

Stefan-Boltzmann law

Josef Stefan in 1879 determined from experimental data that the total power emitted by a radiant object is proportional to the fourth power of its absolute temperature T . Five years later Ludwig Boltzmann showed how to derive the same relation from principles of thermodynamics. The modern form of the Stefan-Boltzmann law is

$$P = A\varepsilon\sigma T^4$$

where P is total power, A is surface area, ε is an emissivity constant, and σ is the Stefan-Boltzmann constant

$$\sigma = 5.67 \times 10^{-8} \text{ watt meter}^{-2} \text{ kelvin}^{-4}$$

For example, consider a one cubic centimeter block of wrought iron at 1000 kelvin. The emissivity constant for wrought iron is $\varepsilon = 0.94$ hence the total radiant power is

$$P = \underset{\text{surface area 1 cm cube}}{6 \times 10^{-4} \text{ meter}^2} \times 0.94 \times 5.67 \times 10^{-8} \text{ watt meter}^{-2} \text{ kelvin}^{-4} \times 1000^4 \text{ kelvin}^4 = 32 \text{ watt}$$