① Constant Pressure process

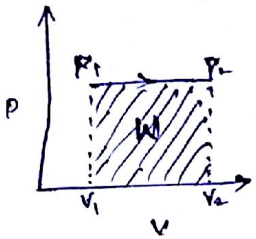
$P = c$ $P_1 = P_2$

Characteristic gas equation

$\frac{PV}{T} = c$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{V_1}{V_2} = \frac{T_1}{T_2}$.



Work done.

$W = \int_1^2 P.dv$.

$= P[V]_1^2 = P_1(V_2 - V_1)$

(or).

$W = P_2(V_2 - V_1)$

Heat Transfer

$Q = m C_p (T_2 - T_1)$

Change in Internal Energy (ΔE) KJ.

$\Delta E = m C_v (T_2 - T_1)$

change in Enthalpy (ΔH).

$\Delta H = m C_p (T_2 - T_1)$

change in Entropy (ΔS)

$\Delta S = m C_p \ln\left(\frac{T_2}{T_1}\right)$

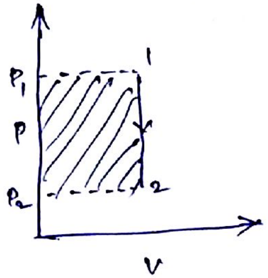
② Constant Volume process

$V = C$ $V_1 = V_2$

$\frac{PV}{T} = C$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$



Work done

$W = \int_1^2 P.dv$

$= P.[V]_1^2 = P[V_2 - V_1]$

$W = 0$.

Heat Transfer

$Q = m.C_v (T_2 - T_1)$

change in Internal Energy.

$\Delta E = m C_v (T_2 - T_1)$

change in Enthalpy.

$\Delta H = m C_p (T_2 - T_1)$

change in Entropy.

$\Delta S = m C_v \ln\left(\frac{T_2}{T_1}\right)$

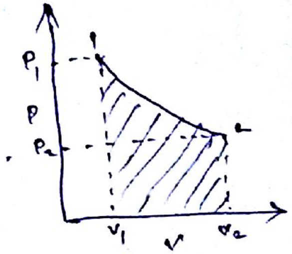
③ Constant Temperature process.

$T = C$. $T_1 = T_2$.

$\frac{PV}{T} = C$.

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$.

$P_1V_1 = P_2V_2$



$PV = P_1V_1 = P_2V_2$

$P = \frac{P_1V_1}{V}$.

Work done

$W = \int_1^2 P.dv$.

$= \int_1^2 \frac{P_1V_1}{V}.dv$

$= P_1V_1 \int_1^2 \frac{dv}{V} = P_1V_1 [\ln V]_1^2$

$= P_1V_1 [\ln V_2 - \ln V_1]$

$W = P_1V_1 \left(\ln \frac{V_2}{V_1}\right)$

Heat Transfer.

$Q = m.C_p (T_2 - T_1)$.

Change in Internal Energy.

$\Delta E = 0$.

change in Enthalpy.

$\Delta H = 0$.

change in Entropy.

$\Delta S = mR \ln\left(\frac{V_2}{V_1}\right)$.

Hyperbolic Process :-

It follows the laws of $PV = C$ and also identical to Isothermal process.

Isothermal process is applicable to gases only, and hyperbolic process is applicable to vapour.

All the other properties as same in isothermal process.

Eg:- Expansion vapour is not isothermal process, it is said to be hyperbolic process.

Adiabatic (or) Isentropic process :-

Adiabatic equation $PV^{\gamma} = C$.

It is the process in which neither heat is received nor rejected. there will be no heat transfer during this process, only possible when the working substances remain thermally insulated.

Relation between P and V.

$$PV^{\gamma} = C.$$

$$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$$

$$\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^{\gamma}$$

$$\left(\frac{P_1}{P_2}\right)^{1/\gamma} = \frac{V_2}{V_1}$$

Relation between T and V.

$$PV^{\gamma} = C$$

$$\frac{PV^{\gamma}}{PV/T} = C$$

$$\frac{V^{\gamma}T}{V} = C$$

$$V^{\gamma-1}T = C.$$

$$V_1^{\gamma-1}T_1 = V_2^{\gamma-1}T_2$$

$$\frac{T_1}{T_2} = \left(\frac{V_2}{V_1}\right)^{\gamma-1}$$

$$\frac{V_2}{V_1} = \left(\frac{T_1}{T_2}\right)^{\frac{1}{\gamma-1}}$$

Relation between T and P.

gas equation $\frac{PV}{T} = C$. Take γ in power on both side

$$\frac{P^{\gamma}V^{\gamma}}{T^{\gamma}} = C.$$

$$\frac{P^{\gamma}V^{\gamma}}{T^{\gamma}PV^{\gamma}} = C$$

$$\frac{P^{\gamma-1}}{T^{\gamma}} = C.$$

$$\frac{P_1^{\gamma-1}}{T_1^{\gamma}} = \frac{P_2^{\gamma-1}}{T_2^{\gamma}}$$

$$\left(\frac{P_1}{P_2}\right)^{\gamma-1} = \left(\frac{T_1}{T_2}\right)^{\gamma}$$

$$\frac{P_1}{P_2} = \left(\frac{T_1}{T_2}\right)^{\gamma/\gamma-1} \Rightarrow \frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$$

Work done :-

$$W = \int_1^2 P.dv. \qquad \because PV^{\gamma} = C \qquad P = \frac{C}{V^{\gamma}}$$

$$W = \int_1^2 \frac{C}{V^{\gamma}}.dv.$$

$$W = C \int_1^2 \frac{1}{V^{\gamma}}.dv = C\int_1^2 V^{-\gamma}.dv$$

$$W = C\left[\frac{V^{-\gamma+1}}{-\gamma+1}\right]_1^2$$

$$W = C\left[\frac{V_2^{-\gamma+1} - V_1^{-\gamma+1}}{-\gamma+1}\right] = \frac{CV_2^{-\gamma+1} - CV_1^{-\gamma+1}}{-\gamma+1}$$

Substitute $C = PV^{\gamma}$

$$W = \frac{P_2V_2^{\gamma}V_2^{-\gamma+1} - P_1V_1^{\gamma}V_1^{-\gamma+1}}{-\gamma+1}$$

$$\boxed{W = \frac{P_2V_2 - P_1V_1}{1-\gamma}} = \frac{mRT_2 - mRT_1}{1-\gamma}$$

$$W = \frac{mR(T_1 - T_2)}{\gamma-1} \text{ KJ}$$

Heat Transfer :-

$$Q = 0.$$

change in internal Energy :-

$$Q = W + \Delta E.$$

$$0 = W + \Delta E.$$

$$-W = \Delta E.$$

$$\Delta E = -\left[\frac{P_2V_2 - P_1V_1}{1-\gamma}\right]$$

$$\Delta E = \frac{P_2V_2 - P_1V_1}{\gamma-1} \text{ KJ}.$$

$$\boxed{\Delta E = m C_v (T_2 - T_1)}$$

change in Enthalpy :-

$$\Delta H = \int_1^2 mC_p.dT = mC_p\int_1^2 dT$$

$$= mC_p(T_2 - T_1)$$

$$\boxed{\Delta H = mC_p(T_2 - T_1) \text{ KJ}}$$