a rate proportional to the fourth power of the body and directly proportional to its surface area.

$$q_{emitted} = \sigma A T^4$$

q → rate of radiant energy emitted; W, J/s
T → absolute temperature; K
σ → Stephen-Boltzman constant; w/m^2K^4

$$\sigma = 5.664.10^{-8}\ w/m^2K^4$$

The net radiant exchange between two surfaces is proportional to the difference in absolute temperatures to the fourth power:

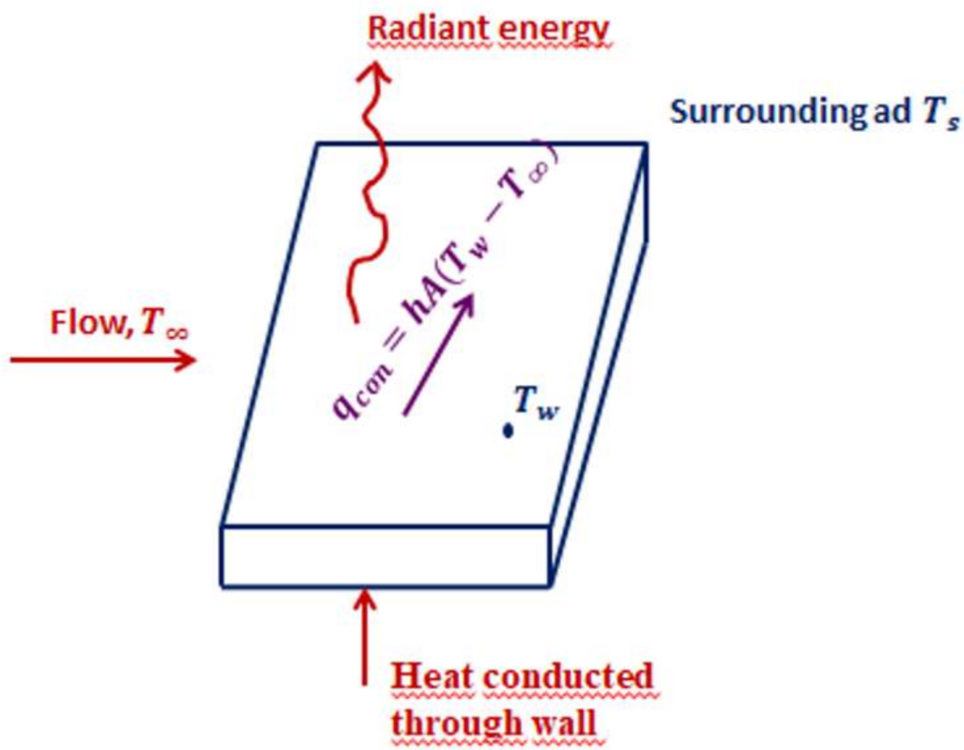
$$q_{net\ change} \propto \sigma A(T_1^4 - T_2^4)$$

- All the radiction leaving one surface do not reach toother surface since electromagnetic radiation trawels in straight line and some is lost to the surroundings. Therefor, a new factor is introduced to the equation.

$$q_{net\ change} = F_E F_G \sigma A(T_1^4 - T_2^4)$$

F_G → geometric view factor
F_E → emissivity function

Combination of conduction, convection and radiation heat transfer.



The heat conducted through the plate is removed from the plate surface by a combination of convection and radiation. An energy balance gives:

$$-kA\frac{dT}{dy}\Big|_{wall} = hA(T_w - T_\infty) + F_E F_G \sigma (T_w^4 - T_s^4)$$

T_s → temperature of surroundings

T_w → surface (wall) temperature

T_∞ → fluid temperature

Example: Two infinite blockbodies (black plates) at 800℃ and 300℃ exchange heat by radiation. Calculate the heat transfer per unit area.

$$\frac{q}{A} = G\left(T_1^4 - T_2^4\right)$$

$$G = 5.667 \times 10^{-8}\ {}^{W}/_{m^2K}$$

$$T_1 = 800 + 273 = 1073\ K$$

$$T_2 = 300 + 273 = 573\ K$$

$$= \left(5.667 \times 10^{-8}\ {}^{W}/_{m^2K}\right)(1073^4 - 573^4)K$$

$$= 69.03\ {}^{kW}/_{m^2}$$