Week5 Assignment
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1.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 between two black surfaces, the heat exchange between the two gray surface and finally the definition of radiative resistances.

Radiative heat transfer

The radiative heat transfer takes place around us. It doesn't require any medium. The process of radiating electromagnetic waves due to temperature becomes radiative heat transfer. The radiative heat transfer occurs on any object above absolute zero, regardless of the material (liquid, solid, gas), thermal radiation is also the only form of heat transfer in vacuum. The higher the temperature, the greater the energy of heat radiation.

The definitions of emissivity

The emissivity (ε)is the ratio of the amount of radiation on the surface of the object to the amount of radiation of the black body at the same temperature at a certain temperature. Its value is between 0 and 1. Emissivity is a measure of how a surface approximates a black body.

The definitions of absorptivity

Absorptivity (α) is the ratio of radiation absorbed onto an object and total radiation projected onto the object. Its value is between 0 and 1. It reflects the ability of an object to absorb radiation. The larger the value, the stronger the ability of the object to absorb radiation.

The definitions of reflectivity

Reflectivity (ρ) is the ratio of the radiation that is projected onto the object and the total radiation that is projected onto the object. Its value is between 0 and 1. It reflects the ability of an object to reflect radiation. The larger the value, the stronger the ability of the object to reflect radiation.

The definitions of the view factor

The view factor (F) is the amount by which a surface-emitting thermal radiation is intercepted by another surface ratio the amount of surface-emitting thermal radiation. The view factor is a geometric quantity, no unit. Its range is between 0 and 1.

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: $A_1E_{b1}F_{1-2}$- $A_2E_{b2}F_{2-1}$, (A represents the area of the black surface, E_b represents the amount of radiation emitted per unit area per unit time, F represents the view factor), and applying the reciprocity relation: $A_1F_{1-2}= A_2F_{2-1}$, so $\dot{Q}_{1\to2} = A_1 \times F_{12} \times \sigma \left(T_1^4 - T_2^4\right)$.

The heat exchange between the two gray surfaces

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: $A_iJ_iF_{i-j}$- $A_jJ_jF_{j-i}$, (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: $A_1F_{1-2}= A_2F_{2-1}$, so $\dot{Q}_{\mathrm{i}\to\mathrm{j}} = A_\mathrm{i} \times F_{\mathrm{i}-\mathrm{j}} \times \left(\mathrm{J}_\mathrm{i} - \mathrm{J}_\mathrm{j}\right)$.

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.

2. 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*$10^{-8}\frac{W}{m^2 \cdot K4}$

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?

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

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

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}*(298^4-308^4) =-0.9466 W

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

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.