Week5_MelissaMartinoli

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01.Summary

Thermal radiation is one of the fundamental mechanisms of heat transfer, the radiation occurs at all temperatures with the rate of emission increasing with the temperature.
Electromagnetic waves are characterized by their frequency (v) or their wavelength (λ), in relation with the speed of propagation of the wave (c).
A black body is an idealized physical body that absorbs all electromagnetic radiation, regardless of wavelength and direction.

a.emissivity

We can describe emissivity as the capacity of a material to emit a radiation. Considering our situation, we can assume as a thermal radiation emit by a surface. We use letter ε for the emissivity and we can calculate by the fraction between amount of thermal energy emitted by a body and the energy emitted by a black body. If the emissivity of a body is equal to 1 we can consider it a black body.
The real bodies have an emissivity less than 1.

$\varepsilon = \frac{E}{E_b}$

b.absorptivity

We can describe absorptivity as the capacity of a material to absorb a radiation.
Considering our situation, we can assume as a thermal radiation absorb by a surface.
We use letter α for the absorptivity and we can calculate by the fraction between the amount of absorbed thermal radiation and the incident thermal radiation.
The value of absorptivity is including between 0 and 1.

$\alpha = \frac{Gabs}{G}$

There is a relation between emissivity and absorptivity expressed by the Kirchoff law:
$\varepsilon(T) = \alpha(T)$
This formula means that emissivity and absorptivity are the same for a body at a certain temperature.

c.reflectivity

We can describe reflectivity as the capacity of a material to reflect a radiation. Considering our situation, we can assume as a thermal radiation reflected by a surface.
We use letter ρ for the reflectivity and we can calculate by the fraction between the amount of reflected thermal radiation and the incident thermal radiation.
The value of absorptivity is including between 0 and 1.

$\rho = \frac{Gref}{G}$

d.view factor
We can describe the view factor as the fraction of the radiation that is leaving a surface and that is intercepted by another surface. This view factor depends only from the area (A) and we use letter F for this factor.

e.heat exchange between two black surfaces
In the heat exchange between two black bodies, their emissive power is equal to:

Eb (T) = σT4 (W/m2)

the radiation exchanged by the surface S1 is: Eb1 x A1
the radiation exchanged by the surface S2 is: Eb2 x A2

These two surfaces also absorb each radiation, so the heat exchange between these bodies can be calculated as:

Q̇ 12 = A1 x Eb1 x F1,2 - A2 x Eb2 x F2,1

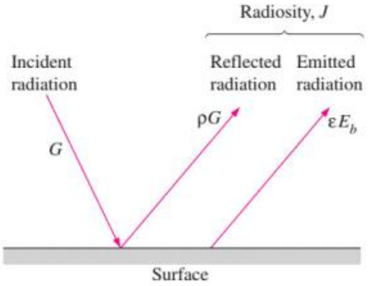
Q̇ 12 = A1 x F1,2 x σ (T41 - T42)

f.heat exchange between two grey surfaces
Grey and opaque surfaces can absorb just a fraction of the thermal radiation compared to black bodies, but their emissive power can be calculated as for a black body.

Eb (T) = σT4i (W/m2)

It is possible to find the heat exchange between two grey surfaces through this formula:

Q̇ i = Ai (Ji x Gi)
J is the radiosity
G is the incident radiation



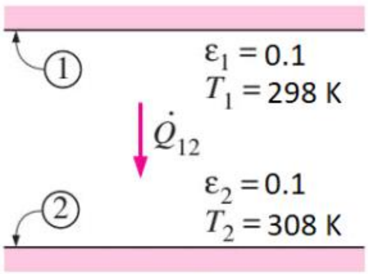
The radiosity J can be found as: εi Ebi + (1 - εi) Gi (W/m2)

g.radiative resistance
Radiative resistance is a value to measure the energy related with loss resistance which is converted in heat radiation, the energy lost by radiation resistance is converted in radio waves.

The formula to calculate it is: Ri = $\frac{1 - \varepsilon_i}{A_i\ \varepsilon_i}$

02.Following the example solved in class, find the net radiative heat exchange between the surface 1 and the surface 2.

A1 = 1,5 m2
Є1 = 0.1
Є2 = 0.1
T1 = 298 K
T2 = 308 K
σ = 5.67 x 10-8 (W/m2 x K4)



$\dot{Q}$ 12 = $\frac{A\sigma\,(T_1^4 - T_2^4)}{\frac{1}{\epsilon 1}+\frac{1}{\epsilon 2}-1}$ $\quad\quad$ $\dot{Q}\ 12 = \frac{1{,}5 \text{ x } (5.67 \text{ x } 10^{-8}) \text{ x } (308^4 - 298^4)}{\frac{1}{0.1}+\frac{1}{0.1}-1} = 4{,}982 \text{ W}$

F1,2 = $\frac{1}{\frac{1}{\epsilon 1}+\frac{1}{\epsilon 2}-1}$ $\quad\quad$ $\text{F1,2} = \frac{1}{\frac{1}{0.1}+\frac{1}{0.1}-1} = 0{,}052$

when F1,2 = 0.01

Q̇ 12 = A1 x F1,2 x σT41 - A1 x F1,2 x σT42 = A1 x F1,2 x σ (T41 - T42)

Q̇ 12 = 1,5 x 0,01 x 5.67 x 10-8 (3084 - 2984) = 0,947

From the values obtained, we can see that the emissivity (Є) can widely affect the radiative heat exchange between surfaces.