

I-C-Engine

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Books:-

- Automotive mechanics by Joseph Heitrus
(For concept & Interview purpose)
- I-c - engines by v. Ganesan.
(For Problem purpose)
- I-c-Engines by Mathur & sharma
(For IES Problem)

— $\frac{70}{80}$ → marks

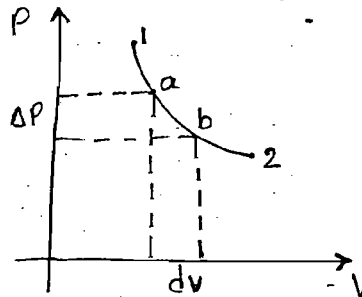
- The only difference in b/w reversible & irreversible process is Friction-loss.
- In quasi-static process will not be taken in irreversible process.
- Degree of randomness means measurement of out of order. (for entropy).

Quasistatic process :-

⇒ Quasi → partly \odot rest
or. differential calculus are same meaning.

$$w = \int dw = \int_1^2 P dv$$

$$w = P(v_2 - v_1)$$



Quasi-static process is not used for irreversible process.

- It should be taken when the value is constant & it change the value.
- Table showing the various expression For the different thermodynamic process undergone by a system :-
- only For ideal gas reversible process

SL NO	CONTENTS Process	Constant Volume Process	Constant Pressure Process	Constant Temperature Process	The Adiabatic process
1	P, v & T relations	$\frac{P_2}{P_1} = \frac{T_2}{T_1}$	$\frac{V_2}{V_1} = \frac{T_2}{T_1}$	$P_1 V_1 = P_2 V_2$	① $P_1 V_1^\gamma = P_2 V_2^\gamma$ ② $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ ③ $\left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = \frac{T_2}{T_1}$ ④ $\left(\frac{V_2}{V_1}\right)^{\gamma-1} = \frac{T_1}{T_2}$
2	Change in Internal energy (du)	$mc_v(T_2 - T_1)$	$mc_v(T_2 - T_1)$	0	$mc_v(T_1 - T_2)$
3	work done	0	$P(V_2 - V_1)$	$P_1 V_1 \log_e \frac{V_2}{V_1}$	$\frac{P_1 V_1 - P_2 V_2}{\gamma - 1}$
4	Heat transfer (dq)	$mc_v(T_2 - T_1)$	$mc_p(T_2 - T_1)$	$P_1 V_1 \log_e \frac{V_2}{V_1}$	0
5	change in enthalpy (dh)	$mc_p(T_2 - T_1)$	$mc_p(T_2 - T_1)$	0	$mc_p(T_2 - T_1)$
6	change in entropy (ds)	$mc_v \log_e \frac{T_2}{T_1}$	$mc_p \log_e \frac{T_2}{T_1}$	$mR \log_e \frac{T_2}{T_1}$	$ds = 0$ (or) $(S_2 - S_1) = 0$ (or) $(S_2 = S_1)$

- Heat supplied, work done, heat rejection & compression then the cycle is completed.
- The order of cycle is - HA → WD (expansion) → HR → compression.
- NO heat rejection in case of expansion process then it should be adiabatic and also it is for compression process.

Cycle :-

When a system after undergoing a number of process is called or is able to attain its original condition, it is then said to have completed a cycle.

IF a cycle is not completed, then continuous work will not be obtained.

The following are the requirement for completing a cycle.

i.e, HA, HR, Expansion (useful WD) + compression.

Ideal cycle :-

An ideal cycle is cycle in which both the expansion and compression process must take place reversibly + Adiabatically.

I.C. Engines :-

An I-c-engine is the engine in which the combustion takes place inside the engine, besides all the operations required for a complete cycle take places inside the engine. thus the I-c-engine (his by itself a complete plant).

Only costly liquid and gaseous fuel can be used for I-c-engines.

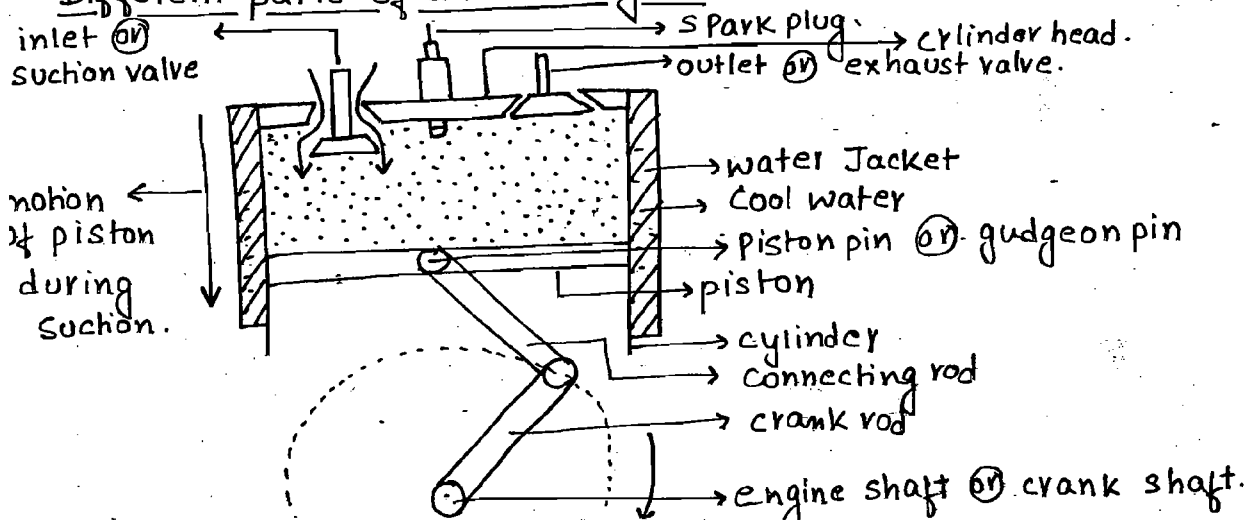
External combustion engine :-

An external combustion engine is the engine in which the combustion take place on the outside of the engine. exceptig the expansion process, the rest of the operation are carried out outside the engine.

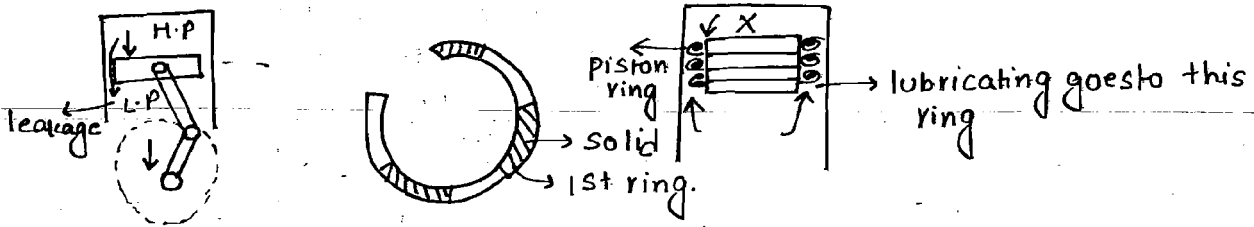
cheaper solid fuels can also be used for external combustion engines.

When a cycle is taken into account by considering only the expansion process, then the efficiency of the external combustion engine is higher than that of the internal combustion engines.

Different parts of an I-c-engine :-

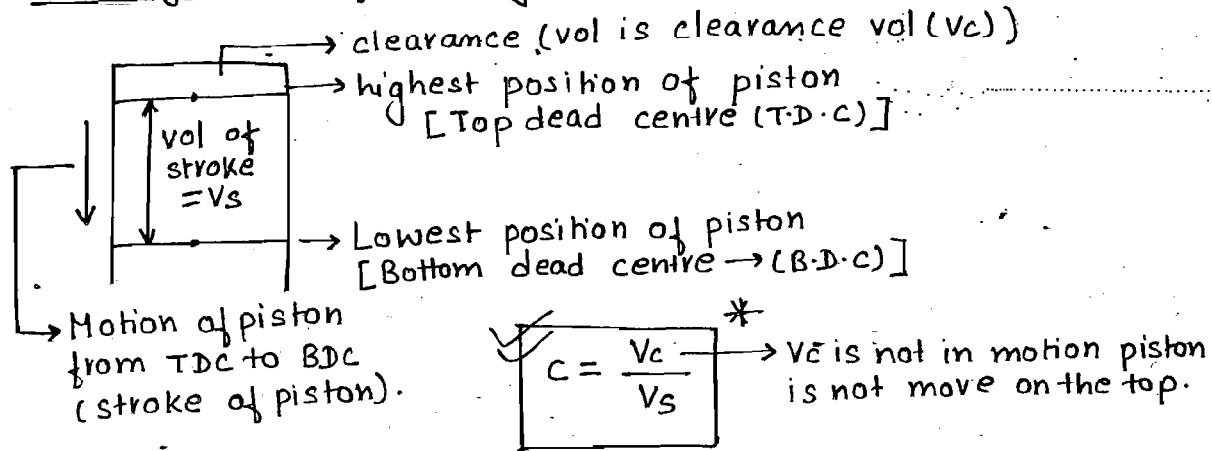


Leakage is more → engine starting create problem.



• compression ratio is same for all cycle.

→ Thermodynamics of I-c-engine :-



• clearance is provide in the cylinder because the pressure is still inside the cylinder.

• In case of heat addition the diesel engine, the volume will change.

clearance ratio :-

The ratio of the clearance volume to stroke volume is defined as the clearance ratio of the engine.

It is given by,

$$c = \frac{V_c}{V_s} *$$

Volume ratio :-

The ratio of longer volume to lesser volume during any process inside an I-c engine is defined as the volume ratio of that process. the volume ratio during compression is known as compression ratio. compression ratio remains same for all the cycles of I-c engines.

The volume ratio during the expansion process is known as expansion ratio & is different for different cycle of I-c engine.

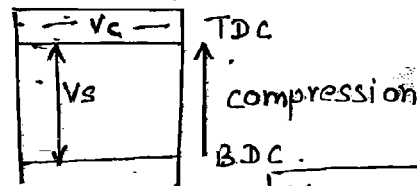
⇒ The compression ratio is :-

$$r_c = \frac{V_1}{V_2}$$

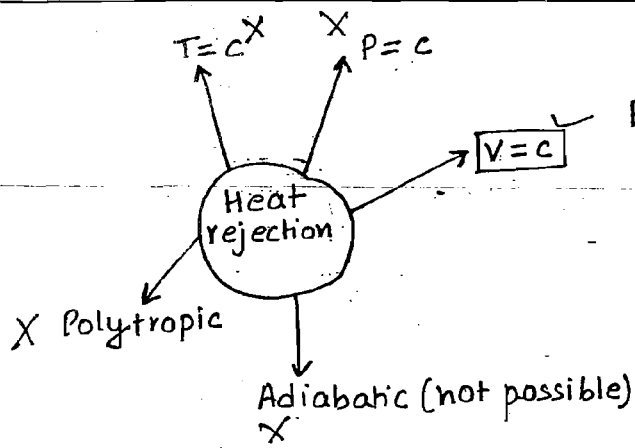
$$V_2 = V_c$$

$$r_c = \frac{V_c + V_s}{V_c}$$

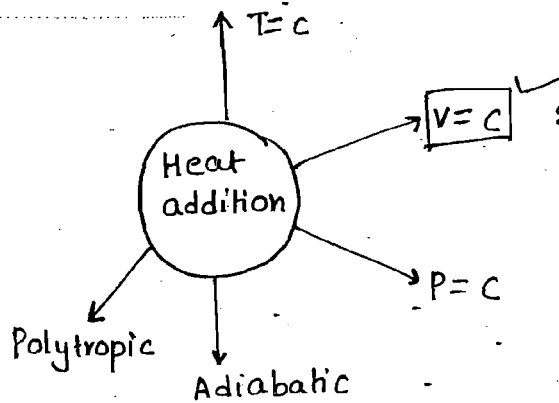
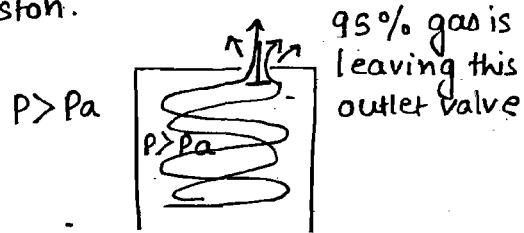
$$V_1 = (V_c + V_s)$$



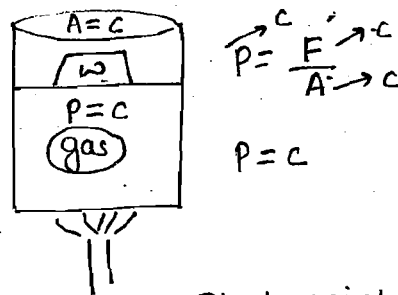
$$(ii), r_c = 1 + \frac{V_s}{V_c} \Rightarrow \frac{V_s}{V_c} = (r_c - 1) **$$



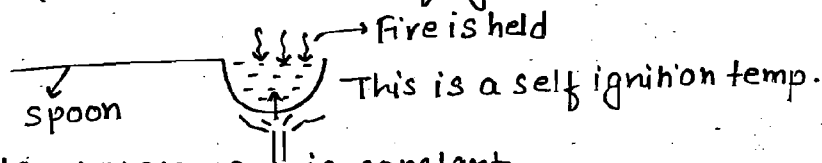
Piston is change its direction inside the cylinder during expansion is over, then piston is at BDC piston.



same as for heat rejection.



- For any fuel is to be burn then it ^{is} should be at Flash point temp.
- Fire point temp - minimum temp so fuel to be burn at the burner.
- spark plug is behaves like a burner.
- Fire point temp to Flash point temp then spark plug is takes place continuously.
- Compression ratio in petrol engine is less (6 to 8) in comparison to that of diesel engine (and it is 15 to 16).
- No need of Burner in diesel engine so it is not have any spark plug required.
- Temp is very high in diesel engine so that the fuel is automatically burned & this process is called a self ignition temp.



- Diesel cycle \rightarrow pressure is constant
- Nicolas August otto \rightarrow Gives at a constant volume

Due to engine limitations, heat rejection will take place at constant volume only for all the cycle of I-c engine.

Hence, the following operation are the same for all the ideal cycle of I-c engine.

- Isentropic expansion.
- Isentropic compression.
- Heat rejection at const volume.