## *WEEK ASSIGMENT 5*

### *Problem 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*

Thermal radiation, one of three types of heat transfers, is the emission or transmission of electromagnetic waves from objects that has a temperature more than absolute zero. Radiation of all bodies is in the form of photons moving in a random direction, with random phase and frequency. When radiated photons reach some different kind of surface, there is three ways how that can end. They can be transmitted, reflected or apsorbed.

### *The emissivity, the absorbtion, the reflectivity and the transmissivity*

1. The amount of thermal radiation emitted depends on the emissivity of the object's surface. Emissivity is  ratio of the energy radiated from a material's surface to that radiated from a a perfect emitter, known as a blackbody, at the same temperature and wavelength and under the same viewing conditions. The emissivity coefficient is commonly indicated with the symbol $\varepsilon$. In reality, the emissivity of real objects is generally wavelength dependent and indicated with the symbol $\varepsilon\lambda$, which is called spectral emissivity coefficient. A real object emits only a part $E\lambda$ of the radiation emitted by a blackbody $E\lambda b$ at the same temperature and at the same wavelength. The emissivity coefficient is indicated with Greek letter **$\varepsilon$**. The value of emissivity can be between $0 \leq \boldsymbol{\varepsilon} \leq 1$, where the 1 is ideal black body,
2. The amount of thermal radiation absorbed depends on the absorbtivity of the object’s surface.

The absorbtion coefficient:

- Different semiconductor materials have different absorption coefficients
- Materials with higher absorption coefficients more readily absorb photons, which excite electrons into the conduction band
- Knowing the absorption coefficients of materials aids engineers in determining which material to use in their solar cell designs

  The absorption coefficient determines how far into a material light of a particular wavelength can penetrate before it is absorbed. In a material with a low absorption coefficient, light is only poorly absorbed, and if the material is thin enough, it will appear transparent to that wavelength. The absorption coefficient depends on the material and also on the wavelength of light which is being absorbed.

3. The reflectivity is the ratio of the amount of radiation reflected by the surface to the total radiation energy of the electromagnetic wave. In other words, 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: $0 \leq \rho \leq 1$
4. The transmissivity is the fraction of radiation transmitted is called the transmissivity ($\tau$). 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 means that:

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

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.

*View factor ( F )* is the fraction of radiation leaving one surface which is intercepted by a second surface. The intensity of the emitted radiation depends on the view factor of the surface relative to the sky.

*Problem 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 $\epsilon_1$=0.2 and $\epsilon_2$=0.7;

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

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

When the $\epsilon_1$=$\epsilon_2$=0.1;

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

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

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