Week5 YUYUE

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**

1) The definitions of emissivity:

The ratio of the radiation exit of the heat radiator to the radiation exit of the full radiator at the same temperature. It is used to measure the ability of an object's surface to release energy in the form of heat radiation.

2) The definitions of absorptivity:

The ratio of the thermal radiation energy absorbed by the object to the object and the total heat radiation energy projected onto the object is called the absorption rate of the object.

3) The definitions of 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 (surface condition), as well as the wavelength and incident angle of the incident electromagnetic wave. The range of reflectivity is always less than or equal to 1 and the reflectivity can be used to judge the properties of the object.

4) 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.

5) 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

$$\dot{Q}_{net_{1-2}} = A_1 * F_{12} * (T_2^4 - T_1^4)$$

6) 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:

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

$$\dot{Q}_{i \to j} = A_i * F_{i \to j} * \left(j_i - j_j\right)$$

7) 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

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

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

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?**

$$\dot{Q}_{net_{1-2}} = \frac{A\sigma(T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1} = \frac{(1.5 * 5.67 * 10^{-8}) * (308^4 - 298^4)}{\frac{1}{0.1} + \frac{1}{0.1} - 1}$$

$$= 4.9821 W/m^2$$

$$F_{12} = \frac{1}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1} = \frac{1}{\frac{1}{0.1} + \frac{1}{0.1} - 1} = 0.0526$$

The example solved in the class:

$$F_{12} = 0.01$$

$$\dot{Q}_{net_{1-2}} = A_1 * F_{12} * \sigma(T_1^4 - T_2^4)$$

$$= 1.5 * 0.01 * 5.67 * 10^{-8} * (308^4 - 298^4) = 0.9466 W$$