Week 5

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Task 1: Summary of the topics about radiative heat transfer including the definitions of emissivity, absorptivity and reflectivity, the view factor, the heat exchange between two black surfaces, the heat exchange between the two gray surface and finally the definition of radiative resistances

About **Emissivity**:

Emissivity shows how close is the actual thermal radiation of the object to that of the black body. It represents 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. It can be represented by the symbol ε, and usually $0 \leqslant \varepsilon \leqslant 1$. When $\varepsilon=1$, we can regard the object as black body.

About **Absorptivity and Reflectivity:**

When an object receives radiation, there are usually three phenomena: absorption, reflection, and penetration. The absorptivity and reflectivity are the ratio of the absorbed and reflected radiation of the object to the total received radiation. They can be represented by the symbol α ρ, and usually $0 \leqslant \alpha\ \rho \leqslant 1$, $\alpha + \rho + \tau = 1$.

About **the View Factor:**

The view factor represents the amount of radiation emitted from one surface and received by another. It's a geometric quantity, independent of the surface properties of the object, and only related to the distance between the two surfaces and the area of the surface.

About **the Heat Exchange between Two Black Surfaces:**

The radiation emitted from the surface of one black body (1) is E1*A1, which is completely absorbed by the surface of the other black body (2). After absorption, the blackbody 2 will release the amount of E2*A2 radiation, which will be fully absorbed by blackbody 1. This process occurs simultaneously, so both surfaces receive the same amount of radiation at the same time. The heat transfer is the radiation leaving surface1 and surface2 minus the radiation leaving surface2 and surface1, that can be present in formula: $Q = E_1A_1F_{1-2} - E_2A_2F_{2-1}$

About **the Heat Exchange between Two Gray Surfaces:**

After receiving radiation, the gray body not only absorbs but also reflects. Therefore, the radiation departing from the surface of the gray body is defined as Radiosity J, and it is the sum of the radiation emitted from the surface of the gray body and the reflected radiation. Therefore, the heat transfer Q is the amount of radiation from the surface of the gray body minus the amount of radiation absorbed by the surface of the gray body, namely formula $A_1(J_1\text{-}G_1)$. After the transformation, we can get $\frac{A1-\varepsilon 1}{1-\varepsilon 1}(\varepsilon 1 - j1)$

About **the Definition of Radiative Resistances:**

Radiative resistance is an equivalent resistance, and the energy lost due to its radiation resistance will be converted into radiation. When the current flowing through the resistance is the input current, the power it consumes is equal to the radiation power. It is used to measure the conversion of electrical resistance to thermal radiation. It can be shown on formula: $R_1=\frac{1-\varepsilon 1}{A1\varepsilon 1}$

Task 2 Solve the last example (radiative heat exchange between two parallel plates) awhile considering the two emissivity to be 0.1, what can you conclude from the result?

We already known: $A_1=1.5m^2$, $T_1=800K$, $T_2=500K$, $\sigma=5.67*10^{-8}\ {}^{W}/_{m^2K^4}$

When $\varepsilon_1=0.1$, $\varepsilon_2=0.7$

$$Q_{12} = \frac{A\sigma(T_2^4-T_1^4)}{\frac{1}{\varepsilon 2}+\frac{1}{\varepsilon 1}-1} = \frac{1.5*5.67*10^{-8}*(800^4-500^4)}{\frac{1}{0.2}+\frac{1}{0.7}-1} = 5436.62W$$

When $\varepsilon_1=\varepsilon_2=0.1$

$$Q_{12} = \frac{A\sigma(T_2^4-T_1^4)}{\frac{1}{\varepsilon 2}+\frac{1}{\varepsilon 1}-1} = \frac{1.5*5.67*10^{-8}*(800^4-500^4)}{\frac{1}{0.1}+\frac{1}{0.1}-1} = 1553.73W$$

$$F_{1-2} = \frac{1}{\frac{1}{\varepsilon 2}+\frac{1}{\varepsilon 1}-1} = \frac{1}{\frac{1}{0.1}+\frac{1}{0.1}-1} \approx 0.0526$$

When $F_{1-2} = 0.01$

$$Q1\text{-}2 = A\sigma F_{1-2}(T_1^4-T_2^4) = 1.5*5.67*10^{-8}*0.01*(800^4-500^4) = 295.21W$$

We can see from those two situation that emissivity value can greatly affect the radiative heat exchange between two surfaces.