WEEKLY SUBMISSION - TASK 05

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1) Find the net radiative heat exchange between the surface 1 and 2 where $\epsilon_1 = 0.1$, $\epsilon_2 = 0.1$, $T_1 = 298$ K, $T_2 = 308$ k,
$\sigma = 5.67 \times 10^{-6} \frac{W}{m2k4}$, $F1-2 = 0.01$

Soln: According to the formula,

$$\dot{Q}_{net\ 2\text{-}1} = \frac{A\sigma(T_2^4 - T_1^4)}{\frac{1}{\epsilon 2}+\frac{1}{\epsilon 1}-1}$$

$$\dot{Q}_{net\ 2\text{-}1} = \frac{A(5.67 \times 10^{-6})(308^4 - 298^4)}{\frac{1}{0.1}+\frac{1}{0.1}-1}$$

$$F_1 = \frac{1}{\frac{1}{\epsilon 2}+\frac{1}{\epsilon 1}-1} = \frac{1}{\frac{1}{0.1}+\frac{1}{0.1}-1}$$

$= 0.0526$

For parallel

$\dot{Q}_{net\ 1\text{-}2} = AF_1\sigma(T_2^4 - T_1^4)$

$= A \times 0.0526\ (5.67 \times 10^{-6})(308^4 - 298^4)$

$= 0.331A$ W

For $\epsilon_1 = 0.2$, $\epsilon_2 = 0.7$

$$F_1 = \frac{1}{\frac{1}{\epsilon 2}+\frac{1}{\epsilon 1}-1} = \frac{1}{\frac{1}{0.2}+\frac{1}{0.7}-1}$$

$= 0.1841$

$\dot{Q}net\ 2\text{-}1 = AF_1\sigma(T_2^4 - T_1^4)$

$= A \times 0.1842\ (5.67 \times 10^{-6})(308^4 - 298^4)$

$= 1.159A$ W

COMPARISION:
So with the little difference in the emissivity of each surface the heat transfer is largely affected.

SUMMARY

Radiative heat transfer
Heat transfer from a body with a high temperature to a body with a lower temperature by radiation. Thermal radiation does not require a medium, so the two bodies do not need to have physical contact. Since absolute zero is an idealized physical condition, so it happens almost in all objects, regardless of the material form of the object.

Definitions:

Emissivity
The emissivity of the surface is efficiency of the surface to radiate energy, the value varies from 0 to 1. The greater the value of emissivity is, the closer the surface to a blackbody .
The emissivity of a real surface is affected by temperature of the surface as well as the wavelength and the direction of the emitted radiation.

Absorptivity
Absorptivity of the surface is a measure of the ability of a material to absorb radiation. Its value varies from 0 to 1.

Reflectivity
The ability of the surface to reflect the radiation. It is the ratio of reflected radiation to the incident radiation.

View factor
It is the degree to which heat carried by radiation can be passed between two surfaces. The intensity of the emitted radiation depends on the view factor of the surface relative to the sky..

Heat exchange between two black surfaces
A black surface will emit a radiation of E_{b1} per unit area per unit time. If the surface is having A_1 unit area, then it will emit E_{b1} *A_1 radiation in unit time. This radiation will go to the other black surface and totally absorb by it but at the same time. The 2nd black body will emit its radiation E_{b2}*A_2 per second and it will go to 1st body and totally absorbed by it. So the net heat transfer between these surfaces will be the net heat per second gained by any of the two surfaces. The net heat transfer is the radiation leaving the entire surface 1 that strikes surface 2 subtracts the radiation leaving the entire surface 2 that strikes surface 1. $A_1E_{b1}F_{12} - A_2E_{b2}F_{21}$.

Heat exchange between two grey surfaces
A gray surface will reflect/absorb a given fraction of the thermal radiation a black body surface would absorb. More importantly, the graybody / blackbody fraction is independent of radiation wavelength.
For a given grey body surface I, with the area A_i, emitting a radiation of E_{bi} per unit time. The net heat transfer is the radiation leaving the entire surface *I* subtracts the radiation incident on the entire surface I, which is, in formula: $A_i(J_i-G_i)$. The radiosity J_i can be calculated by: $\epsilon E_{bi}+(1-\epsilon_i)G_i$.

Radiative resistance
Radiative resistance is a value to measure the energy depleted by loss resistance which is converted to heat radiation: the energy lost by radiation resistance is converted to radio waves.
It can be calculated by :

$$R_i = \frac{1-\epsilon i}{Ai\epsilon i}$$