

1.

The emissivity ( $\epsilon$ ) of the surface of a material refers to the effectiveness of the surface in emitting energy as thermal radiation, it is mathematically defined as the ratio of the thermal radiation from the surface to the radiation from an ideal black surface at the same temperature; the value varies from 0 to 1. The greater the value of emissivity is, the closer the surface to a blackbody ( $\epsilon = 1$ ).

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 ( $\alpha$ ) of the surface of a material is a measure of the ability of a material to absorb radiation, i.e., its effectiveness in absorbing radiant energy. We use the ratio of the absorbed radiation to the incident radiant power to calculate the value of absorptivity, the value varying from 0 to 1.

Reflectance ( $\rho$ ) of the surface of a material is its effectiveness in reflecting radiant energy. It is the fraction of total energy transmitted by the body, we use the ratio of the reflected radiation to the incident radiant power to calculate the value of absorptivity, the value varying from 0 to 1.

A view factor (F), The view factor is the fraction of radiation leaving one surface which is intercepted by a second surface. The intensity of the emitted radiation depends on the view factor of the surface relative to the sky.

It is the degree to which heat carried by radiation can be passed between two 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. The whole process happened simultaneously. So the net heat transfer between these surfaces will be the net heat per second (power) gained by any of the two surfaces ( obviously same for both 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, which is, in formula:  $A_1 E_{b1} F_{1-2} - A_2 E_{b2} F_{2-1}$ .

A gray surface will reflect/absorb a given fraction of the thermal radiation a blackbody 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 area 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 the following formula:  $\epsilon E_{bi} + (1 - \epsilon_i) G_i$ .

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It can be calculated by this formula:

$$R_I = \frac{1 - \epsilon_i}{A_i \epsilon_i}$$

2.

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

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

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

$$\begin{aligned} \dot{Q}_{net_{1-2}} &= AF_{1-2}\sigma(T_2^4 - T_1^4) \\ &= 1.5m^2 \times 0.01 \times \left(5.67 \times 10^{-8} \frac{W}{m^2 K^4}\right) (298^4 - 308^4)K^4 \approx -0.9466 W \end{aligned}$$

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

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

By Comparing two amounts, we can conclude that increasing the emessivity leads to increase in radiative heat exchange between the surfaces.