Entropy :→

In an adiabatic transformation, neither the heat energy nor the temperature remains constant. However, there is something which remains constant during Adiabatic transformation Just as temperature remains constant in an isothermal process. That 'something' is called Entropy. The thermal property of a body or the system which remains constant during an adiabatic process when no heat energy is given to or removed from it is called Entropy.

Physical Significance ⇒ The entropy of a substance is a real physical quantity defined by

$$S_A = S_n + \int_n^A \frac{\delta Q}{T} \quad \text{---} \quad (1)$$

$$d_s = \frac{\delta Q}{T} \quad \text{---} \quad (2)$$

where S_A = entropy of the substance in the state 'A'.
S_n = entropy of the substance in the state 'n'.

Clausius introduced a state variable or property of a system and named it entropy of the system. Thus, the entropy of a system is a state variable like temperature, pressure, volume and internal energy of it, where integral along a closed path, reversible or irreversible is zero and along a reversible cyclic process is particularly equal to the integral of dQ/T :

Entropy remains constant when the substance undergoes a reversible adiabatic compression or expansion. Further, entropy was shown to be a definite single valued function of the thermodynamical coordinates defining the state of the body like the temperature, pressure, volume, internal energy, state of magnetisation etc. It is diffucult to form a tangible concept of entropy because there is nothing physical to represent it, it cannot be felt like temperature or pressure. We can however readily infer that it is a measure of the disorder or randomness in the molecular arrangement of the system. The addition of heat to a system increases its entropy; from the kinetic point of view addition of heat produces a more violent agitation of the molecules. Thus by the continuous abstraction of heat the entropy of the system decreases and the molecular motion tends to vanish and the molecular arrangement attains a state of great order. Hence increase of entropy implies a transition from an ordered to a less ordered state of affairs.

Moreover, the entropy is a function of the probability of that macroscopic state, probability being maximum for maximum disorder. Thus growth of entropy implies a transition from a more to a less available energy, from a less probable to a more probable state from an ordered to a less ordered state of affairs. The idea of entropy is necessitated by the existence of irreversible processes. It is measured in calorie per degree or erg per degree.

→ Statistical definition of entropy → In dealing with macroscopic system we define a new quantity or parameter 'S' as

$S = k \log W$ where k = Boltzmann's constt. $= 1.38 \times 10^{-16}$ erg K^{-1}

W = Thermodynamic probability for any macrostate of the system.

This quantity is known as the entropy of the system. If the system is in a state of equilibrium it is in the most probable macrostate so that $W = W_{max}$

∴ For equilibrium state $S = k \log W_{max}$

Since '$\log W$' is a mere number having no dimensions, the dimensions of entropy (S) are the same as that of k.