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Emissivity *c*, is how much radiation is received in respect to a black body. It can also be defined as the ratio of the radiation emitted by the surface to the radiation emitted by the black body at the same temperature. Emissivity depends on the wavelength and direction of emitted radiation.

The maximum possible emissivity is 1 which implies that the greater the value of emissivity, the closer the surface approximates to a black body.

Absorptivity α, is the amount of radiation absorbed by a surface compared to what is absorbed by the black body. It therefore is the fraction of the radiation incident on a surface that is absorbed by that surface.

Reflectivity ρ, is the ratio of the amount of radiation reflected by the surface to its total radiation. It is thus the fraction of radiation reflected by a surface incident on a surface that is absorbed by that surface.

View factor F_{12}, is the energy exchange carried by radiation between two surfaces at different temperatures. It is also defined as the fraction of energy that is emitted/reflected by surface 1 and is to be directly imposed on surface 2.

Heat exchange between two black surfaces

Two black surfaces have the maximum capacity to emit and absorb radiation. The heat exchange is the difference between the radiation being emitted from surface 1 that is imposed and absorbed by surface 2 and the radiation energy emitted from surface 2 and is imposed and absorbed by surface 1.

For two black surfaces with different temperatures, the net radiative heat transfer between them is

$Q\ net_{1-2} = A_1F_{1-2}\ \sigma\ (T_1^4 - T_2^4)$

The fraction of thermal power leaving object 2 and reaching object 1 is

$Q\ net_{2-1} = A_2F_{2-1}\ \sigma\ (T_2^4 - T_2^4)$

In the case of two blackbodies in thermal equilibrium, we can derive the equation by applying the reciprocity with the view factors,

$A_1F_{1-2} = A_2F_{2-1}$

Therefore $Q_{1-2} = A_1F_{1-2}\ \sigma\ (T_1^4 - T_2^4)$

Heat exchange between two grey surfaces

Unlike black surfaces, grey surfaces absorb a certain amount of radiation while reflecting a portion of the radiation off the surface back into space. For a grey surface, its properties are independent of wavelength.

Finding the heat exchange of a grey surface depends on its emissive power and radiation reflected by the surface. Therefore we need to find the radiosity *J* which is the total amount of radiation that is reflected off a surface per unit time and unit area

$J_1=\varepsilon_1 E_{b1} + \rho_1 G_1$

However, to determine the net energy leaving the surface you would need to find the difference between the radiosity and irradiation

$Q_1 = \varepsilon E_{b1}+(1-\varepsilon)\ G_i$

Radiative resistance R_1, is the amount of energy consumed by the loss resistance which is converted to heat radiation and the energy lost by radiation resistance is converted to electromagnetic waves.
Formula : $R_1 = 1- \varepsilon_1 / A_1\ \varepsilon_1$

Example from class

$A= 1.5m^2$ $\varepsilon_1 =0.1$ $\varepsilon_2 = 0.1$ $T_1 =298$ K $T_2 = 308$K $\sigma = 5.67 * 10^{-8}$

$Q_{net\ 2\text{-}1} = A\ \sigma\ (T_2^{\ 4} - T_1^{\ 4}) /[(1/ \varepsilon_2) + (1/ \varepsilon_1) - 1]$

$= 1.5 *(5.67 * 10^{-8}) *[(800^4 - 500^4)] / [(1/0.1 + 1/0.1) -1]$

$=1035.8$ W

From the exercise, the net heat exchange between the two surfaces is affected by the emissivity of each of the surfaces.