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Define Entropy. what is its physical significance. Show that the Entropy remains contain in reversible process of change in irreversible process.?

A measure of the unavailabitity of a system's ~~its~~ energy to do work is called entropy. It is denoted by the symbol 'S'. An increase in entropy is accompained by a decrease in energy ~~av.~~ availabity. when a system undergoes a reversible change the entropy (S) changes by an amount equal to the entropy (Q) absorbed by the system devided by the thermodynamic temp. (T) at which the energy is absorbed.

i.e $\Delta S = \frac{\Delta Q}{T}$. However all real processes are to a certain extent irreversible changes and is always accompained by an increase in entropy.

In a wider sense entropy can be enterpreted as a measure of a system's disorder. The higher, the entropy greater the disorder. As an real change of a closed system tends towards higher entropy and therfore higher disorder, it follows that the entropy of the universe is increasing and its available energy is decreasing. This increase in entropy of the universe is one way of starting the Second law of thermodynemics.

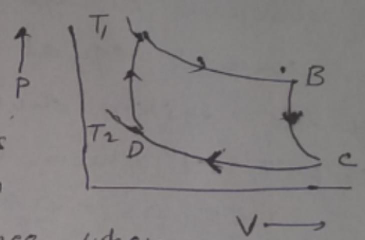
Physical Significance:-

The change in ~~ener~~ entropy

of a substance is defined by $\Delta S = \frac{Q}{T}$ shows that the heat energy has the same dimensions as the product of entropy and absolute temp in earth's gravitational field, the P.E of a body is proportional to the product of its mass and height above some zero level. A comparision indicates that if we regard height as corresponding to temp, then mass corresponds to entropy.

Change of Entropy in a Reversible Process:→

Let us consider a complete reversible process:→ A Carnot's cycle ABCD shown in figure. In the isothermal expansion from A to B, the working substance (perfect gas) absorbs an amount of heat Q_1 at a constant temp T_1 of the source. When



heat is absorbed by the system Q_1 is (+ve), the entropy change in (+ve) because T is (+ve), hence gain in Entropy of working substance from A to B = Q_1/T_1. Since the source loses this heat Q_1 at temp T_1, hence its entropy decreases by $\frac{Q_1}{T_1}$. During adiabatic expansion from B to C, there is no change in entropy because heat is neither taken nor given out. During the isothermal compression from C to D, the working substance gives out a quantity of heat Q_2 at a constant temp T_2 of sink and so the loss in entropy from C to D = $\frac{Q_2}{T_2}$. Again during adiabatic compression from D to A, there is no change in entropy. So the net gain in entropy of working substance in the whole cycle ABCD is

$$= \frac{Q_1}{T_1} = -\frac{Q_2}{T_2}$$

But in complete reversible Carnot's cycle

$$\frac{Q_1}{T_1} - \frac{Q_2}{T_2} \quad \therefore \frac{Q_1}{T_1} - \frac{Q_2}{T_2} = 0$$

So the total change in entropy of the working substance in a complete cycle of reversible process is zero. The change in entropy of a combined system of source and sink is also 0. In a cycle of reversible process, the entropy of the system remain unchanged.

Entropy in an irreversible process:→

The effeciency of a carnot reversible cycle working between absolute temp T_1 & T_2 is

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{Q_2}{Q_1} \quad (\because Q \propto T)$$

where Q_1 is the amount of heat taken in in at temp T_1 & Q_2 that given up at temp T_2. Since the cycle is reversible, then

$$\frac{Q_2}{Q_1} = \frac{T_2}{T_1}$$

$$\therefore \eta = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1}$$

This is the maximum possible effeciency of an engine working b/w T_1 and T_2. If the cycle of the engine be reversible the effeciency well be lowered

$$\eta = 1 - \frac{Q_2}{Q_1} < 1 - \frac{T_2}{T_1}$$

or $\frac{Q_2}{Q_1} > \frac{T_2}{T_1}$ or $\frac{Q_2}{T_2} > \frac{Q_1}{T_1}$

Now during complete irreversible cycle, the entropy of the source decreases by $\frac{Q_1}{T_1}$ while that of the sink increases by $\frac{Q_2}{T_2}$. The net change in the entropy of the working substance is also zero

The total increase in entropy of the system plus sourrounding is $= \Delta S + \frac{Q_2}{T_2} - \frac{Q_1}{T_1}$ which is (+ve)