Week Assignment 5

Question 1

In you own words (which means in your own words) write a summary of the topics about radiative heat transfer we went through including the definitions of emissivity, absorptivity and reflectivity, the view factor, the heat exchange between two black surfaces, the heat exchange between the two grey surface and finally the definition of radiative resistances

Solution

Radiative Heat Transfer: Radiative heat transfer of energy does not need any medium. Heat transfer occurs from a body with high temperature to the body with low temperature by radiation.

Emissivity: In simpler terms, it is a measure of how much thermal radiation a body emits to its environment. It can be defined as the ratio of radiant energy emitted by a surface to that of energy emitted by an ideal black body at the same temperature. The ratio varies from 0 to 1 (that of a black body surface is 1).

Absorptivity: In simpler terms, it is a measure of how much radiation is absorbed by the body. It can be defined as the ratio of absorbed radiation to that of the incident radiation hitting that surface. Like emissivity, value of absorptivity is in the range of 0 to 1.

Reflectivity: In simpler terms, it is how much energy is reflected. It is defined as the ratio of amount of radiation reflected by the surface to that of the incident radiation that hit the surface. The range is between 0 to 1. More reflectivity of the surface means the radiation reflection of the surface is more and less will be absorbed.

View Factor: It is defined as the degree to which heat carried by radiation can be passed between two surfaces.

Heat exchange between two black surfaces: In simpler terms, it can be calculated as radiation leaving the surface 1 to 2 minus the radiation leaving the surface 2 to 1. $A_1E_{b1}F_{12} - A_2E_{b2}F_{21}$.

Heat exchange between two grey surfaces: A gray surface will reflect/absorb a given fraction of the thermal radiation. Radiosity is equal to the radiation emitted by the surface plus the radiation reflected by the surface. Net radiation of heat transfer of grey surfaces is all radiation leaving surface minus incident radiation on surface.

Radiative Resistances: It can be defined as the value to calculate the energy that is released from resistance and which is converted to heat radiation. More resistance makes more heat radiation.

Question 2

Solve the last example you solved in the class (radiative heat exchange between two parallel plates) awhile considering the two emissivity's to be 0.1, what can you conclude from the result?

Solution

$$\dot{Q}_{net\ 2\text{-}1} = \frac{A\sigma(T_2^4 - T_1^4)}{\frac{1}{\epsilon 2} + \frac{1}{\epsilon 1} - 1}$$

$$\dot{Q}_{net\ 2\text{-}1} = \frac{A(5.67 \times 10^{-6})(308^4 - 298^4)}{\frac{1}{0.1} + \frac{1}{0.1} - 1}$$

$$F_1 = \frac{1}{\frac{1}{\epsilon 2} + \frac{1}{\epsilon 1} - 1} = \frac{1}{\frac{1}{0.1} + \frac{1}{0.1} - 1} = 0.0526$$

For parallel

$\dot{Q}_{net\ 1\text{-}2} = AF_1\sigma(T_2^4 - T_1^4)$

$= A \times 0.0526\ (5.67 \times 10^{-6})(308^4 - 298^4)$

$= 0.331A\ W$

For $\epsilon_1 = 0.2$, $\epsilon_2 = 0.7$

$$F_1 = \frac{1}{\frac{1}{\epsilon 2} + \frac{1}{\epsilon 1} - 1} = \frac{1}{\frac{1}{0.2} + \frac{1}{0.7} - 1} = 0.1841$$

$\dot{Q}_{net\ 2\text{-}1} = AF_1\sigma(T_2^4 - T_1^4)$

$= A \times 0.1842\ (5.67 \times 10^{-6})(308^4 - 298^4)$

$= 1.159A\ W$

Comparing the results above, we can conclude that the value of emissivity has an impact on the affect of radiative heat exchange between the surfaces.