Some Definition about Radiations.

(1) Diathermanous Medium: A medium which allows heat radiations to pass through it without absorbing them is called diathermanous medium. Thus the temperature of a diathermanous medium does not increase irrespective of the amount of the thermal radiations passing through it e.g., dry air, SO_2, rock salt (NaCl).

(i) Dry air does not get heated in summers by absorbing heat radiations from sun. It gets heated through convection by receiving heat from the surface of earth.

(ii) In winters heat from sun is directly absorbed by human flesh while the surrounding air being diathermanous is still cool. This is the reason that sun's warmth in winter season appears very satisfying to us.

(2) Athermanous medium: A medium which partly absorbs heat rays is called a thermous medium as a result temperature of an athermanous medium increases when heat radiations pass through it e.g., wood, metal, moist air, simple glass, human flesh etc.

Glass and water vapors transmit shorter wavelengths through them but reflects longer wavelengths. This concept is utilized in Greenhouse effect. Glass transmits those waves which are emitted by a source at a temperature greater than 100°C. So, heat rays emitted from sun are able to enter through glass enclosure but heat emitted by small plants growing in the nursery gets trapped inside the enclosure.

(3) Reflectance, Absorptance and transmittance

When thermal radiations (Q) fall on a body, they are partly reflected, partly absorbed and partly transmitted.

(i) Reflectance or reflecting power (r): It is defined as the ratio of the amount of thermal radiations reflected (Qr) by the body in a given time to the total amount of thermal radiations incident on the body in that time.

(ii) Absorptance or absorbing power (a): It is defined as the ratio of the amount of thermal radiations absorbed (Qa) by the body in a given time to the total amount of thermal radiations incident on the body in that time.

(iii) Transmittance or transmitting power (t): It is defined as the ratio of the amount of thermal radiations transmitted (Qt) by the body in a given time to the total amount of thermal radiations incident on the body in that time.

From the above definitions $r = \frac{Q_r}{Q}$, $a = \frac{Q_a}{Q}$ and $t = \frac{Q_t}{Q}$

By adding we get $r + a + t = \frac{Q_r}{Q} + \frac{Q_a}{Q} + \frac{Q_t}{Q} = \frac{(Q_r + Q_a + Q_t)}{Q} = 1$

$\therefore \quad r + a + t = 1$

(a) r, a and t all are the pure ratios so they have no unit and dimension.

(b) For perfect reflector : r = 1, a = 0 and t = 0

(c) For perfect absorber : a = 1, r = 0 and t = 0 (Perfectly black body)

(d) For perfect transmitter: t = 1, a = 0 and r = 0

(e) If body does not transmit any heat radiation, t = 0 $\therefore r + a = 1$ or $a = 1 - r$

So if r is more, a is less and vice-versa. It means good reflectors are bad absorbers.

(4) Monochromatic Emittance or Spectral emissive power

For a given surface it is defined as the radiant energy emitted per sec per unit area of the surface with in a unit wavelength around λ i.e. lying between $\left(\lambda - \frac{1}{2}\right)$ to $\left(\lambda + \frac{1}{2}\right)$.

Spectral emissive power $(E_\lambda) = \frac{\text{Energy}}{\text{Area} \times \text{time} \times \text{wavelength}}$

Unit: $\frac{Joule}{m^2 \times sec \times \mathring{A}}$ and Dimension: $[ML^{-1}T^{-3}]$

(5) Total emittance or total emissive power

It is defined as the total amount of thermal energy emitted per unit time, per unit area of the body for all possible wavelengths. $E = \int_0^\infty E_\lambda d\lambda$

Unit: $\frac{Joule}{m^2 \times \sec}$ or $\frac{Watt}{m^2}$ and Dimension: $[MT^{-3}]$

(6) Monochromatic absorptance or spectral absorptive power

It is defined as the ratio of the amount of the energy absorbed in a certain time to the total heat energy incident upon it in the same time, both in the unit wavelength interval. It is dimensionless and unit less quantity. It is represented by a_λ.

(7) Total absorptance or total absorptionpower: It is defined as the total amount of thermal energy absorbed per unit time, per unit area of the body for all possible wavelengths.

$$a = \int_0^\infty a_\lambda d\lambda$$

It is also unit less and dimensionless quantity.

(8) Emissivity (e): Emissivity of a body at a given temperature is defined as the ratio of the total emissive power of the body (Epractical) to the total emissive power of a perfect black body (Eblack) at that temperature.

i.e. $$e = \frac{E_{practical}}{E_{black}}$$

e = 1 for perfectly black body but for practical bodies emissivity (e) lies between zero and one (0 < e < 1).

(9) Perfectly black body: A perfectly black body is that which absorbs completely the radiations of all wavelengths incident on it. As a perfectly black body neither reflects nor transmits any radiation, therefore the absorptance of a perfectly black body is unity i.e. t = 0 and r = 0 $\therefore$ a = 1.

We know that the color of an opaque body is the color (wavelength) of radiation reflected by it. As a black body reflects no wavelength so, it appears black, whatever be the color of radiations incident on it.

When perfectly black body is heated to a suitable high temperature, it emits radiation of all possible wavelengths. For example, temperature of the sun is very high (6000 K approx.) it emits all possible radiation so it is an example of black body.

(10) Ferry's black body: A perfectly black body can't be realized in practice. The nearest example of an ideal black body is the Ferry's black body. It is a doubled walled evacuated spherical cavity whose inner wall is blackened. There is a fine hole in it. All the radiations incident upon this hole are absorbed by this black body. If this black body is heated to high temperature then it emits radiations of all wavelengths.