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Engine Terminologies

* Definition - types - IC and EC engines - Comparison -

Engine :- Engine is a device which converts one form of energy into another form. As known as engine.

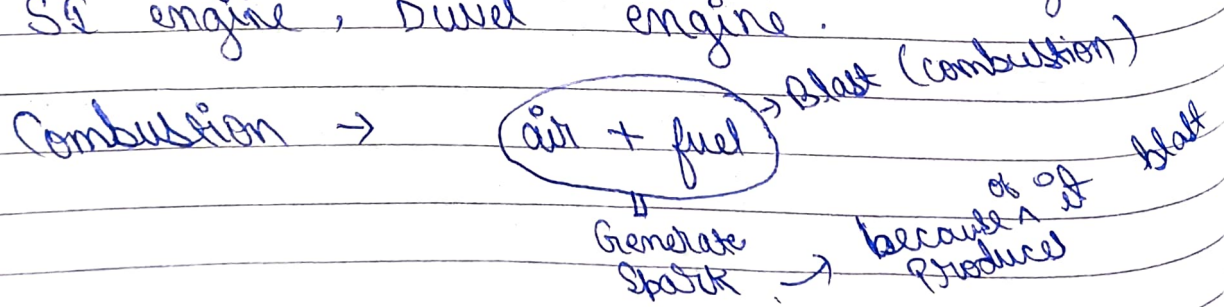
Heat Engine :- The device which converts heat energy by means of chemical energy into mechanical energy is known as Heat Engine. Example :- Chemical energy \rightarrow Mechanical (Heat) \rightarrow petrol / diesel

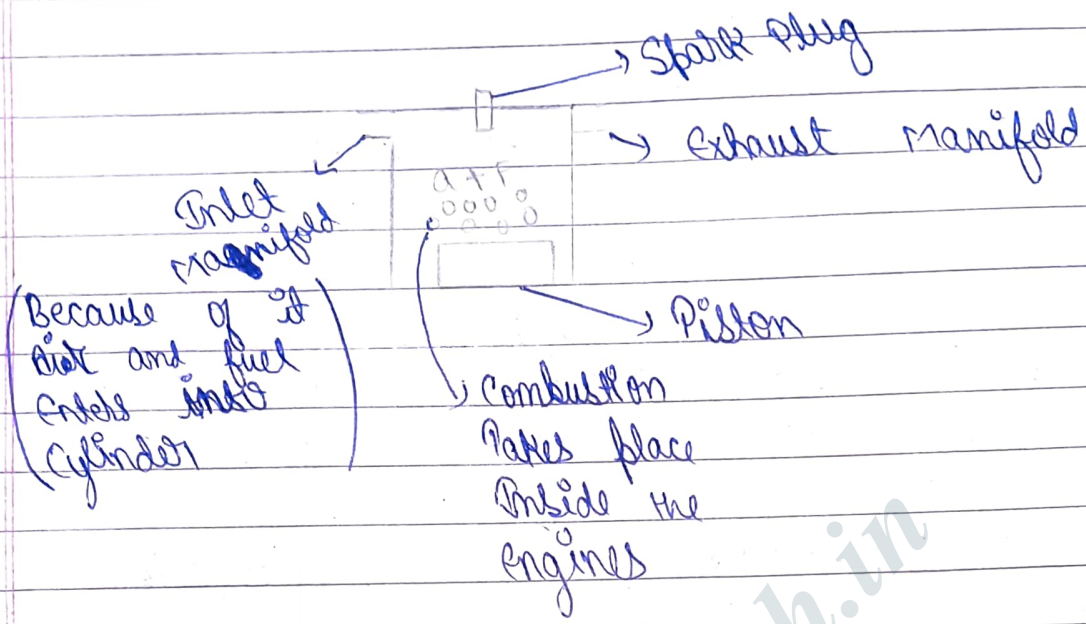
There are two types of Heat Engine -

- ① IC engines
- ② EC engines

① IC Engines (Internal Combustion engine)

If the combustion of fuel takes place inside the cylinder is known as IC engine. For example :- CI engine, SI engine, Diesel engine.





Classification of I.C engines

① According to type of ignition

Ignition = Combustion
 @ Spark ignition Engine :-

In, SI engine ignition is done through spark plug.

② Compression ignition Engine :-

In, CI engine air is compressed and ignites by fuel injector.

~~③ Four stroke~~

④ According to number of stroke

@ ~~Four~~ Four stroke engine
 These engine which contains 4 strokes are known as 4 stroke engine. The



Four strokes are

- Suction
- Expansion
- Compression
- Exhaust

(b) Two Stroke engine
 These engine which contains two stroke is known as 2 stroke engine. The two strokes are
 → Compression → Expansion

(3) According to fuel used

(a) Petrol engine

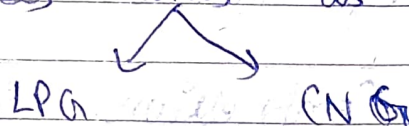
These engine which uses petrol as a fuel.

(b) Diesel engine

These engine which uses diesel as a fuel.

(c) Gas engine

These engine which uses Gas as a fuel



(4) According to thermodynamics cycle.

(a) Otto cycle engine.

These engine in which combustion takes place at a constant volume is known as Otto cycle engine. → SI engine

(b) Diesel cycle engine.

These engine in which combustion takes place at a constant pressure is known as Diesel cycle engine.

① Duel Cycle engine
 Those engine in which combustion takes place at a constant pressure as well as constant volume is called Duel Cycle engine.

* Components / Parts of IC Engine :-

① Cylinder :- It is a part of engine where fuel is burnt and power developed. The inside diameter of the cylinder is called bore. Sleeve is connected fitted tightly in the cylinder to prevent from the wearing of the block.

② Piston :- It is close fitting to the hollow cylinder, the plunger is moving up and fro in the cylinder.

Function of Piston

The power developed by the combustion fuel is transmitted by piston to the crank shaft through connecting rod.

② Piston Ring

It maintains a tight seal between piston and cylinder head. It is inserted into the grooves provided at the top end of the piston. So it prevents the leakage of the

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④

Connecting Rod :- It is the link that connects the piston and the crank shaft by means of pin joint.

Function :- It converts the rectilinear motion of the piston into rotary motion of crank shaft. It has two ends

Big End - to Crank Pin
Small End - to Gudgeon Pin

⑤ Valve :- These are the devices which are used to control the flow of intake of fluid and exhaust of the combustion product.

⑥ Fly wheel :- It is mounted on the crank shaft to maintain uniform rotation of crank shaft.

- ⑦ Crank case :- It is also called oil pan or oil sump. It is inclosed space for crank shaft and sump for lubricating oil.
- ⑧ Crank shaft :- It receives the efforts or thrust supplied by the piston to the connecting rod shaft and it converts the reciprocating motion into rotatory motion of the crank shaft.
- ⑨ Spark Plug :- It is to ignite the air compressed air fuel mixture of the combustion chamber.
- ⑩ Injector :- It is used in CI engine. It express fuel into combustion chamber at end of the compression.
- $$\text{Compression Ratio} = \frac{V_c + V_t}{V_t}$$
- ⑪ Camshaft → It is used to control the opening and closing of the valve at proper timing. It provides the drive to Ignition System. It is driven by the Crank shaft through timing gear.
- Camshaft - To control the valve.

TDC (Top dead Centre)

- The Piston are the farthest from the Crank shaft.

Note :- TDC is in vertical engine.

IDC \rightarrow Horizontal engine \rightarrow BDC
 TDC \rightarrow Vertical engine \rightarrow ODC

The position of piston is nearest to Crank shaft.

Swept volume :- It is the gap b/w the cylinder and piston when it is at TDC, that is known as Swept volume.

Displacement volume or Swept volume (V_s)

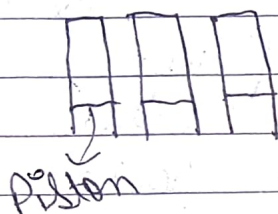
- It is the part of volume of combustion chamber.

- The volume swept by the moving piston when from one side centre to another side centre is called swept volume.

$$V_s = A \times L$$

$$= \frac{\pi D^2}{4} \times L$$

(c (Cubic Centimetre³) → Cubic (m³))



$$3 V_s = 3 \times \frac{\pi D^2}{4} \times L$$

* Parts and Components of the Cylinder.

1. Bore (D) :- Internal diameter of engine cylinder.

2. TDC :- Top dead centre

3. BDC :- Bottom dead centre.

4. Stroke (L) :- Distance travelled by piston is known as stroke.

TDC → BDC or BDC → TDC.

5. Swept Volume :- The volume swept by the piston when it moves TDC to BDC is known as swept volume.

$$\text{Swept Volume } (V_s) = \pi r^2 \times L$$

$$= \pi \left(\frac{D}{2}\right)^2 \times L = \frac{\pi D^2 L}{4}$$

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Q. What is the difference between valve and port in IC engine.

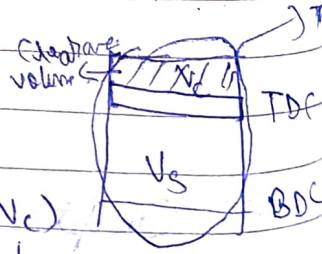
Ans :- ① A valve in an engine is operated mechanically whereas a port is just an opening which is opened and closed by a piston.

② A 4 stroke engine uses valves.
A 2 stroke engine uses ports.

③ Ports are the open spaces from where fuels intake or exhausts in 2 stroke engine.

④ Valves are mechanical components used in IC engines to allow or restrict the flow of fluid or gas to and from the combustion chambers or cylinders during engine operation.

* Clearance Volume :- When the piston is at TDC then, the volume above TDC is known as Clearance Volume.
Clearance Volume (V_c) =



Total Volume (V_t) = Clearance volume (V_c) + Swept volume (V_s)

* Compression Ratio :- It is the ratio of total volume to clearance volume.

Compression Ratio = $\frac{V_t}{V_c} = \frac{V_c + V_s}{V_c}$

Principle Working Principle of Engine

If an engine is to work successfully then it has to follow a cycle of operations in a sequential manner.

Cycle of operation

1) According to the operation

IC engine are classified into two types

(i) Constant volume heat addition cycle Engine \rightarrow Otto cycle engine \rightarrow SI engine

(ii) Constant pressure heat addition cycle Engine \rightarrow Diesel engine \rightarrow CI engine.

4 - Stroke SI engine

In a 4-Stroke engine, the cycle of operation is completed in 4-Stroke of the engine & two revolution of the crank shaft. Each stroke consist of 180° rotation of Crank shaft the cycle is completed through 720° of crank rotation. The cycle of operation for an ideal of SI engine consist of the following 4-Stroke.

- ① Suction / Intake Stroke.
- ② Compression Stroke.
- ③ Expansion / Power Stroke

④ Exhaust / outlet stroke

Suction → Compression → Combustion → Power
Generate → Exhaust



Suction

* Working

Ideal PV diagram

① Suction or Intake stroke

The piston moves from TDC to BDC. In this the inlet valve is opened and Exhaust valve is closed. The pressure inside the cylinder is reduced below the ~~at~~ atmospheric pressure (ATP). The mixture of air fuel is sucked into cylinder through inlet valve.

The piston moves from BDC to TDC. Both valves are closed. The air fuel mixture inside the cylinder is compressed at the

End of the Compression . the combustion

The burning takes place when the piston is ~~to~~ towards TDC and PDC. The process 2 to 3 is heat addition at constant volume and the temperature inside the ~~chamber~~ cylinder is about 2000°C . The pressure it also rises due to temperature rise.

(ii) Expansion / Power / working stroke

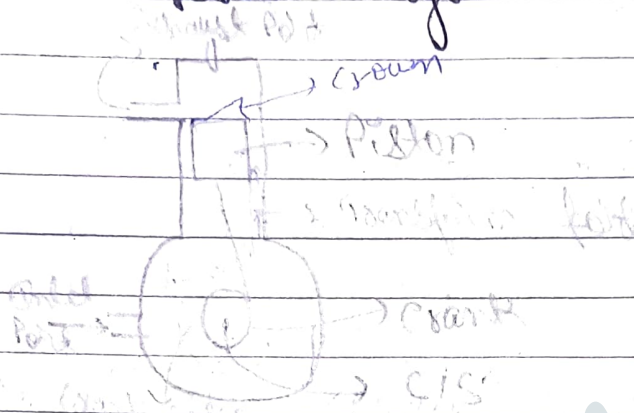
The high pressure of the burnt gases pushes the piston towards the BDC.

Both the valves are in closed position and pressure and temperature decreases ~~both~~ during the expansion.

(iii) Exhaust / outlet stroke.

Piston moves upward from BDC to TDC. On this, Exhaust valve is opened and Inlet is closed. The burnt gases are forced out to the atmosphere through the exhaust valve.

* 2-Stroke petrol engine.



A piston reciprocates inside the cylinder. It is connected to the crank shaft by means of connecting rod and crank.

- There is no valve. Instead of valves ports are cut on the cylinder. There are three ports:
 - ① Inlet port.
 - ② Transform port.
 - ③ Exhaust port.

The closing and opening of the ports is controlled by the movement of piston. The crown of piston is made into a curved shape.

Working of 2-Stroke petrol engine

→ 1st stroke (Compression)

The piston moves from BDC to TDC. Both transfer and exhaust ports are governed by the piston.

which is transferred already

On the engine cylinder is compressed by moving piston.

The pressure and temperature increases at the end of compression.

(i) Ignition and Inductance.

The piston almost reaches the BDC. The mixture (A/F) is ignited by means of an electric spark plug by means of spark plug at same time the inlet port is uncovered and fresh air ~~fluid~~ mixture through the inlet port.

(ii) The burning gases expand in the cylinder. It force the piston to move down. Thus, useful work is obtained. When the piston down the mixture in crank case is partially compressed. This compression is known as Crank Case Compression.

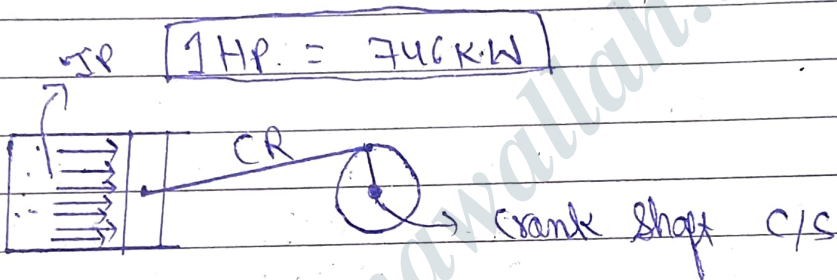
(iii) Exhaust stroke
At the end of expansion, exhaust is opened and burnt fuel gases is kept to atmosphere. The transfer port is also opened and the compressed mixture enters the cylinder through the transfer port. The crown of the

$P_m \rightarrow$ Mean effective power
Power indicate \rightarrow IP

$$\frac{IP}{746} = IHP \rightarrow \text{Indicated horse power.}$$

Break Power \rightarrow BP
Frictional power \rightarrow FP

$$IP - FP = BP$$



$$F = P_m \cdot A$$

$$IP = \frac{PLANK}{60}$$

$P_m =$ Pressure in the Cylinder.

$L =$ Stroke length

$A =$ Area ⁱⁿ the Cylinder

$N =$ Speed of the crank shaft.

$K =$ Number of Cylinder.

$N \rightarrow$ 2-Stroke, (N)
 $N \rightarrow$ 4-Stroke, $(N/2)$

T → Torque of shaft
 ω → Speed of shaft

$BP = T \cdot \omega = T \cdot \frac{2\pi N}{60}$ (KW)

Mechanical efficiency, $\eta_{mech} = \frac{BP}{IP}$

$\eta_{ith} = \frac{IP}{m_f \cdot CV}$

where,

- IP = indicated power.
- m_f = mass of fuel.
- CV = Calorific value of fuel.
- η_{ith} = Indicated thermal efficiency.

$\eta_{bth} = \frac{BP}{m_f \cdot CV}$

where,

- η_{bth} = Brake thermal efficiency.
- BP = Brake power.
- m_f = Mass of fuel.
- CV = Calorific value of fuel.

Mechanical efficiency

$\eta_{mech} = \frac{BP}{IP} = \frac{\eta_{bth}}{\eta_{ith}}$

Q1) What is the difference between 2-stroke engine and 4-stroke engine.

2-Stroke engine	4-Stroke engine
(i) Cycle is completed in two strokes of piston.	(i) Cycle is completed in four strokes of piston.
(ii) One revolution of crank shaft in one cycle.	(ii) Two revolutions of crank shaft in one cycle.
(iii) Power is developed in every revolution of crank shaft.	(iii) Power is developed in every alternate revolution of crank shaft.
(iv) This engine is lighter and more compact so that less space is required.	(iv) This engine is heavier and larger so that more space is required.
(v) Number of power stroke (n) = N	(v) Number of power stroke (n) = N/2.
(vi) Crank shaft can rotate in both directions.	(vi) Crank shaft rotates only in one direction.
(vii) Used for lower power application like Scooter, motor cycle, Auto Rickshaw etc.	(vii) Used for high power applications like Bus, truck, tractor etc.

~~(viii) Two strokes are suction and~~

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Q. 2. Difference between Petrol Engine and Diesel engine.

Ans: Petrol Engine	Diesel Engine
i) The air and petrol are mixed in carburetor before they enter into the cylinder.	i) The fuel is fed into the cylinder by a fuel injector and is mixed with air inside the cylinder.
ii) The petrol engine works on Otto cycle i.e., on constant volume.	ii) The diesel engine works on diesel cycle i.e., on constant pressure.
iii) The petrol engine compresses a mixture of air and petrol which is ignited by an electric spark.	iii) The diesel engine compresses only a charge of air and ignition is done by the heat of compression.
iv) Compression ratio is low.	iv) Compression ratio is high.
v) Less power is produced due to lower compression ratio.	v) Due to higher compression ratio more power is produced.
vi) Petrol engine is fitted with spark plug.	vi) Diesel engine is fitted with diesel engine.
vii) Fuel consumption in petrol engine is high.	vii) Fuel consumption in diesel engine is less.

* Explain the advantages of 2-stroke and 4-stroke engines considering specific example.

Ans:-

2-stroke engines advantages	4-stroke engines advantages

Ans:- In a two stroke engine :- The working cycle is completed in two strokes of the piston at one revolution of the crankshaft. There are many advantages of 2-stroke engine.

- (i) A two stroke engine gives twice the number of power strokes than the four stroke cycle engine at the same engine speed. It means it will develop twice the power as that of four stroke cycle engine.
- (ii) A two stroke cycle engine is lighter, less bulky and occupies less floor area than the four stroke engine.

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(iii) A two stroke cycle engine has a lighter flywheel and gives higher mechanical efficiency than a four stroke cycle engine.

In a four stroke engine - the working cycle is completed in four strokes of the piston or two revolutions of the crankshaft. The advantages of 4-stroke engines are

(i) Higher efficiency: Four stroke engines are more efficient than 2-stroke engines, as they complete a power stroke every four strokes, resulting in better fuel economy and lower emissions.

(ii) Lower emission: Four - stroke engines produce fewer engine emissions, as the combustion process is more complete, and the engine does not release unburned fuel into the atmosphere.

(iii) Easier maintenance :- Four - stroke engines are generally easier to maintain than two - stroke engines, as they have fewer components and are less prone to wear and tear.

* Explain the construction and working of 4-Stroke diesel (CI) engine cycle.

Q:- 4-Stroke diesel engine cycle is also known as compressed ignition engine (CI engine) because the air is firstly compressed by the piston and ignites by heat produced by compression. The construction of 4-Stroke diesel (CI) engine is as follows:

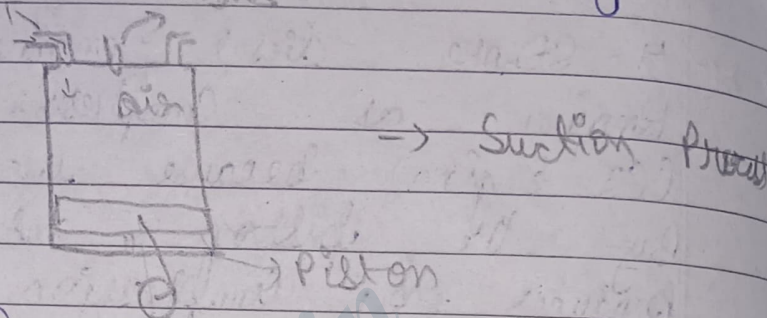
- (i) Piston :- It is a closed fitting in the cylinder which moves to and fro.
- (ii) Crankshaft :- It is a shaft which rotates by the help of piston. Crankshaft and piston is connected with connecting rod.
- (iii) Valves :- It is a space from where inlet and exhaust takes place.
- (iv) Cylinder :- It is a component in which combustion takes place.
- (v) Fuel injector :- It is a device by which fuel is injected into the cylinder. Diesel cycle engine.

Working of diesel (CI) engine cycle.

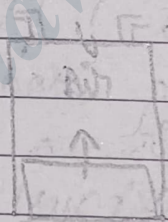
In a diesel (CI) engine cycle, firstly a small charge of air is compressed by the piston and then, it ignites by the help of fuel injector. The working of diesel (CI) engine cycle takes place by 4 process.

- (i) Suction :- It is the process in which

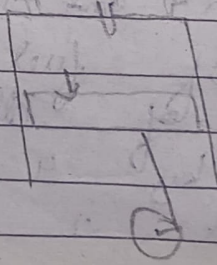
A small charge of air comes inside the cylinder ~~with~~ by the help of valves.
valve injector



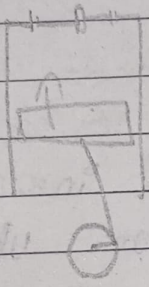
(ii) Compression :- It is the process in which air is compressed inside the cylinder with the help of piston. In compression valves are closed. The piston moves BDC To TDC.



(iii) Combustion :- It is the process in which air is ignited in the by the help of fuel injector inside the cylinder. In this process piston moves from TDC to BDC. In combustion process constant pressure produces.



(iv) Exhaust :- After the process of combustion, the burnt gases which are produced during combustion exhaust from outlet valve. ~~After this process~~



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