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.

radiative heat transfer

While the object emits radiant energy outward, it also continuously absorbs the radiant energy emitted by other surrounding objects and converts it into thermal energy. The heat transfer between the objects that emits radiant energy and absorbs radiant energy is called radiation heat transfer. If the radiation heat transfer is between two objects with different temperatures, the result of the heat transfer is that the high temperature object transfers the heat to the low temperature object. If the temperature of the two objects is the same, the radiation heat transfer between the objects is equal to zero, but the object. The process of radiation and absorption is still ongoing. The process of relying on electromagnetic wave radiation to achieve heat transfer between hot and cold objects is a non-contact heat transfer that can also be carried out in a vacuum.

Emissivity

The emissivity is the ratio of the radiation exitivity of an object to the radiation outlier of an absolute black body at the same wavelength of the same temperature. It characterizes the proximity of the thermal radiation of the actual object to the thermal radiation of the black body. It is one of the important basic factors affecting the surface temperature. The specific emissivity varies with the dielectric constant, surface roughness, temperature, wavelength, and direction of observation of the material, and the value is between 0 and 1.

Absorptivity

Absorptivity refers to the ratio of the heat radiation energy absorbed by an object onto the object and the total heat radiation energy projected onto the object is called the absorption rate of the object. The Absorptivity of the surface of the object is related to the nature of the object, the surface condition and the temperature. It is an inherent characteristic of the object itself, and has nothing to do with the external environment.

Reflectivity

The radiant energy reflected by an object as a percentage of the total radiant energy is called the reflectivity. The reflectivity of different objects is also different, which depends mainly on the nature of the object itself, as well as the wavelength and incident angle of the incident electromagnetic wave. The range of the reflectivity is

always less than or equal to 1, and the reflectivity can be used to judge the properties of the object.

View Factor

The view factor, is a geometrical quantity corresponding to the fraction of the radiation leaving surface i that is intercepted by the surface j. It does not depend on the surface properties. It is also called shape factor, configuration factor, and angle factor.

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 $\dot{Q}_{1\to 2} = A_1 \times F_{12} \times \sigma\left(T_1^4 - T_2^4\right)$.

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: AiJiFi-j- AjJjFj-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: A1F1-2= A2F2-1, so $\dot{Q}_{\mathrm{i}\to\mathrm{j}} = A_{\mathrm{i}} \times F_{\mathrm{i}-\mathrm{j}} \times \left(\mathrm{J_i} - \mathrm{J_j}\right)$.

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.

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, $\boldsymbol{\epsilon_1}$=0.1, $\boldsymbol{\epsilon_2}$=0.1, $\boldsymbol{\sigma}$=5.67*10-8$\frac{\boldsymbol{W}}{\mathrm{m}^2\cdot\boldsymbol{K4}}$.

Solution:

$$\dot{Q}_{2\to1}=\frac{A_1\sigma(T_1^4-T_2^4)}{\frac{1}{\in_1}+\frac{1}{\in_2}-1}=\frac{1.5*5.67*10^{-8}*(308^4-298^4)}{\frac{1}{0.1}+\frac{1}{0.1}-1}=4.9823W$$

$$\mathrm{F}_{2\to1}=\frac{1}{\frac{1}{\in_1}+\frac{1}{\in_2}-1}=\frac{1}{\frac{1}{0.1}+\frac{1}{0.1}-1}=0.0526$$

$$\mathrm{F}_{12}=0.01$$

$$\dot{Q}_{1\to2}=A_1*\mathrm{F}_{12}*\sigma(T_1^4-T_2^4)=1.5*0.01*5.67*10^{-8}*(298^4-308^4)=-0.9466W$$

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

Conclusion:

It can be seen from the results that as the emissivity value increases, the field of view factor will increase more significantly, and the value of radiant heat transfer will also increase significantly.