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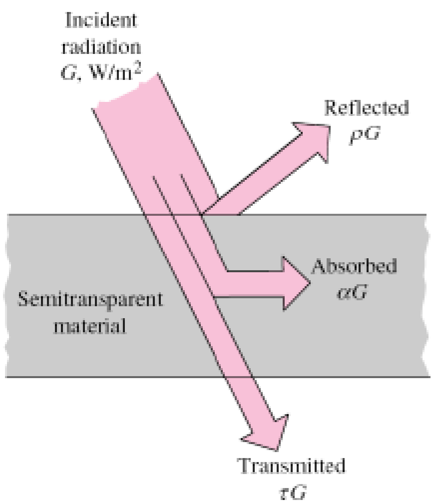
#Week 5 assignment

Task 1: Write a summary of the topics about radiative heat transfer.

Any object (solid, liquid, and gaseous) emits radiations, and even can reflect radiations emitted or reflected by other objects. Thermal radiation does not need a medium, so the two objects So in order to calculate radiative heat transfer from two surfaces, we need to calculate the quantity of radiations (emitted+reflected) from a designated surface. This calculation is called Radiosity, and named J.



1- <u>Emissivity</u>

Emissivity is the degree of how much an object can emits energy by radiation from its surface.

Emissivity (ε) is the ratio of the radiation leaving the surface (emitted + reflected) at a given temperature divided by the radiation emitted by a blackbody at the same temperature.

Emissivity (ε)= Emitted radiations Surface 1 / Emitted Radiations Black Object

Emissivity is a number between 0 and 1. It is comparison between the selected object and the perfect emitter Black Object. So it is a measure of how closely a surface approximates a blackbody with a ε = 1.

2- <u>Absorptivity</u>

Absorptivity is the degree of how much an object can absorb incoming radiations.

Absorptivity (α) 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.

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

Absorptivity is a number between 0 and 1. It is comparison between the selected object and the perfect absorbent BlackObject. So it is as well a measure of how closely a surface approximates a blackbody with a $\alpha = 1$.

3- <u>Reflectivity</u>

Reflectivity is the degree of how much a surface can reflect incoming radiations.

Reflectivity (ρ) is 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

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

Reflectivity is a number between 0 and 1. It is comparison between the selected object and the perfect reflector BlackObject. So it is as well a measure of how closely a surface approximates a blackbody with a $\rho = 1$

4- <u>View factor</u>

View factor is the portion of radiation leaving a certain surface 1 and intercepted by surface 2.

It is calculated by the ration of the rate of radiation leaving S1 and received by S2 over the rate of radiation leaving S1

$F_{12} = Q_{\text{leaving S1 and received by S2}} / Q_{\text{leaving S1}}$

Considering we have two surfaces 1 and 2. F_{12} is the one for the radiations leaving surface 1 toward surface 2. And F_{21} is the one for the radiations leaving surface 2 toward surface 1.

Note that:

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

5- <u>Net Heat exchange between two black surfaces</u>

If we have two black bodies, each body will emit its own radiation which will be absorb by the other. So black body 1 will emit radiations toward black object 2, which will be absorbed by Object 2. And the same happens to object 2.

To find the net heat exchange between two black surfaces S_1 and S_2, we calculate the difference between the radiations leaving S1 and captured by S2 and the radiations leaving S2 and captured by S1.

$E_{\text{black object}} = \sigma T^4$

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

$Q_{\text{emitted by 1 and captured by 2}} = A_1 \times F_{12} \times E_1$

$Q_{\text{emitted by 2 and captured by 1}} = A_2 \times F_{21} \times E_2$

$Q_{1 \text{ to } 2} = A1 \times F12 \times \sigma (T_1^4 - T_2^4)$

6- Net Heat exchange between the two gray surfaces

Compared to black bodies, gray surfaces have reflectivity. So in addition to the emitted radiations/absorbed radiations, we have the reflective radiations. We calculate the difference between the radiations leaving S1 and captured by S2, called J, and the radiations incident on S1, called G1.

J = Radiation emitted by the surface + Radiation reflected by the surface

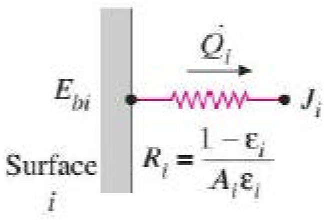
$J = \varepsilon . \sigma . T^4 + \rho . G$

$Q = A . (J - G)$

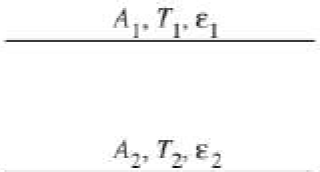
7- Radiative resistances

Radiative resistance is a degree to measure of how much energy is converted to heat radiation.

It is calculated by the following:



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?



$A_1 = A_2 = A$
$F_{12} = 1$

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

A = 1.5 m2

σ = 5.670 . 10^-8 W/m2.K^4

T1= 298 K

T2= 308 K

ε1= 0.1

ε2= 0.1

Q_{12}= 4.9825 W

Q_{12} with F_{12} = 0.01 is very small compared to the data with ε=0.1.