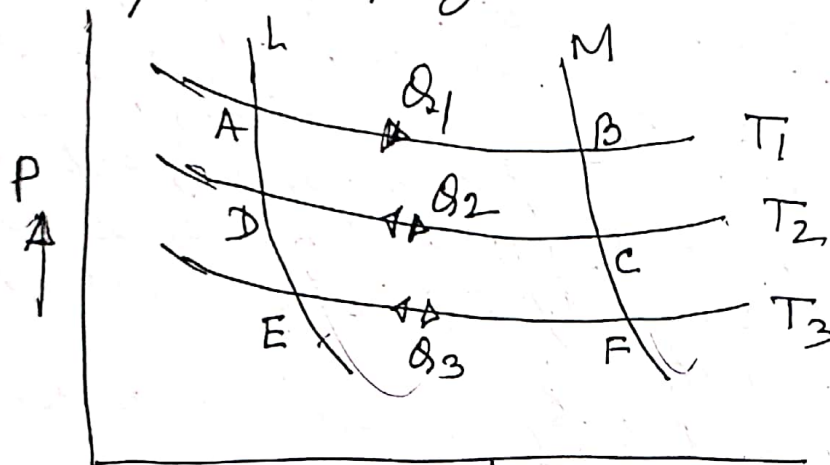


In any reversible process the heat gain by the process is directly proportional to its absolute temp. This property is k/a "Entropy"

Q/T



Let us consider two adiabatic curve LM and MN and three isothermal curve AB, DC & EF at temp T_1, T_2 & T_3 respectively

Let us consider a Carnot reversible cycle ABCDA in which Q_1 is the heat absorbed at temp T_1 and Q_2 is the heat rejected at temp T_2

$$\therefore \frac{Q_1}{T_1} = \frac{Q_2}{T_2} \quad \text{--- (1)}$$

In reversible cycle DCFED;

$$\frac{Q_2}{T_2} = \frac{Q_3}{T_3} \quad \text{--- (2)}$$

$$\therefore \frac{Q_1}{T_1} = \frac{Q_2}{T_2} = \frac{Q_3}{T_3} = \text{constant}$$

This shows that between two adiabats the ratio of heat and temp is constant & it is k/a change in entropy (S)

$$\frac{Q}{T} = \text{constant (S)}$$

For small change of heat dQ ;

$$\frac{dQ}{T} = dS = \text{change in "entropy"}$$

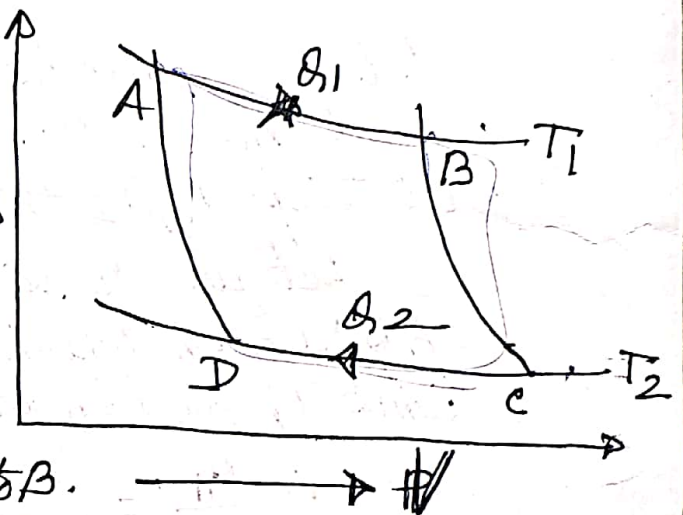
Physical Significance:-

Entropy remains constant in adiabatic process. When heat is absorbed by the system, there is an increase in entropy. When heat is rejected by the process or system, entropy is decreased. At M.P and B.P of substance the heat received by the system increases the entropy of the substance.

Change in entropy in reversible process

The change in ~~to~~ entropy in reversible process is zero

Let us consider a reversible cycle ABCD, at temp T_1 (Source) and temp T_2 (Sink).



The increase in entropy of the working substance from A to B.

$$dS_1 = \frac{Q_1}{T_1} \quad \text{--- (1)}$$

The loss in entropy from C to D.

$$dS_2 = \frac{Q_2}{T_2} \quad \text{--- (2)}$$

From (1) & (2) $\frac{Q_1}{T_1} = \frac{Q_2}{T_2}$

$$\Rightarrow \boxed{dS_1 = dS_2}$$

The change in entropy in reversible process

$$\boxed{dS_1 - dS_2 = 0}$$

change in entropy in irreversible Process

In irreversible process like conduction, convection or friction heat is loss or gain by the body.

Let us consider an engine working at temp T_1 (source) & temp T_2 (sink). The efficiency of irreversible engine

$$\eta = 1 - \frac{Q_2}{Q_1}$$

The efficiency of Carnot's engine.

$$\eta_c = 1 - \frac{T_2}{T_1}$$

From Carnot's theorem.

$$\eta < \eta_c \text{ or, } 1 - \frac{Q_2}{Q_1} < 1 - \frac{T_2}{T_1}$$

or,

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

or,

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

$$\Rightarrow \sum \frac{Q_i}{T_i} < 0$$

Hence there is always ~~decrease~~ increase in entropy in irreversible Process.

Entropy of Perfect gas:-

For Perfect gas $PV = \gamma RT$ ($\gamma = nR$)

or, $PdV + VdP = \gamma dT$

or, $PdV = \gamma dT - VdP$ — (1)

Using 1st law of thermodynamics

$$dS = du + dw.$$

$$TdS = C_v dT + PdV.$$

$$TdS = (C_p - R)dT + \gamma dT - VdP.$$

$$C_p - C_v = R$$

For one mole $\gamma = \gamma R = R$.

$$\therefore TdS = C_p dT - R dT + R dT - VdP$$

$$\therefore \boxed{ds = C_p \frac{dT}{T} - R \frac{dP}{P}}$$

Integrating it we get

$$\int_{S_1}^{S_2} ds = C_p \int_{T_1}^{T_2} \frac{dT}{T} - R \int_{P_1}^{P_2} \frac{dP}{P}$$

$$\Rightarrow \boxed{S_2 - S_1 = C_p \log \frac{T_2}{T_1} - R \log \frac{P_2}{P_1}}$$

