Weekly submission 5

martedì 5 novembre 2019 12:21

Summary

Radiative heat transfer

·Definition of emissivity

Emissivity is the ratio between the flow of radiation emitted per unit area of an object and the flow of radiation emitted by the black body at the same temperature.
It shows that the actual thermal radiation of the object is close to the one with the black body.

·Definitions of absorbency

The absorbency of the surface of a material is a measure of the absorption capacity of a material. We use the ratio between the absorbed radiation and the incident radiant power to calculate the absorbency value, which varies from 0 to 1. It is a measure of a substance's ability to absorb light at a given wavelenght.

·Definitions of reflectivity

Reflectivity is the amount of radiant energy reflected by an object.
The intensity of the emitted radiation depends on the visual factor of the surface relative to the sky, and is the degree to which the heat carried by the radiation can pass through two surfaces. The visual factor is the fraction of radiation that leaves a surface that is intercepted by a second surface.

·Heat exchange between two black surfaces

A black surface emits a radiation of Eb_1 per unit area per unit time.
This radiation will go to the other black surface and will be completely absorbed by it, but at the same time the 2nd black body will in turn emit the radiation ($Eb_2 \times A_2$) per second, which will go to the first body and will be totally absorbed by it.
So the net heat transfer between these surfaces is equal to the net heat per second, i.e. the power obtained from any of the two surfaces.
The net heat transfer is equal to the radiation that leaves the entire surface 1 hitting surface 2, subtracting the radiation that leaves surface 2 hitting surface 1.
all surface 2 hitting surface 1, which is, in formula: $A_1Eb_1F_1F_{1\text{-}2}$ - $A_2Eb_2F_2F_{2\text{-}1}$.

·Heat Exchange (between the two Gray Surface):

Unlike black surface, the heat exchange between two gray surfaces absorbs and reflects only a portion of the radiation.
Can be expressed by a formula: $A_iJ_iF_{i\text{-}j}$- $A_jJ_jF_{j\text{-}i}$, (A represents the area of the black surface, J represents the amount of radiation emitted per unit area per unit time, F represents the view factor), and applying the reciprocity relation:
$A_1F_{1\text{-}2} = A_2F_{2\text{-}1}$
so : $\dot{Q}_{i\rightarrow j} = A_i \times F_{i-j} \times \left(J_i - J_j\right)$

·Radiative Resistances:

The radiative resistance is a value used to measure the loss resistance energy, and the loss energy is converted into heat radiation; the energy lost by the radiative resistance is converted into radio waves.

Task2: Solve the last example you solved in the class (radiative heat exchange between two parallel plates) awhile considering the two emissivities to be 0.1, what can you conclude from the result?

Question:

Find the net heat exchange between the surface 1 and 2 where $A_1 = 1.5\ m^2$, $F_{12} = 0.01$, $T_1 = 298\ K$, $T_2 = 308\ K$, ϵ_1=0.1, ϵ_2=0.1, σ=5.67*10-8$\frac{W}{m^2 \cdot K_4}$.
Solve the last example in the class (radiative heat exchange between two parallel plates) awhile

considering the two emissivities to be 0.1, what can you conclude from the result?

Answer:

$$\dot{Q}_{1\to2} = \frac{A_1\sigma\left(T_1^4 - T_2^4\right)}{\frac{1}{\epsilon_1}+\frac{1}{\epsilon_2}-1} = \frac{1.5*5.67*10^{-8}*\left(308^4 - 298^4\right)}{\frac{1}{0.1}+\frac{1}{0.1}-1} = 4.9821\text{W}$$

$$F_{12} = \frac{1}{\frac{1}{\epsilon_1}+\frac{1}{\epsilon_2}-1} = \frac{1}{\frac{1}{0.1}+\frac{1}{0.1}-1} = 0.0526$$

The example solved in the class:

F_{12} = 0.01

$\dot{Q}_{1\to2} = A_1 \times F_{12} \times \sigma\left(T_1^4 - T_2^4\right)$ =1.5*0.01*5.67*10-8*(2984-3084) =-0.9466 W

$\dot{Q}_{2\to1} = -\dot{Q}_{1\to2}$ = 0.9466 W

Conclusions

From the result, we can see that when the value of emissivity increases, the view factor will increase more, and the value of radiative heat transfer will also increase, so we can see that the value of emissivity would significantly affects the radiative heat exchange between the surfaces.