#WEEK 5_WANG YIJIN

Task 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 betweeen two black surfaces, the heat exchange between the two gray surface and finally the definition of radiative resistances.*

SUMMARY

Radiative heat transfer

Each object in nature is constantly emitting radiant heat into space, and at the same time, it is constantly absorbing the radiant heat emitted by other objects. The heat transfer between the surface of the object is completed by the combined action of radiation and absorption, which is radiative heat transfer.

Definition of emissivity ,absorptivity and reflectivity

1) Emissivity

The ratio of the radiation flux emitted per unit area on the surface of an object to the radiation flux emitted by the black body at the same temperature.
The ratio of the radiation emission of an object to that of an absolute black body at the same temperature and wavelength. It shows that the actual thermal radiation of the object is close to that of the black body. It is one of the important basic factors that affect the surface temperature.

2) Absorptivity

Absorptivity is the ratio of the amount of radiation absorbed by the surface to the total radiation energy of the incident electromagnetic wave.The value of absorptivity is related to the properties of the substance to be measured, the solvent and the wavelength of light.

3) Reflectivity

Reflectivity is the ratio of the amount of radiation reflected by the surface to the total radiation energy of the incident electromagnetic wave.Reflectivity deviates from the other properties in that it is bidirectional in nature. In other words, this property depends on the direction of the incident of radiation as well as the direction of the reflection.

The view factor

The view factor, is a geometrical quantity corresponding to the fraction of the radiation leaving surface A that is intercepted by the surface B.
In radiative heat transfer, a view factor, is the proportion of the radiation which leaves surface A that strikes surface B. In a complex 'scene' there can be any number of different objects, which can be divided in turn into even more surfaces and surface segments.

The heat exchange between two black surfaces

The heat exchange between two black surfaces refers to the process in which one black surface emits radiation to another black surface and is completely absorbed, while the other black surface also emits radiation and is also completely absorbed by the first black surface. Can be expressed by a formula: A1Eb1F1-2- A2Eb2F2-1, (A represents the area of the black surface, Eb represents the amount of radiation emitted per unit area per unit time, F represents the view factor), and applying the reciprocity relation: A1F1-2= A2F2-1, so $\dot{Q}_{1\to 2} = A_1 \times F_{12} \times \sigma \left(T_1^4 - T_2^4\right)$.

The 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. A gray surface i emits radiation to another gray surface j, radiation leaving the entire surface i that strikes surface j subtracts radiation leaving the entire surface j that strikes surface i. Can be expressed by a formula:

$$J_i = \varepsilon E_{bi} + \rho G = \varepsilon \sigma T^4 + (1-\varepsilon)G$$

$$\dot{Q}_{i\to j} = A_i F_{i\to j}(J_i - J_j)$$

The definition of 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.

From one surface to another, the total resistance is

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

$$R_{\text{total}} = R_i + R_{i-j} + R_j = \frac{1-\varepsilon_i}{A_i \varepsilon_i} + \frac{1}{A_i F_{i-j}} + \frac{1-\varepsilon_j}{A_j \varepsilon_j}$$

***Task 2** 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 A1 = 1.5 m2, F12 = 0.01, T1 = 298 K, T2 = 308 K, ϵ_1=0.1, ϵ_2=0.1, σ=5.67*10-8$\frac{W}{m^2 \cdot K4}$.

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?

Solution:

$$\dot{Q}_{1\to2} = \frac{A_1\sigma\left(T_1^4 - T_2^4\right)}{\frac{1}{\epsilon_1}+\frac{1}{\epsilon_2}-1} = \frac{1.5\times5.67\times10^{-8}\times(308^4-298^4)}{\frac{1}{0.1}+\frac{1}{0.1}-1} = 4.9821\text{W}$$

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

The example solved in the class:

$F_{12} = 0.01$

$$\dot{Q}_{1\to2} = A_1 \times F_{12} \times \sigma\left(T_1^4 - T_2^4\right) = 1.5\times0.01\times5.67\times10^{-8}\times(298^4-308^4) = -0.9466W$$

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

Conclusion:

From the result, we can see that when the value of emissivity increases, the view factor will increase more obviously, and the value of radiative heat transfer will also increase significantly.