Azra OZYURT - Week 5

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Radiative Heat Transfer

One of the ways for the heat to transfer from one body to another is radiative heat transfer. It will occur with waves carrying the energy. So the heat transfer will be defined and occur with wavelengths and frequencies. All matters which have the temperature above the absolute zero always emits thermal radiation. The energy that is emitting from one body will be absorbed by another. The waves does not require material in between space to carry the heat, so radiation can occur in vacuumed areas. Though it will take place in all forms of material such as solids, liquids and gasses.

Emissivity

Emissivity is a body creating and giving away heat with waves carrying energy. All matters with a temperature above 0 Kelvin, will emit radiation. It is defined in the ratio between the effective emissivity of the surface and an ideal black body with perfect emissivity. The value is between 1 and 0. If ratio is closer to 1, the emissivity is closer to a perfect emissive body. I is calculating how close the material is to a blackbody. It depends on the temperature, wavelength and direction of the emitted radiation.

Absorptivity

Absorptivity is the body absorbing the emitted heat waves from objects in the area. It is the ability of a material to absorb the radiated heat. It is used in the ratio with the incident radiation and the value is between 0 and 1.

Reflectivity

If the body is not an ideal blackbody, material surface will reflect some of the heat radiated and will not absorb all of it. It is the effectiveness of the reflectivity. It is a ratio with the incident radiation with a value between 1 and 0.

The view factor

The view factor is the geometrical quantity of the angle in between the two surfaces emitting, absorbing (etc) radiative heat transfer. It does not depend on the surface properties but depends on the placement of the two surfaces regarding one another.

The heat exchange between two black surfaces

A blackbody emits and absorbs he maximum amount of radiation per unit in a given surface. It is a standard to calculate the existing materials and radiative movements. The radiation emitted by a blackbody will be calculated as Eb(T)= σT^4

The black surface will emit a certain value of energy (Eb1) from a certain area (A) and the other black surface (Eb2) will absorb all of the energy coming from the surface 1. And vice versa. This will all happen simultaneously. So the net heat transfer between these two surfaces will be the energy gained per time by one of these surfaces. The net formula is radiation leaving the surface one and hitting the surface two, subtracted from the radiation leaving the surface two and emitted by the surface one. Which the formula is

(A1Eb1F12)-(A2Eb2F12)

Heat exchange between two gray surface

A gray surface will emit some radiosity, absorb some and reflect some. A radiation emitted by surface "i" added to the radiation reflected by surface "i" will give us the radiosity of the surface at a given time.

Net heat transfer between two gray surfaces can be calculated by (radiation leaving the entire surface) – (radiation incident on entire surface i)

Definition of Radiative resistances

It is the energy that was lost during radiation which will be turned into different waves.

The formula for the resistances is:

$$R_I = \frac{1-\varepsilon_i}{A_i \varepsilon_i}$$

Find the net radiative heat exchange between he surface 1 and 2 where

$A_1 = 1.5\ m2 \quad \epsilon_1 = 0.1 \ , \quad \epsilon_2 = 0.1 \ , T_1 = 298\ K \ , \quad \boldsymbol{T_2 = 308\ K}$

σ = 5.67*10^-8

$$\dot{Q}_{net_{2-1}} = \frac{A\sigma(T_2^4 - T_1^4)}{\frac{1}{\epsilon_2} + \frac{1}{\epsilon_1} - 1}$$

=1.5*(5.67*10^-8) * (308^4 - 298^4) / $\frac{1}{0.1} - \frac{1}{0.1} - 1$

=4.9822 W

Previous solution with he values of $\epsilon_1 = \epsilon_2 = 0.01$

$\dot{Q}\,1 \rightarrow 2 \ = \ A_1 \times F_{12} \times \sigma(T_1^4 - T_2^4)$ 1.5*0.01*5.67*10^-8*(298^4-308^4) = - 0.9466 W

WHAT WE CAME UP WITH THIS COMPARISION IS*:*

When we compare the two values from different emission values, we can see that increasing the value of emissivity will make a significant difference on he net heat transfer value

and cannot be ignored. Increasing the emissivity value will increase the radiavite heat transfer outcome.