Week 5 --- Kou Yu

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

1) Emissivity

---The black body has the strongest ability to emit thermal radiation at the same temperature, including all directions and all wavelengths.

---The surface of a real object has a lower emission capacity than the black body at the same temperature.

---Therefore, the emissivity E is defined: the ratio of the radiation force of the actual object to the total radiation power of the black body at the same temperature is the emissivity

---But this time the ratio is only for the direction and spectral averaging. In fact, the true surface emission ability varies with direction and spectrum.

2）Absorptivity

The percentage of the object absorbed by the radiant energy of a particular wavelength. The change of the spectral absorptivity with the wavelength reflects the selective absorption characteristics of the actual object.

$$\textit{Absorptivity:} \qquad \alpha = \frac{\text{Absorbed radiation}}{\text{Incident radiation}} = \frac{G_{\text{abs}}}{G}, \qquad 0 \le \alpha \le 1$$

3)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 angle of incidence of the incident electromagnetic wave.

$$\textit{Reflectivity:} \qquad \rho = \frac{\text{Reflected radiation}}{\text{Incident radiation}} = \frac{G_{\text{ref}}}{G}, \qquad 0 \le \rho \le 1$$

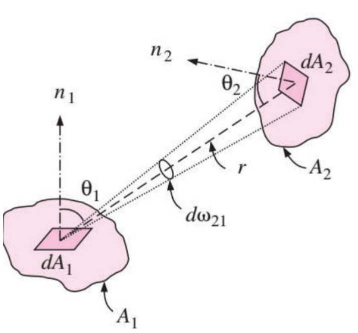
4) Transmissivity

Transmissivity is the phenomenon of incident light after it has been refracted through an object. If the transparent body is colorless, most of the light passes through the object except that a small amount of light is reflected. In order to indicate the extent to which the transparent body transmits light, the light transmission property of the object is usually characterized by the ratio τ of the transmitted light flux to the incident light flux.

$$\textit{Transmissivity:} \qquad \tau = \frac{\text{Transmitted radiation}}{\text{Incident radiation}} = \frac{G_{\text{tr}}}{G}, \qquad 0 \le \tau \le 1$$

5) View factor

The angular coefficient is the percentage of radiant energy emitted by a surface that falls to another surface.



$$F_{12} = F_{A_1 \to A_2} = \frac{\dot{Q}_{A_1 \to A_2}}{\dot{Q}_{A_1}}$$

$$F_{21} = F_{A_2 \to A_1} = \frac{Q_{A_2 \to A_1}}{\dot{Q}_{A_2}}$$

$$A_1 F_{12} = A_2 F_{21}$$

6）The heat exchange between two black surfaces

The black surface will emit Eb1 radiation per unit area per unit time. If the surface has an A1 unit area, it will emit Eb1*A1 radiation per unit time, which will reach the other black surface and be completely absorbed by it but at the same time the second black body will emit radiation Eb2*A2 every second and Reach the first black body and be completely absorbed by it. The whole process happens at the same time. Therefore, the net heat transfer between these surfaces is net heat. The heat (power) obtained per second of either surface (the two surfaces are clearly the same).

Therefore, the net heat transfer is Eb1 * A1-Eb2 * A2. This is a black body. However, in the case of a normal human body, it does not absorb all of the radiation, nor does it reflect the radiation of the first body, and the radiation is again absorbed by the first body. We use the term radiance (represented by J)

7)heat exchange between the two gray surface

the gray surfaces don't neither absorb all incident radiation nor emit all inner heat, so the
$J_i = \epsilon E_{bi} + \rho G = \epsilon\sigma T^4 + (1-\epsilon)G$
as the same process above we can know $Q_{i\to j} = A_i F_{i\to j}(J_i - J_j)$

8) **radiative resistances**

Because we known that $\dot{Q}_i = \frac{E_{bi} - J_i}{R_i}$ So,defining the $R_i = \frac{1-\varepsilon_i}{A_i\varepsilon_i}$

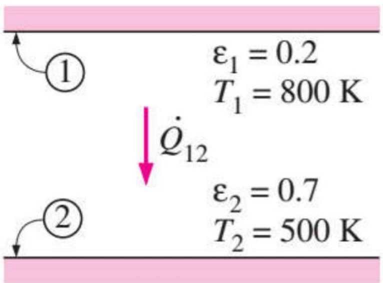
We know that $A_1F_{1\to 2} = A_2F_{2\to 1}$

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

$$\dot{Q}_{i\to j} = \frac{J_i - J_j}{R_{i\to j}}$$

We can get $R_{i\to j} = \frac{1}{A_i F_{i\to j}}$

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?



A1=A2

F12=1

$$\dot{Q}_{12} = \frac{A\times\sigma\times(T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1}+\frac{1}{\varepsilon_2}-1} = \frac{5{,}67 * 10^{-8}\times(800^4 - 500^4)}{\frac{1}{0{,}1}+\frac{1}{0{,}1}-1} = \frac{19680{,}57}{19} = 1035{,}82\ W$$

Comparing the different values derived from the change in E, the increase in R leads to a large change in heat exchange.