Assignment of Week 5
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Course: Technical Environmental System, Dr. Behzad Najafi

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Task 1:

The heat transfer from a body with a high temperature to a body with a lower temperature by radiation is called heat radiation. Thermal radiation doesn't need a medium in order to take place. Thermal radiation happens in all kind of objects (Solid, liquid, and Gas). Note that the rate of emission of radiation through radiative heat transfer increases with the temperature. When radiations reach another surface of nearby objects, they may be absorbed, reflected or transmitted.

Emissivity (ε): Emissivity is the relation of how much an object can emits energy by radiation. It is the ratio of the total amount of radiation emitted by a surface of an object to that of a black body emitting at the same temperature. It can ranges from 0 to 1, where one is the emissivity of an ideal black body. A black body absorbs all the radiation it hits, and emits all the energy it has.

Absorptivity (α): Absorptivity is the relation of how much an object can absorb incoming radiations. It is the ratio of the radiation absorbed by the surface at a given temperature divided by the quantity of incident radiations on the same surface. It is as well a number between 0 and 1. It is comparison between the selected object and the perfect absorbent black object, where one stands for the perfect absorbent in the case of a blackbody with a $\alpha = 1$.

Reflectivity (ρ): Is the degree of how much a surface can reflect incoming radiations. It is calculated by the ratio of the total radiations reflected by the surface at a given temperature divided by the quantity of incident radiations on the same surface. Like previous, reflectivity is a number between 0 and 1.

View factor (F): View factor is the quantity of radiations emitted from a certain surface 1 and intercepted by surface 2. It is calculated by the ration of the quantity of radiation leaving S1 and received by S2 over the rate of radiation leaving S1. Note that $A_1.F_{12} = A_2.F_{21}$ (A1 being the area of surface of object 1, A2 of object 2, F12 for the radiation emitting from object 1 toward 2, and F21 for the radiations from object 2 to object 1)

Net Heat exchange between two black surfaces:

Having two black bodies in one space, black body 1 will emit radiations toward black object 2. These radiations will be absorbed by Object 2. Than black body 2 will emit radiations toward black object 1. These radiations will be absorbed by Object 1. The net heat exchange between two black objects is the difference between the radiations leaving S1 and captured by S2 and the radiations leaving S2 and captured by S1.

$Q_{1,2} = Q_{\text{emitted by 1 and captured by 2}} - Q_{\text{emitted by 2 and captured by 1}}$

Q $_{\text{emitted by 1 and captured by 2}}$ $=A_1.F_{12}.E_1$ and Q $_{\text{emitted by 2 and captured by 1}}$$=A_2.F_{21}.E_2$

$Q_{1,2}$= A1.F12.σ $(T_1^4 - T_2^4)$

<u>Net Heat exchange between the two gray surfaces:</u> Compared to black bodies, gray surfaces have reflectivity. So we have the reflective radiations to take care of. We calculate the difference between the radiations leaving S1 and captured by S2 (J), and the radiations incident on S1 (G). Q=A.(J – G)

<u>Radiative resistances:</u> Radiative resistance is used to measure the quantity of energy that is converted to heat radiation, through radio waves.

<u>Task 2:</u>

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?

A = 1.5 m^2 ; σ = 5.670 . 10^-8 W/m2.K^4 ; T1= 800 K ; T2= 500 K ; ε1= 0.1 ; ε2= 0.1

$$\dot{Q}_{12} = \frac{A\sigma(T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$

Applying the formula appearing above, with ε1= 0.2; ε2= 0.7, the result will be:

Q_{12}= 1.5 x 5.67 x 10^{-8} x $(800^4 - 500^4)$ / (1/0.2 + 1/0.7 -1) = 5438.1 W

Applying the formula appearing above, with ε1= 0.1; ε2= 0.1, the result will be:

Q_{12}= 1.5 x 5.67 x 10^{-8} x $(800^4 - 500^4)$ / (1/0.1 + 1/0.1 -1) = 1553.81 W

We conclude that when we increase the emissivity, we are also increases the heat exchange between the two parallel plates.