Task 1 In your 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 gray surface and finally the definition of radiative resistances

Radiative heat transfer

The radiation heat transfer happens when there is a an object that has temperature higher than absolute zero (0°C or -273,15 K). The radiation transfer occurs in solids, liquid and gases and it doesn't require the presence of a material medium to take place and this is the most difference form conduction and convection. We can understand from that that every object around us emits thermal radiation in relation of their own temperature, higher is the temperature higher is the thermal radiation emitted. The thermal radiation is related to the electromagnetic wave, that transport energy (photons or quanta). Every electromagnetic wave is characterized by their frequency (ν) and wavelength (λ). These two properties are related by a formula: $\lambda = c / \nu$.

Emissivity (ε)

ε is the value of the emissivity and it's related to the capacity of the surface of the material to emit thermal radiation. It depends only on the material and it's value is the ratio of thermal radiation of a surface and the radiation of an ideal black surface at the same temperature. The value could wave between 0 and 1. The maximum value is 1, and if the object obtains this value it's mean that his behavior is very close to a black body that is the object that has the maximum emission of thermal radiation. The emissivity of a real surface varies with the temperature of the surface as well as the wavelength and the direction of the emitted radiation.

Absorptivity ($\propto$)

The absorptivity ($\propto$) is the measure of the ability of that material to absorb the thermal radiation. The value like the emissivity waves from 0 to 1 and it's is calculated by:

$$\propto = G_{abs} / G$$

Where G is the incident radiation and G_{abs} is the absorbed radiation.

Reflectivity (ρ)

The reflectivity (ρ) is the capacity of the material to reflect the radiation. The value waves from 0 to 1 and it's the ratio of reflected radiation and incident radiation

$$\rho = G_{ref} / G$$

The view factory (F_{ij})

The view factor is the geometrical quantity corresponding to the fraction of the radiation leaving surface *i* that is intercepted by the surface *j.* The view factor doesn't depend on the material of the object but on the shape factor, angle and configuration factor. It is the degree to which heat carried by radiation can be passed between two objects.

Heat exchange between two black surfaces

The black surfaces are two objects that has the maximum capacity to emit and absorb radiation. The heat exchange between these two bodies is a difference between the radiation leaving the entire surface 1 that strikes surface 2 and the radiation living the entire surface 2 that strikes surface 1. The equation is equal to: $Q_{1-2} = \dot{A}_1 E_{b1} F_{1-2} - A_2 E_{b2} F_{2-1}$

Applying the reciprocity relation: $A_2 F_{2-1} = A_1 F_{1-2}$

$Q_{1-2} = A_1 \dot{F}_{1-2} \sigma (T_i^4 - T_j^4)$ (W)

Heat exchange between two grey surfaces

The grey surface differs from the black surface because it's behavior it's not like an ideal model and it's not able to have the maximum capacity to emit and absorb thermal radiation because the grey surface reflects and absorbs a given fraction of the thermal radiation, instead the black body absorb that completely. The radiosity (radiation leaving a surface) in this case depends on the radiation emitted by the surface i and the radiation reflected by the same surface :

$J_i = \varepsilon_1 E_{bi} + \rho_i G_i$ (W/m^2)

Instead the value of the thermal radiation depends on a difference between the radiation leaving the entire surface i and the radiation incident on the entire surface i.

$$\dot{Q}_i = A_i\left(J_i - \frac{J_i - \varepsilon_i E_{bi}}{1 - \varepsilon_i}\right) = \frac{A_i \varepsilon_i}{1 - \varepsilon_i}(E_{bi} - J_i)$$

Radiative resistance

The radiative resistance is the value to measure the energy depleted by loss resistance which is converted to heat radiation and the energy lost by radiation resistance is converted to electromagnetic waves.

$R_i = 1 - \varepsilon_i / A_i - \varepsilon_i$

Task 2 Solve the last example you solved in the class (radiative heat exchange between two parallel plates) awhile considering the two emissivity to be 0.1, what can you conclude from the result?

Problem

Find the net radiative heat exchange between the surface 1 and the surface 2 where $A_1 = 1{,}5\ m^2$, $\varepsilon_1 = 0{,}1$, $\varepsilon_2 = 0{,}1$, $T_1 = 298$ K, $T_2 = 308$ K, $\sigma = 5{,}67*10^{-8}\ W/m^2K^4$

Answer

$\dot{Q}_{net2-1} = A\sigma(T_2^4 - T_1^4)\ /\ (1/\varepsilon_1 + 1/\varepsilon_2 - 1)$ = $1{,}5 * 5{,}67 * 10^{-8} * (308^4 - 298^4)/(1/0{,}1 + 1/0{,}1 - 1)$ = 4,9823 W

$F_{21} = 1/(1/\varepsilon_1 + 1/\varepsilon_2 - 1) = (1/0{,}1 + 1/0{,}1 - 1) = 0{,}0526$

Considering $F_{12} = 0{,}01$

$\dot{Q}_{net1-2} = AF_{12}\sigma(T_2^4 - T_1^4) = 1{,}5 * 0{,}01 * 5{,}67 * 10^{-8} * (298^4 - 308^4) = -0{,}9466\ W$

$A_1 = A_2$

$\dot{Q}_{net2-1} = -\dot{Q}_{net1-2} = 0{,}9466\ W$

Comparing the two values of the net heat exchange, we can see the value of emissivity would greatly affect the radiative heat exchange between the surfaces