CONCEPT
MAP

THERMODYNAMIC PROCESSES

State of a thermodynamic system can be changed by interacting with its surroundings through work and heat. When this change occurs in a system, it is said that the system is undergoing a process. Most processes of interest to pyrometallurgists can be idealised as operating at constant temperature (isothermal) or constant pressure (isobaric).

Class XI

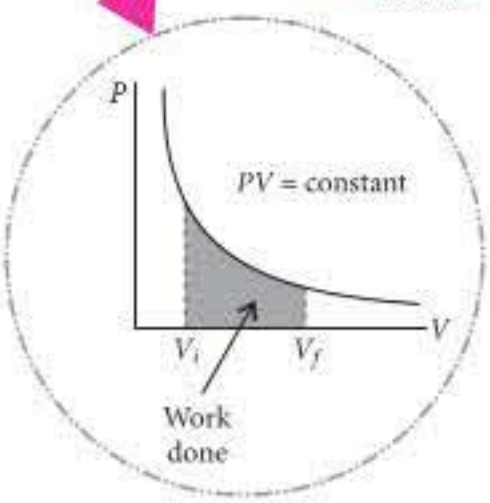
Isothermal Process

A process in which temperature remains constant *i.e.*,

$\Delta T = 0$

$\Delta U = 0$

$q = -w$



Reversible Process

A process in which the direction may be reversed at any stage by merely a small change in a variable like temperature, pressure, etc.

For isothermal reversible process :

$$q = -w = nRT \ln \frac{V_f}{V_i} \text{ or } q = nRT \ln \frac{P_i}{P_f}$$

V_f and P_f = Final volume and pressure

V_i and P_i = Initial volume and pressure

Irreversible Process

A process which is not reversible is called an irreversible process.

All the natural processes are irreversible.

For isothermal irreversible process :

$q = -w = P_{ex}(V_f - V_i)$

Note : (i) If gas expands $V_f > V_i$, w is negative.

(ii) If gas contracts, $V_f < V_i$, w is positive.

Adiabatic Process

A process in which the system does not exchange heat with the surroundings, *i.e.*, $q = 0; \Delta U = w_{ad}$

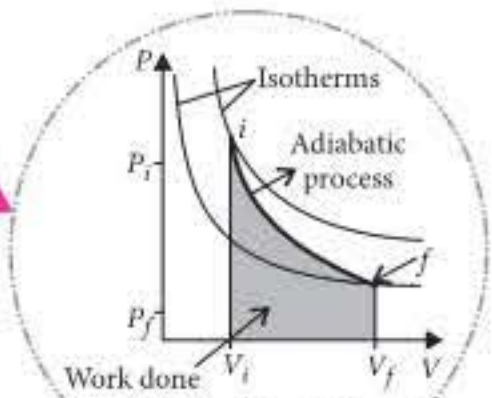
Work done in adiabatic process,

$w = (P_1V_1 - P_2V_2)/\gamma\text{-}1$

For an adiabatic process, PV^γ = constant

where $\gamma = C_p/C_v$

	C_v	C_p
Monoatomic gas	3/2R	5/2R
Diatomic gas	5/2R	7/2R
Triatomic gas	7/2R	9/2R



Isobaric Process

A process in which the pressure of the system remains constant.

P = constant, $\Delta U = q - w$

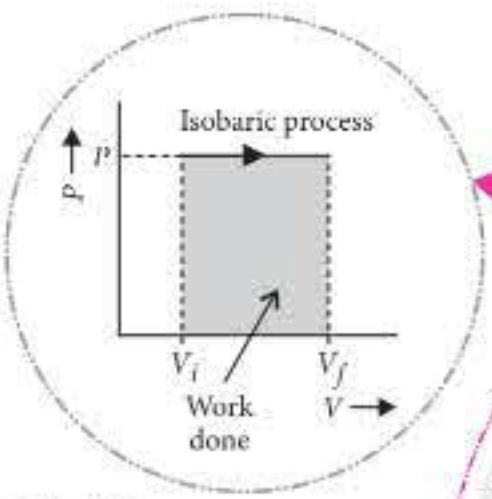
$w = P\Delta V = nR\Delta T, \Delta U = nC_v\Delta T$

$q_p = \Delta U + w = nC_v\Delta T + nR\Delta T$

$= n(C_v + R)\Delta T = nC_p\Delta T$

$C_p = C_v + R$ = molar specific heat at constant pressure

C_v = molar specific heat at constant volume



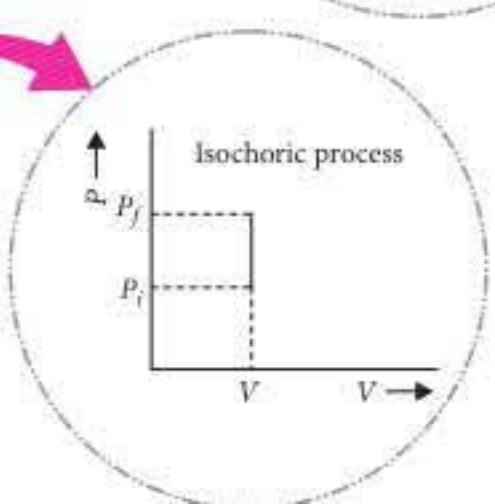
Isochoric Process

A process in which volume of the system is constant.

V = constant, $\Delta V = 0$,

$w = P\Delta V = 0$

$\Delta U = q_v = nC_v\Delta T$



Important Points

- **Sign conventions :**

Heat absorbed by the system = $+q$

Heat evolved by the system = $-q$

Work done on the system = $+w$

Work done by the system = $-w$

- **Free expansion :** Expansion of a gas in vacuum ($P_{ex} = 0$) is called free expansion. No work is done during free expansion of an ideal gas whether the process is reversible or irreversible.

q (at constant volume) = ΔU

q(at constant pressure) = ΔH

$\Delta H = \Delta U + P\Delta V$

or $\Delta H = \Delta U + \Delta n_g RT$