Brief introduction of thermal radiation

(IV)

Part II

Proof:- Let e_λ and a_λ be the emissive and absorptive power respectively of a body for a particular wavelength of heat radiation λ at a particular temperature.

Let Q be the amount of heat radiation incident on its surface in time 1 second and the amount of radiation absorbed by its surface in time one second is Q_1 then the amount of heat radiation reflected from the surface in time one second is given by

$$Q_2 = (Q - Q_1) \quad -(i)$$

As the body emits heat ~~all~~ at all temperature, then the amount of heat emitted by the body in time one second is given by

$$e_\lambda d_\lambda \quad -(ii)$$

Thus the total amount of heat given out from the surface of the body in time one second is given by

$$= Q_2 + e_\lambda d_\lambda$$

$$= (Q - Q_1) + e_\lambda d_\lambda \quad -(iii)$$

In equilibrium ~~for~~ eqn (i) we may write

$$Q = (Q - Q_1) + e_\lambda d_\lambda$$

$$\Rightarrow Q_1 = e_\lambda d_\lambda \quad -(iv)$$

$\therefore \quad a_\lambda = \frac{q_1}{q}$

$q_1 = a_\lambda q \quad$ — (V)

from eqn (IV) & (V) we get—

$a_\lambda q = e_\lambda d\lambda$

$\therefore \quad \frac{e_\lambda}{a_\lambda} = \frac{q}{d\lambda} = \text{Constant} \quad$ — (VI)

For a perfectly black body

$a_\lambda = 1$

$e_\lambda = E_\lambda$

$\therefore$ we get—

$\frac{E_\lambda}{1} = \frac{q}{d\lambda} = \text{Const} \quad$ — (VII)

$\therefore$ From eqn (VI) & (VII) we get—

$$\boxed{\frac{e_\lambda}{a_\lambda} = E_\lambda = \text{Const}}$$

proved.