ASSIGMENT 5 (WEEK 5)

Task 1: In your 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 between two black surfaces, the heat exchange between the two grey surface and finally the definition of radiative resistances.

Solution:

The **emissivity** coefficient is commonly indicated with the symbol ε. In reality, the emissivity of real objects is generally wavelength dependent and indicated with the symbol ελ, which is called spectral emissivity coefficient. A real object emits only a part Eλ of the radiation emitted by a blackbody Eλb at the same temperature and at the same wavelength.

For some nonblackbody objects, the emissivity does not vary with the wavelength; these objects are called greybodies. A comparison between the spectral radiant emittance of a blackbody, a greybody and a real body, all at the same temperature. From these plots, it is clear that the radiation curve of a greybody is identical to that of a blackbody except that it is scaled down for the radiated power by the factor ε. Conversely, the radiation distribution of a real object depends on the wavelength.

The **absorption** coefficient describes the intensity attenuation of the light passing through a material. It can be understood as the sum of the absorption cross-sections per unit volume of a material for an optical process. The higher it is, the shorter length the light can penetrate into a material before it is absorbed.

The **reflectivity** is the fraction of radiation reflected by the surface. It is the ratio of reflected radiation (G ref) to incident radiation (G). Its value: $0 \leq \rho \leq 1$

The **transmissivity** is the fraction of radiation transmitted is called the transmissivity (τ). It is the ratio of transmitted radiation (G tr) to incident radiation (G). Its value: $0 \leq \tau \leq 1$

The first law of thermodynamics requires that the sum of the absorbed, reflected, and transmitted radiation energy be equal to the incident radiation. That is,

$G_{abs} + G_{ref} + G_{tr} = G$

Dividing each term of this relation by G yields

$\alpha+\rho+\tau=1$

For opaque surfaces, $\tau=0$, and thus

$\alpha+\rho=1$

This is an important property relation since it enables us to determine both the absorptivity and reflectivity of an opaque surface by measuring either of these properties.

Radiation resistance is that part of an antenna's feedpoint resistance that is caused by the radiation of electromagnetic waves from the antenna, as opposed to loss resistance (also called ohmic resistance) which is caused by ordinary electrical resistance in the antenna, or energy lost to nearby objects, such as the earth, which dissipate RF energy as heat.

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?

Solution:

When the ϵ_1=0.2 and ϵ_2=0.7;

$$R_{total} = \frac{1}{0.2} + \frac{1}{0.7} - 1 = 5.43$$

$$\dot{Q}_{12} = \frac{A\sigma(T_1^4 - T_2^4)}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1} = A * 5.67 * 10^{-8} * \frac{800^4 - 500^4}{\frac{1}{0.2} + \frac{1}{0.7} - 1} = 3624.68\, A\, W$$

When the ϵ_1=ϵ_2=0.1;

$$R'_{total} = \frac{1}{0.1} + \frac{1}{0.1} - 1 = 19$$

$$\dot{Q}'_{12} = \frac{A\sigma(T_1^4 - T_2^4)}{\frac{1}{\epsilon'_1} + \frac{1}{\epsilon'_2} - 1} = A * 5.67 * 10^{-8} * \frac{800^4 - 500^4}{\frac{1}{0.1} + \frac{1}{0.1} - 1} = 1035.72\, A\, W$$

From the result we can conclude that when the emissivity is lower, the heat transfer is also lower.