"Power Plant"

Thermodynamic Cycle

- **Power producing**
  - ↓
  - C.ω, +ve Cycles
  - C.ω in T-S, P-V diagram
  - W_{net} = +ve
  - [η]
- **Power consuming**
  - ↓
  - -ve, ACW
  - ACW ic T-S, P-V diag.
  - W_{net} = -ve
  - [COP]

Thermodynamic Cycle

- **Vapour Cycle**
  - working fluid remain in gaseous phase in one part & remains in liquid phase in other part Cycle
  - (i) Rankine
  - (ii) VCRC
- **Gas cycle**
  - working fluid remains in gaseous phase throughout the Cycle.
  - (i) Belcalmen Cycle
  - (ii) Brayton Cycle

T.D. Cycle

- **Open Cycle**
  - * New working fluid is admitted at the end of each Cycle
  - * working fluid is air only.
- **Closed Cycle**
  - * Same working fluid is recirculated again & again in each cycle
  - * Any better working fluid

* Less Efficient
* There will be a Internal Combustion
* Better grade of fuel burned
* Blade Erosion is more
* Light weight

→ Combustion :

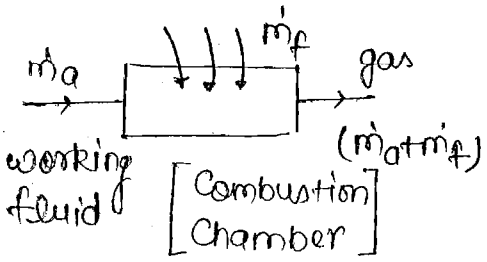
* C_p, C_v values are high. hence More Efficient.
* There will be an External Combustion.
* Any grade of fuel burned.
* Blade Erosion is absent
* Bulky Cycle

The burning of fuel is known as Combustion.

The aim of Combustion is to supply Heat to the working fluid.

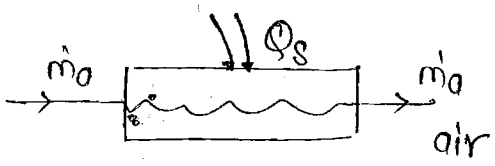
Combustion

Internal Combustion — (99%) open Cycle



→ When fuel burned inside the system boundary i.e working fluid & fuel both are mixed and burned together.

External Combustion



→ When fuel burned outside the system boundary i.e fuel burned separately from the working fluid. Only Heat interaction will taken place.

Parameter	Steam P.P	Gas P.P	I.C Engine
	60%	10-12%	1-2%
Cycle	Rankine	Brayton or Joul.	Diesel, Otto, duel
Fuel	Coal, High Speed diesel	Natural gases Ethane, Methan	Diesel, Petrol
Working fluid	Water, Steam	Air, gas	Air, gas
Max. Temp.	620°C	1300°C	2500°C
Pressure ratio r_p	220-300 bar	15-20 bar	20-25
Weight to power ratio	55 Kg/Kw	20 Kg/Kw ↓ Hence used in air-craft	110 Kg/Kw
Thermal Eff.	max. 35-40%	min 20-25%	medium 26-27%
Installation period	3-4 Yr for 200 MW	2.5-3 Yr for 200MW	1-2 month for 10KW
Pollution	Max.	Min.	medium

* Note : $\eta_{th_{I.C}} > \eta_{th.gas}$ → Eff. is more

$\eta_{m_{gas}} > \eta_{m_{I.C}}$ → Losses are more in I.C Engine

For 200 MW Steam → 110 Ton/hr Coal

↓ 33% Ash

35 Ton/hr Ash

Fly Ash (80%) → 25 Ton/hr → To atm

Bottom Ash (20%)

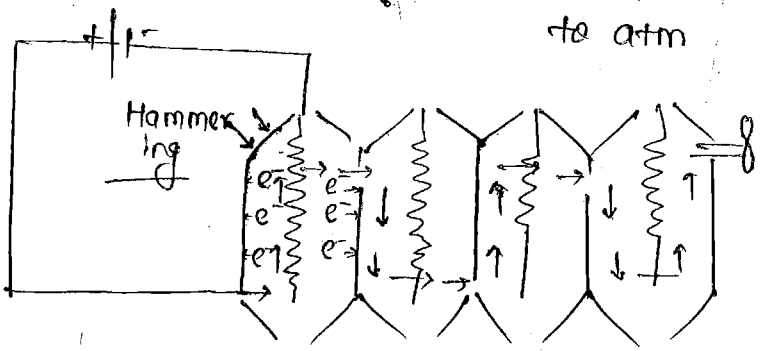
ESP - 20-25% Power Produced by P.P

↓ ESP

98-99% Bottom Ash

↓

0.5 Ton/hr to atm

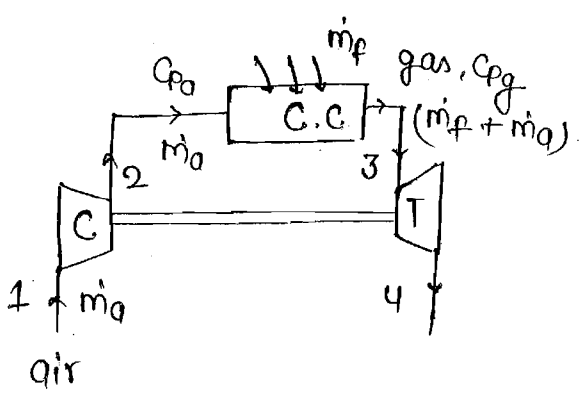


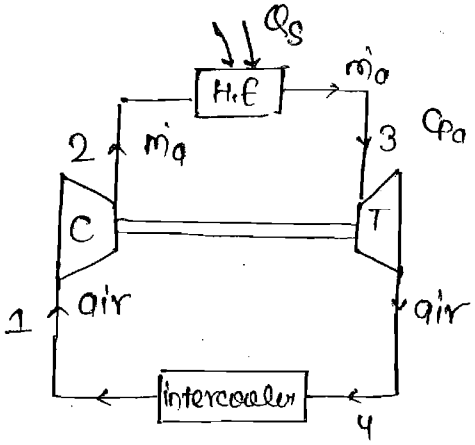
air- ionized

Bottom Ash

Brayton Cycle

- Open Brayton Cycle
- Close Brayton Cycle





1-2 - isentropic Comp.
2-3 - Const pressure H.A (C.C or H.E)
3-4 - isentropic Exp.
4-1 - Const. pressure ~~H.~~ Rejection (intercool).