Radiation

Radiation is energy that comes from a source and travels through space and may be able to penetrate various materials.

Absolute zero

Absolute zero is the lowest temperature possible. At a temperature of absolute zero there is no motion and no heat. Absolute zero occurs at a temperature of 0 degrees Kelvin, or -273.15 degrees.

black body

A black body or blackbody is an idealized physical body that absorbs all incident radiation, regardless of frequency or angle of incidence. (It does not only absorb radiation, but can also emit radiation).

gray surface

A gray surface, or graybody, is a surface that reflects/absorbs a given fraction of the thermal radiation a blackbody surface would absorb. More importantly, the graybody/ blackbody fraction is independent of radiation wavelength.

Heat exchange between two black surfaces

The fraction of the radiative energy that is diffused from one surface element and strikes the other surface directly with no intervening reflections.

Heat exchange between two grey surfaces

A grey surface will reflect/ absorb a given fraction of the thermal radiation a blackbody surface would absorb. More importantly, the grey body/black body fraction is independent of radiation wavelength.

Radiation resistance

Radiation resistance is a value to measure the energy depleted by loss resistance which is converted to heat radiation. the energy lost by radiation resi3os converted to radio waves.

Task 2

Find the net radiative heat exchange between the surface 1 and 2 where $A_1 = 1.5m^2$, $\epsilon_1 = \epsilon_2 = 0.1$, $T_1 = 298\ K$, $T_2 = 308\ K$, $\sigma = 5.67\ \times\ 10^{-8}\ \frac{W}{m^2K^4}$.
Solution:

According to the formula,

$$\dot{Q}_{net_{2-1}} = \frac{A\sigma(T_2^4 - T_1^4)}{\frac{1}{\epsilon_2} + \frac{1}{\epsilon_1} - 1}$$

By introducing the values mentioned in the question into the formula,

$$\dot{Q}_{net_{2-1}} = \frac{1.5m^2\ \times\left(5.67\ \times\ 10^{-8}\ \frac{W}{m^2K^4}\right) \times \left(308^4\ - 298^4\ \right)K^4}{\frac{1}{0.1} + \frac{1}{0.1} - 1} \approx 4.9823\ W$$

Meanwhile, under situation, based on the following formula

$$F_{2-1} = \frac{1}{\frac{1}{\epsilon_2} + \frac{1}{\epsilon_1} - 1} = \frac{1}{\frac{1}{0.1} + \frac{1}{0.1} - 1} \approx 0.0526$$

So, when $F_{1-2} = 0.01$,

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

$$= 1.5m^2\ \times 0.01\ \times\ \left(5.67\ \times\ 10^{-8}\ \frac{W}{m^2K^4}\right) \times\ \left(298^4\ - 308^4\ \right)K^4$$

$$\approx -0.9466\ W$$

$$\because\ A_1 = A_2, \quad i.e, \quad \frac{A_1\sigma(T_1^4 - T_2^4)}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1} = -\ \frac{A_2\sigma(T_2^4 - T_1^4)}{\frac{1}{\epsilon_2} + \frac{1}{\epsilon_1} - 1}$$

$$\therefore\ \dot{Q}_{net_{2-1}} = -\ \dot{Q}_{net_{1-2}} \approx 0.9466\ W$$

By Comparing the two values of net heat exchange under different situation, we can see that the value of emissivity would greatly affect the radiative heat exchange between the surfaces.