UNIT-2

INTERNAL COMBUSTION ENGINES -REFRIGERATION AND AIR CONDITIONING

Heat engines are otherwise called Thermal Engines. It is a machine which converts heat energy in to useful mechanical work. Heat engines develop more than 80% the energy generated in the world.

Heat engines can be broadly classified into two categories

(i) **External combustion engine**: An engine in which combustion of fuel takes place outside the engine cylinder is called external combustion engine. These engines are generally called EC engines.

Ex: Steam engines, steam turbines, closed cycle gas turbine etc.

(ii) **Internal combustion engine**: An engine in which combustion of fuel takes place inside the engine cylinder is called internal combustion engine. These engines are generally called IC engines.

Ex: Petrol engine, diesel engine, gas engine etc.

CLASSIFICATION OF IC ENGINES

Internal combustion engines are classified according to

1) According to thermodynamic cycle

i) Otto cycle ii) Diesel cycle iii) Dual combustion cycle

2) According to number of strokes

i) Two stroke ii) Four stroke

3) According to number of cylinders

i) Single cylinder engine ii) Multi cylinder engine

4) According to method of ignition

i)Spark ignition (petrol, gas engine)

ii) Compression ignition (diesel, vegetable oil)

5) According to type of fuel used

i) Petrol ii) Diesel iii) Gas

iv) Bio fuel (peanut oil, sunflower oil, linseed oil)

6) According to position of cylinder

i) Horizontal engine (hero Honda)

ii) Vertical engine (car, bus, truck engines)

iii) Vee engine

iv) Radial engine (old aeroplane engine)

v) Opposed cylinder engine

7) According to method of cooling

i) Air cooling ii) Water cooling iii) Liquid cooling

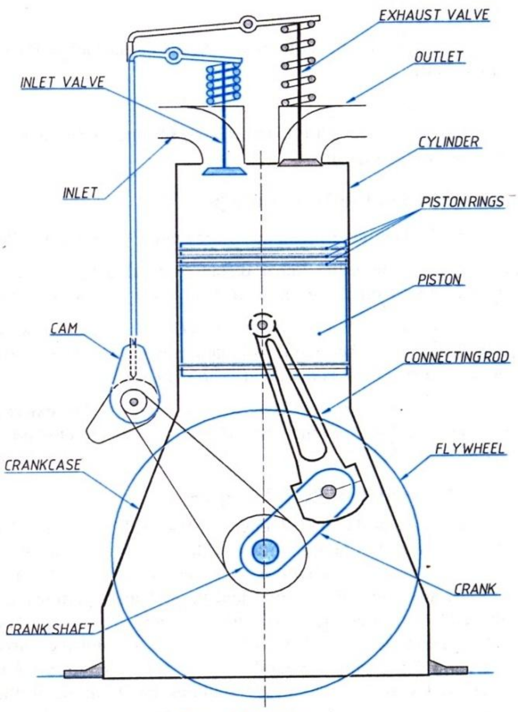
8) According to speed of engine

i) Slow speed engine ii) Medium speed engine iii) High speed engine

PARTS OF INTERNAL COMBUSTION ENGINE

The parts of internal combustion engines are Cylinder, head, piston, piston rings (compression rings and oil control ring), valves, connecting rod and crankshaft.

Function of IC engine parts:



Parts of I.C.Engine

Cylinder: (cylinder block) The cylinder is the main part of an engine. The combustion takes place in the combustion chamber and these gases exert pressure on the piston, due to high gas pressures the piston reciprocates in the cylinder block. The cylinder is designed to with stand high gas pressure. The temperature in the combustion chamber (cylinder block) will reach up to 2800^0 C. The cylinder has to be cooled properly either by air cooling or water cooling. In case of air cooled engines fins are provided around the cylinder block (Scooter and bikes) in water cooled engines water jackets are provided for the circulation of water to carry away the heat around the cylinder block. The cylinder block material; is aluminium alloy

Head: (cylinder head) The head is fitted on the top of the cylinder block. In two stroke engines only spark plug is fitted in the cylinder head.

In four stroke engine inlet valve , exhaust valve and spark is fitted in the cylinder head.- The head is built with two ports, one port, which allows the charge in to the cylinder block, is known as inlet port and the second port that allows the exhaust gases to leave the cylinder block is known as exhaust port. In case of petrol engine spark plug is fitted in the head, in diesel engines fuel injector is fitted to inject the diesel into the cylinder block. The cylinder head material; is aluminium alloy

Piston: The piston is a cylindrical plug, which converts heat energy in to mechanical energy. A two stroke piston is fitted with only compression ring. In four-stroke engine both compression ring and oil control rings are fitted. The piston is connecting to the small end of the connecting rod. The piston is made of aluminium alloy. Functions of piston are

i) The piston will act as a seal
ii) To provide the passage for heat flow from piston to cylinder block through rings.
iii) It transmits the force of explosion to the crankshaft through connecting rod.

Piston rings: The piston rings are the metallic rings inserted into the circumferential grooves provided at the top end of the piston. These rings maintain a gas-tight joint between the piston and the cylinder while the piston is reciprocating in the cylinder.

Valves: the valves are the device which controls the flow of the intake and the exhaust gases to and from the engine cylinder. They are also called poppet valves. These valves are operated by means of cams driven by the crankshaft through timing gear or chain.

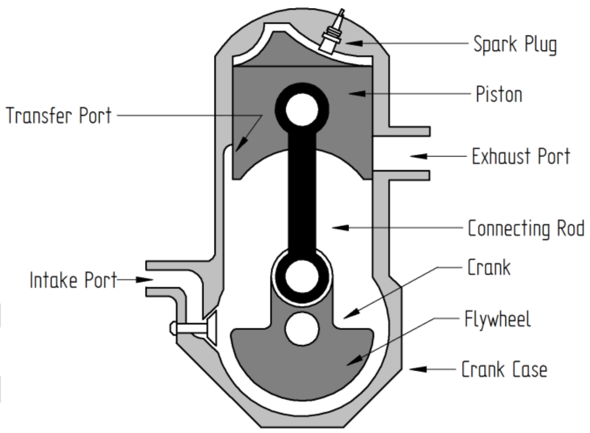
Connecting rod: The small end of the connecting rod is connected to the piston and the big end of the connecting rod is connecting to the crankshaft. The connecting rod converts the reciprocating motion of piston in to rotary motion of crankshaft. The connecting rod is made of I-beam cross section to provide maximum rigidity with minimum weight.

Crankshaft: The big end of the connecting rod is connected to the crankshaft. The power transmission starts from the crankshaft. The crankshaft is rigidly fixed in the crankcase. The other end of the crankshaft is connected to a clutch.

Crankcase: Crankcase is fitted at the bottom of the cylinder block. Two-stroke engine crankcase is properly sealed and made airtight. Four stroke engine crankcase will serve as a reservoir, filled with sufficient quantity of lubricating oil. This oil lubricates the main bearings of crankshaft, big end bearings of connecting rod, lubricates the cylinder liner, piston and piston rings.

WORKING OF TWO STROKE PETROL ENGINE.

The two-stroke petrol engine works on the principle of Otto cycle. The parts of two-stroke petrol engine are cylinder, piston, head, crankcase, connecting rod, crankshaft, spark plug, inlet port, transfer port and exhaust port.



Two Stroke Petrol Engine

The piston performs two strokes to complete one cycle. The two strokes are

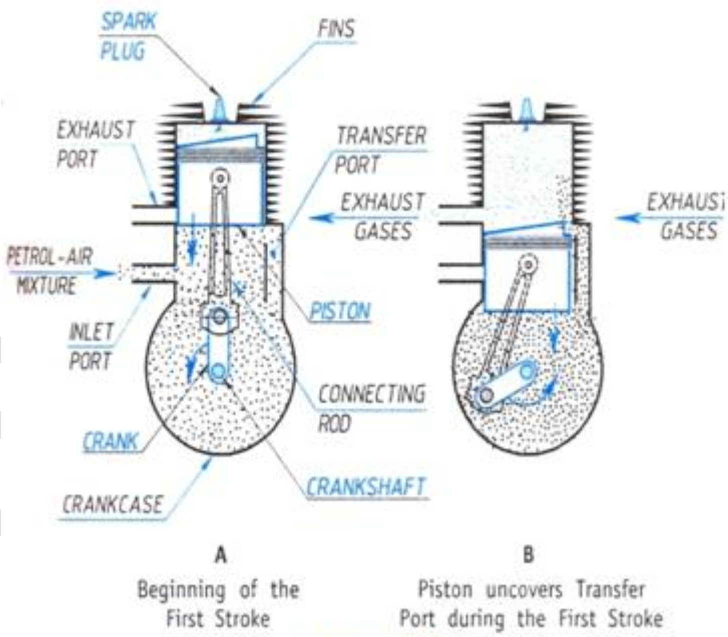
i) First stroke or down ward

ii) Second stroke or upward stroke.

First stroke or Down ward stroke or exhaust stroke: At the beginning of this stroke, the piston is in the TDC as shown in the figure (a). At this position, inlet port is opened and hence fresh air petrol mixture enters into the crank case. At this position, compressed air-petrol mixture present in the cylinder in the previous cycle is ignited by the spark generated by the spark plug. The combustion of fuel releases hot gases which increases the pressure in the cylinder. The high pressure gases exert a pressure on the piston and hence the piston moves from TDC to BDC. Thus piston performs power stroke. The power impulse is transmitted from the piston to the crankshaft through the connecting rod. This causes the crankshaft to rotate at high speeds. Thus work is obtained in this stroke.

As the piston moves downwards, it uncovers the exhaust port and hence burnt gases escape out of the cylinder as shown in the figure (b). As piston moves downwards further, opens the transfer port and the charge in the crank case is compressed by the underside of the piston as shown in figure. (b). The compressed charge from the crankcase rushes into the cylinder through the transfer port as shown in fig. (c). The charge entering the cylinder drives away the remaining exhaust gases through the exhaust port.

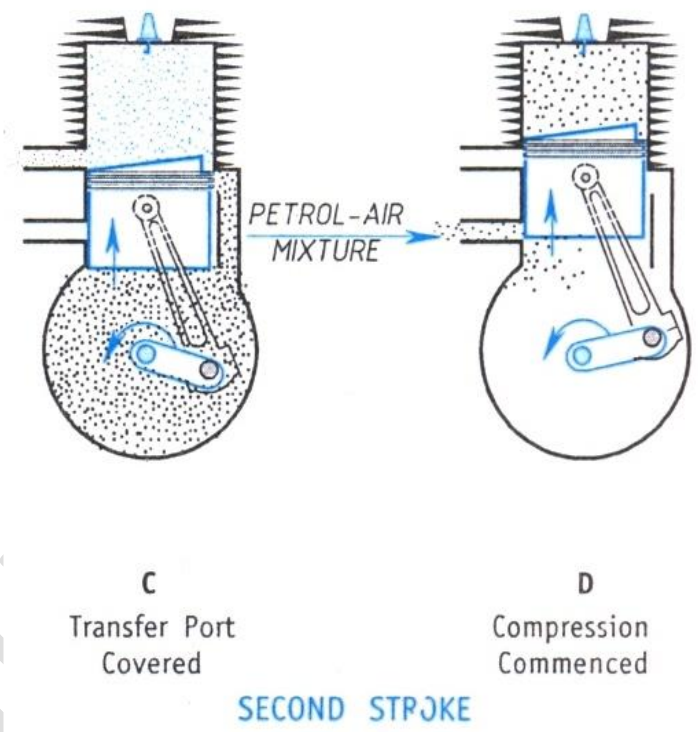
The process of removing the exhaust gases with the help of fresh charge is known as scavenging. The piston is provided with a projection at its top known as 'deflector'. The purpose of providing a deflector is to deflect the fresh charge coming through the transfer port to move towards the top end of the cylinder. By doing this, the fresh charge will be able to drive the entire burnt gases out of the cylinder.



FIRST STROKE

Upward stroke or working stroke: In two-stroke petrol engine some charge is present either in the cylinder block or in the crankcase. To start a two-stroke engine, power is supplied either by using a kicker or by electric start.

During upward stroke, the piston reciprocates from top dead center to bottom dead center. As the piston moves upward volume below the piston increases results in decrease in pressure in the crankcase. Due to pressure difference charge (petrol & air) is drawn from the carburettor. As the piston moves further upwards covers both exhaust and transfer port, now the charge is subjected to compression. Before the end of the compression stroke the spark (crank angle 20^o before TDC) occurs in the combustion chamber. Due to combustion of charge, the pressure increase, which pushes the piston downwards i.e. the working stroke of the piston. As the piston moves rapidly in the down ward direction compresses the charge present in the crankcase



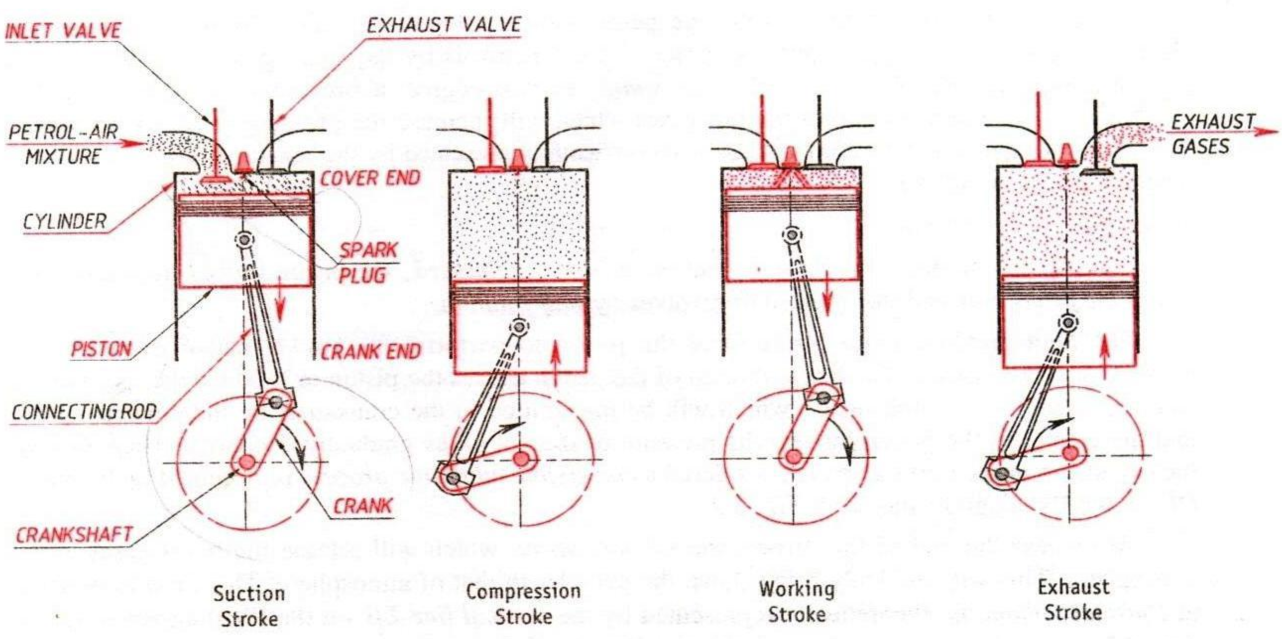
WORKING OF FOUR STROKE PETROL ENGINE

The four-stroke petrol engine works on the principle of Otto (constant volume) cycle. The parts of four-stroke petrol engine are cylinder, piston, head, crankcase, connecting rod, crankshaft, spark plug, inlet and exhaust valve. The four-stroke petrol engine may be air-cooled or water-cooled. The piston performs four strokes to complete one cycle.

The four different strokes are

1) Suction stroke 2) Compression stroke 3) Power or Expansion stroke

4) Exhaust stroke.



Four Stroke Petrol Engine

1. Suction stroke: The suction stroke is completed by rotating the crankshaft from 0^o to 180^o. During suction stroke the inlet valve opens and exhaust valve should kept in closed condition. When the piston starts moving from TDC to BDC, The volume above the piston increases, results in decrease in pressure (vacuum), This decrease in pressure draws the petrol and air mixture from the carburettor and delivered it to the cylinder, this process is continuous till the pressure inside the cylinder becomes equal to atmosphere. At the end of suction stroke the cylinder is completely filled with petrol and air mixture. At the end of suction stroke the inlet valve closes. The line AB in the PV diagram represents suction stroke (volume of mixture filled in the cylinder).

2.Compression stroke: Rotation of crankshaft from 180^0 to 360^0 completes The compression stroke. During compression stroke both inlet and exhaust valves are closed. In this stroke the piston travels from BDC to TDC. When the piston starts moving from BDC to TDC the mixture is compressed, and the pressure increases in the cylinder. The line BC represents the compression stroke.

At or near the before the end of the compression stroke, the spark occurs, this spark ignites the petrol and air mix. The combustion of mixture releases hot gases, which will increase pressure at constant volume. The line CD represents increase in the pressure at constant volume.

3.Power stroke: Rotation of crankshaft from 360^0 to 540^0 completes the power stroke.

During power stroke (expansion stroke) both inlet valve and exhaust valve are in closed position. The high-pressure gases produced due to combustion, will exert pressure on the top face of the piston, the piston moves rapidly in the down ward direction performs power stroke.

4.Exhaust stroke: Rotation of crankshaft from 540^0 to 720^0 completes the exhaust stroke. At the beginning of exhaust stroke, the exhaust valve opens, and the upward movement of the piston pushes the exhaust gases out the cylinder. At the end of the exhaust stroke the exhaust valve closes.

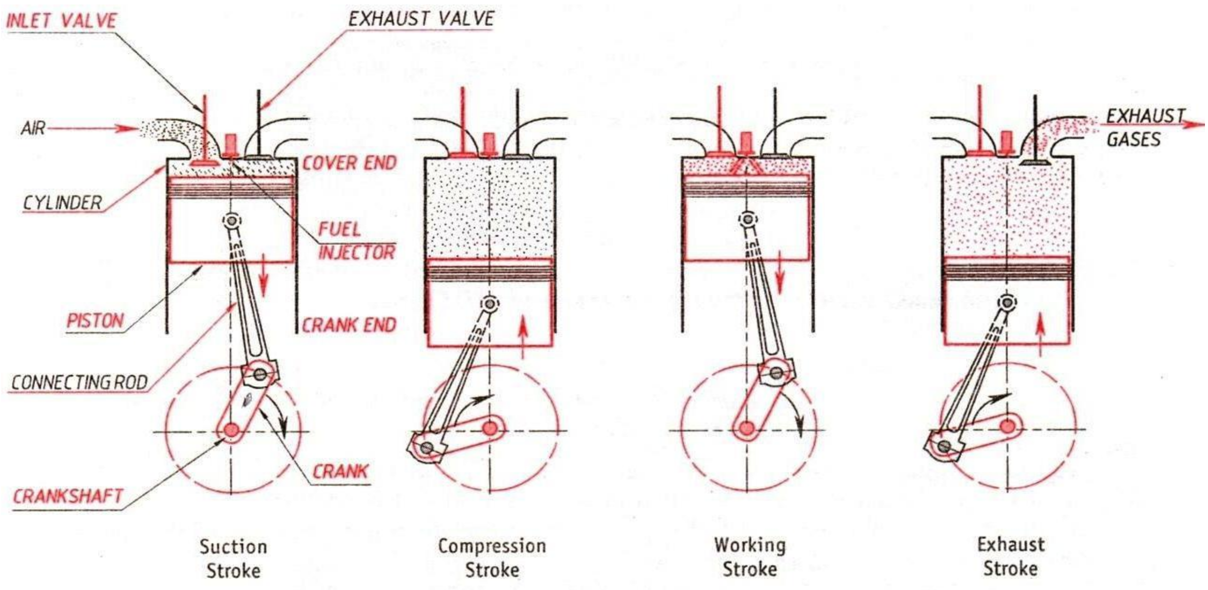
Thus one cycle completes by rotating the crankshaft from 00 to 7200.

WORKING OF FOUR STROKE DIESEL ENGINE

The four-stroke diesel engine works on the principle of diesel (constant pressure) cycle. The parts of four-stroke diesel engine are cylinder, piston, head, crankcase, connecting rod, crankshaft, fuel injector, inlet and exhaust valve. The four-stroke diesel engine may be air-cooled or water-cooled. The piston performs four strokes to complete one cycle.

The four different strokes are

1) Suction stroke 2) Compression stroke 3) Power or Expansion stroke 4) Exhaust stroke.



Four–Stroke Diesel Engine

1) **Suction stroke**: The suction stroke is completed by rotating the crankshaft from 0^o to 180^o. During suction stroke the inlet valve opens and exhaust valve should kept in closed position. When the piston starts moving from TDC to BDC, The volume above the piston increases, results in decrease in pressure (vacuum), This decrease in pressure draws the air from atmosphere and fills the air in to the cylinder, this process is continuous till the pressure inside the cylinder becomes equal to atmosphere. At the end of suction stroke the cylinder is completely filled with air. At the end of suction stroke the inlet valve closes. The line AB in the PV diagram represents suction stroke (Volume of air filled in the cylinder).

2) **Compression stroke**: Rotation of crankshaft from 180^o to 360^o completes the compression stroke. During compression stroke both inlet and exhaust valves are closed. In this stroke the piston travels from BDC to TDC. When the piston starts moving from BDC to TDC the air is compressed, both pressure and temperature of the air increases. At the end of the compression stroke the temperature of the air reaches the ignition temperature of diesel. The line BC represents the compression stroke.

Before the end of the compression stroke, the fuel injector starts injecting the diesel in to the combustion chamber. The heat of the compressed air burns the injected diesel. The combustion takes place at constant pressure. The line CD represents increase in the pressure at constant pressure.

3) **Power stroke**: Rotation of crankshaft from 360^o to 540^o completes the power stroke.

During power stroke (expansion stroke) both inlet valve and exhaust valve are in closed position. The high-pressure gases produced during combustion, will exert pressure on the top face of the piston, the piston moves rapidly in the down ward direction performs power stroke. The energy is supplied to the flywheel during power stroke. This energy propels the vehicle

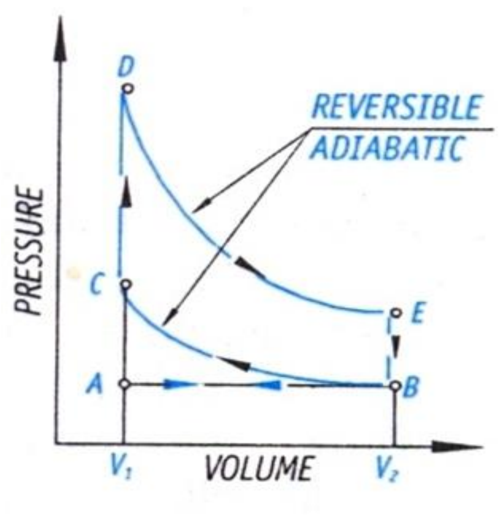
4) **Exhaust stroke**: Rotation of crankshaft from 540^o to 720^o completes the exhaust stroke. At the beginning of exhaust stroke, the exhaust valve opens, and the upward movement of the piston pushes the exhaust gases out the cylinder. At the end of the exhaust stroke the exhaust valve closes.

Thus one cycle completes by rotating the crankshaft from 0^o to 720^o, i.e., two revolutions of the crankshaft.

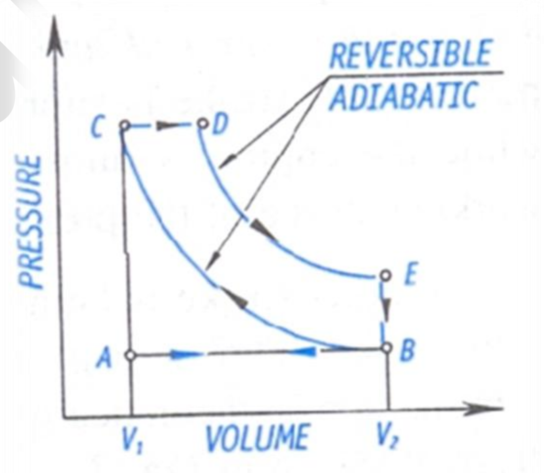
P-V DIAGRAMS

OTTO CYCLE

DIESEL CYCLE



Theoretical Otto Cycle



Theoretical Diesel Cycle

COMPARISON BETWEEN 2-STROKE AND 4-STROKE I.C. ENGINES.

SI. No	Petrol Engine (SI Engine)	Diesel Engine (CI Engine)
1.	Draws a mixture of petrol and air during suction stroke .	Draws only air during suction stroke.
2.	The carburetor is employed to mix air and petrol in the required proportion and to supply it to the engine during suction stroke.	The injector is employed to inject the fuel at the end of compression stroke.
3.	Compression ratio ranges from 7: 1 to 12: I	Compression ratio ranges from 18:1 to 22:1
4.	The charge (Le petrol and air mixture) is ignited with the help of spark plug. This type of ignition is called spark ignition.	The ignition of the diesel is accomplished by the compressed air which will have been heated due to high compression ratio, to the temperature higher than the ignition temperature of the diesel. This type of ignition is called compression ignition.
5.	The combustion of fuel takes place approximately at constant volume.	The combustion of fuel takes place approximately at constant pressure.
6.	Works on theoretical Otto Cycle.	Works on theoretical Diesel Cycle.
7.	Power developed is less.	Power developed is more.
8.	Thermal efficiency is low. It is up to about 26%	Thermal efficiency is high. It is up to about 40%.
9.	These are high speed engines	These are low speed engines.
10.	The maintenance cost is less.	The maintenance cost is more.
11.	The running cost is high because of the higher cost of petrol.	The running cost is low because of lower cost of diesel
12.	Lighter and cheaper because of low	Heavier and costlier because of high

	compression ratio	Compression ratio.

COMPARISON BETWEEN 2-STROKE AND 4-STROKE I.C. ENGINES.

SI. No	2-Stroke Engine	4-Stroke Engine
1.	Requires two separate strokes to complete one cycle of operation.	Requires four separate strokes to complete one cycle of operation.
2.	Power is developed in every revolution of the crankshaft	Power is developed for every revolutions of the crankshaft.
3.	The inlet, transfer and exhaust ports are opened and closed by the movement of piston itself.	The inlet and exhaust are opened and closed by the valves.
4.	Turing moment is not uniform and hence requires a heavier flywheel.	Turing moment is uniform and hence Requires lighter flywheel.
5.	The charge is first admitted into the crankcase and then transferred to the Engine cylinder.	The charge is directly admitted in to the engine cylinder during the suction Stroke.
6.	For the same power developed the Engine is heavy and bulky.	For the same power developed the Engine is light and compact.
7.	Thermal efficiency is low.	Thermal efficiency is high.
8.	Requires greater lubricant and coolant.	Requires lesser lubricant and coolant.
9.	Fuel consumption is more.	Fuel consumption is less.
10.	Initial cost is less.	Initial cost is more.

Simple calculations in internal combustion engines.

i) **Mean effective pressure (p_m)**: It is defined as the average pressure is acting on the piston during the entire expansion (power stroke) stroke.

$$P_m = \frac{s\,a}{l}$$

Where,

p_m = Mean effective pressure N / m^2

s = spring constant of the spring used in the piston indicator,

l = length of the indicator diagram,

a = area of the indicator diagram.

Note that, spring constant is the pressure required to cause unit deflection of the spring.

ii**) Indicated power (IP)**: The power developed within the piston –cylinder arrangement by the combustion of fuel is known as the indicated power.

i) When p_m is expressed in **N/ m^2**

$$IP = \frac{P_m LAn}{60 * 1000} \quad kW$$

ii) When p_m is expressed in **bar**

$$IP = \frac{100 P_m LAn}{60} \quad kW$$

Where,

P_m = mean effective pressure.

L = stroke length.

A = area of cross-section of the piston.

n = number of cycles per minute.

= N/2 for a four stroke engine.

= N for a two stroke engine.

N = crank shaft speed, rpm

ii) **Brake power (BP)**: The power available at the crank shaft is always less than the power developed within the piston-cylinder arrangement because of frictional losses in the moving parts. The power actually available at the crank shaft is called the brake power. It can be measured using *dynamometers.* One such dynamometer is the *brake-drum* dynamometer.

The torque on the brake drum is given by,

$$T = (W - S) * R \quad Nm$$

Where,

W = weight on the rope, N.

S = spring balance reading, N.

R = mean radius of brake drum, m.

Brake power is given by.

$$BP = \frac{2\pi NT}{60 * 1000} \quad kW$$

iii) **Frictional power**: The difference between indicated power and brake power is known as frictional power

$$FP = (IP - BP) \quad kW$$

iv) **Mechanical efficiency:** It is defined as the ratio of brake power to indicated power

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

v) **Thermal efficiency**: In IC engines, energy is supplied to the engine by burning fuel. But all of the energy that is supplied is not converted into useful mechanical work. The thermal efficiency can be calculated either for the indicated power, or for the brake power. Accordingly they are referred to as indicated thermal efficiency, and brake thermal efficiency.

Heat supplied to the engine per sec = mass of fuel burnt (m_f) x calorific value (CV).

1. **Indicated thermal efficiency**

$$\eta_{indicated\ thermal} = \frac{\text{Indicated power}}{m_f * CV}$$

2. **Brake thermal efficiency**

$$\eta_{\text{brake thermal}} = \frac{\text{Brake power}}{m_f * CV}$$

Where,

m_f = Mass of fuel used in **kg / sec**.

CV = Calorific value of fuel **kJ / kg**

3. Specific fuel consumption (SFC):

It is the mass of fuel supplied per hour in order to get unit power output.

$$SFC = \frac{m_f}{\text{Power}} \quad \frac{\text{kg}}{\text{kW}} - \text{hr}$$

SFC can be calculated on indicated power basis or on brake power basis.

***Problems are discussed in the classes**

REFRIGERATION AND AIR CONDITIONING

REFRIGERATION:-Refrigeration is the art and science of maintaining a space at a temperature lower than the surrounding temperature. The device, which is used for this purpose, is the refrigerator. Refrigeration is useful in the preservation of foodstuff, medicines, high precision industries, air conditioning, etc.

AIR-CONDITIONING:- Air conditioning is defined as the process of simultaneous control of temperature, humidity, cleanliness and air motion of the confined space by altering the air properties.

REFRIGERANTS:- Refrigerant is the substance which carries heat from low temperature region and delivers to high temperature region.

PROPERTIES OF REFRIGERANTS

1. Low boiling point at atmospheric pressure to maintain the low temperature in the evaporator space.
2. Low freezing point.
3. High latent heat of the refrigerant reduces the quantity of refrigerant circulated.
4. It should have low viscosity.
5. It should not be chemical reactive with material used for containers and piping.
6. It should be non-flammable and non toxic.
7. It should be easily available at low cost.
8. It should give high COP.
9. Refrigerants should have high thermal conductivity.
10. It should be non explosive.

LIST OF COMMONLY USED REFRIGERANTS IN ENGINEERING

1. **AMMONIA:** It is oldest and most widely used refrigerants in ice plants and cold storage. Its boiling point at atmospheric pressure is -33^{o}C. It is considered as most suitable as it has latent heat, moderate working pressure and high critical temperature. It is less expensive compared with any other refrigerants.
2. **FREON 12:** It is most widely used refrigerant for many applications. It is non toxic and non-flammable and therefore more safe. Its boiling point at atmospheric is 30^{o}C. It is much costlier than ammonia.
3. **FREON-**22: It is another widely used refrigerants and is superior to F-12 in many respects. It is used low temperature industrial and commercial systems as its boiling temperature at atmospheric pressure is -40^{o}C.

4. **Chlorofluorocarbons (CFCs):** These are refrigerants that contain Chlorine, Fluorine and Carbon. They were developed in the 1930's and were used in a variety of industrial, commercial, household and automotive applications. They were ideal for commercial, household, and automotive use due to the fact that they are non-toxic, non-flammable, and non-reactive with other chemical compounds.

5. **Carbon dioxide (CO_2):** Carbon Dioxide is a chemical that can exist as a gas, liquid or solid (dry ice), and can be used under high pressure as a refrigerant. CO_2 has been used as a refrigerant since 1850 and is now
Regaining popularity due to its low environmental impact. Carbon dioxide is very abundant in the environment, waste of many technological
processes; its cost is thus extremely low, easily available anywhere, and its recovery from dismissed equipment or in maintenance is not required

SOME COMMONLY USED DEFINITIONS

1. **Refrigerating effect:** The amount of heat transferred by one kg of refrigerant as it circulates in the refrigeration system is called refrigerating effect.

   Or

   Refrigeration effect is an important term in refrigeration that defines the amount of cooling produced by a system.

   Or

   "The rate at which heat is absorbed from the system" is called refrigerating effect

2. **Ton of Refrigeration:** The standard unit of refrigeration is ton refrigeration or simply ton denoted by **TR**.

   It is defined as amount of heat absorbed to produce 1 ton (2000 lbs) of ice within 24 hours where the water temperature is 0^oC.

   1 TR=3.5kJ/sec

3. **Ice making capacity:** The amount heat removed from the refrigerator to form ice from the liquid water is called ice making capacity

4. **COP:** The performance of a refrigeration machine is measured by a factor known as coefficient of performance (COP).
   It is defined as the ratio of heat extracted from the refrigerator to the work supplied to the system.
   It is given by

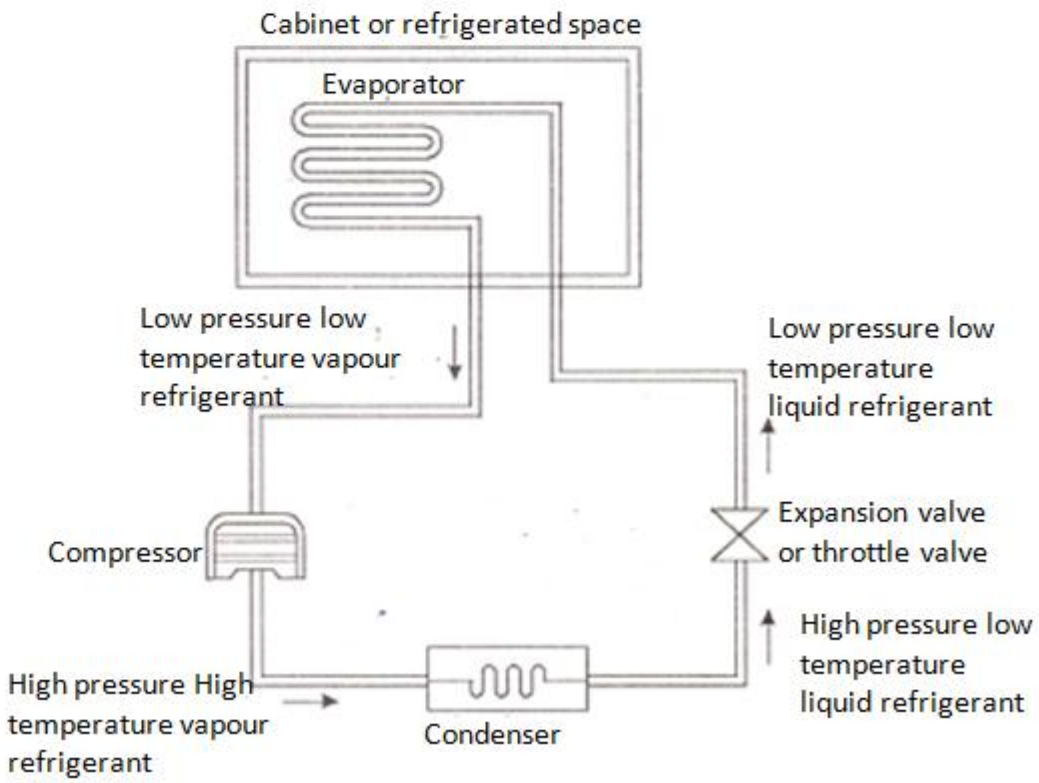
   $$\text{C.O.P}=\frac{Q}{W}$$

   Where
   Q= quantity of heat removed by the refrigeration.
   W= work supplied to the system (Refrigerator)

5. **Relative COP:** It is defined as it is the ratio of actual COP to theoretical COP.
   It is given by

   $$\text{Relative COP}=\frac{\text{Actual COP}}{\text{Therotical COP}}$$

PRINCIPLE AND WORKING OF VAPOR COMPRESSION REFRIGERATOR



Vapour Compression Refrigerator

CONSTRUCTION

The vapour compression system of refrigeration is widely used in modern refrigerating plants. A liquid refrigerant (heat carrying substance) used in this system alternatively undergoes a change of phase from vapour to liquid (condensation) and from liquid to vapour phase (evaporation) during the working cycle.

Figure shows the line diagram of a vapour compression refrigeration system. The system consists of evaporator, compressor, condenser and an expansion valve.

WORKING

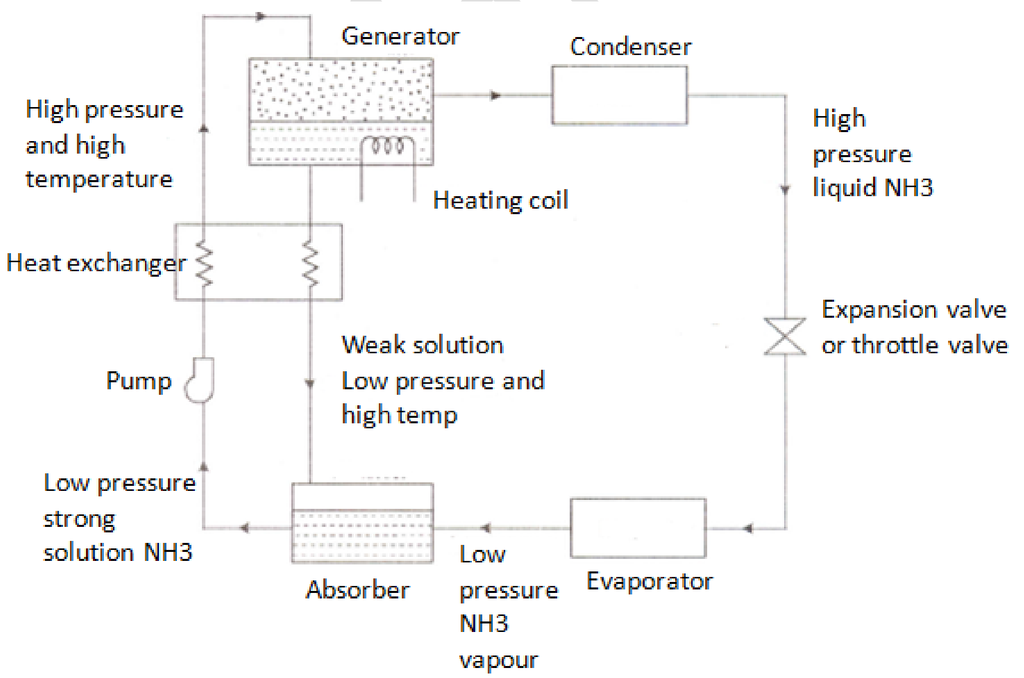
The liquid refrigerant in the evaporator absorbs the heat from the medium (cabinet/refrigerated space) which is to be cooled and undergoes a change of phase form liquid to vapour. The vapour at low temperature and pressure is drawn into the compressor where it is compressed to a high pressure and temperature. The compressed vapour then enters the condenser. In the condenser the vapour refrigerant is cooled and condensed by giving its latent heat to the circulating cooling medium (air or water). The high-pressure liquid refrigerant leaves the condenser and passes through the expansion valve where it is expanded to low pressure and temperature. The temperature of the refrigerant falls to a value less than that of the refrigerated space.

The low pressure-low temperature refrigerant again enters the evaporator where it absorbs the heat from the medium (cools the medium) and evaporates. The low pressure-low temperature vapour is drawn into the compressor and the cycle repeats. Thus, heat is continuously extracted from the medium, thereby keeping the contents at the required lower temperature.

- **WORKING OF VAPOUR ABSORPTION REFRIGERATOR**

CONSTUCTION

In the vapour absorption system, the compressor is replaced by an absorber, a generator and a pump. The refrigerant used in this system must be highly soluble in the solution known as 'absorbent'. The system uses ammonia as the refrigerant and water as absorbent. Figure shows the line diagram of a vapour absorption system.The liquid refrigerant (ammonia) in the evaporator absorbs the heat from the medium that is to be cooled and it undergoes a change of phase form liquid to vapour. The low pressure vapour is then passed to the absorber.



VAPOUR ABSORPTION REFRIGERATOR

WORKING

In the absorber, the low pressure ammonia vapour is dissolved in the weak ammonia solution producing strong ammonia solution at low pressure. The strong ammonia solution is then pumped to a generator through the heat exchanger at high pressure. While passing through the heat exchanger, the strong ammonia solution is warmed up by the hot weak ammonia solution flowing from the generator to the absorber.

The warm strong ammonia solution is heated by an external source in the generator. Due to heating, the vapour gets separated from the solution. The vapour which is at high pressure and high temperature is condensed to low temperature in a condenser by cold water circulation. The high pressure liquid ammonia then passes through the expansion valve where it is expanded to low pressure and temperature. The low pressure-low temperature ammonia liquid again enters the evaporator where it absorbs the heat from the medium (cools the medium) and the cycle repeats.

Comparison between Vapour Compression and Absorption refrigerators

Sl. No	**Parameter**.	**Vapour compression refrigerator.**	**Vapour absorption refrigerator.**
1	Energy input.	It requires large quantity of mechanical work to run the compressor, because it involves compression of large volumes of vapour.	Pump requires very less mechanical work, because it is pumping liquid. In the generator heating can be achieved either by employing coils or by any other form of heating.
2	Noise.	Noise is more due to the presence of a large compressor.	Less noisy due to the presence of pump.
3	Plant capacity.	Not suitable for large capacities.	Well suited for large capacities.
4	Maintenance.	Maintenance is more due more number of mechanical parts.	Maintenance is less due to less number of moving parts.
5	Contamination of refrigerant.	No contamination of refrigerant because only one substance is used.	Water vapour some times enters the condenser and other parts along with the refrigerant, which would reduce the refrigerating effect.

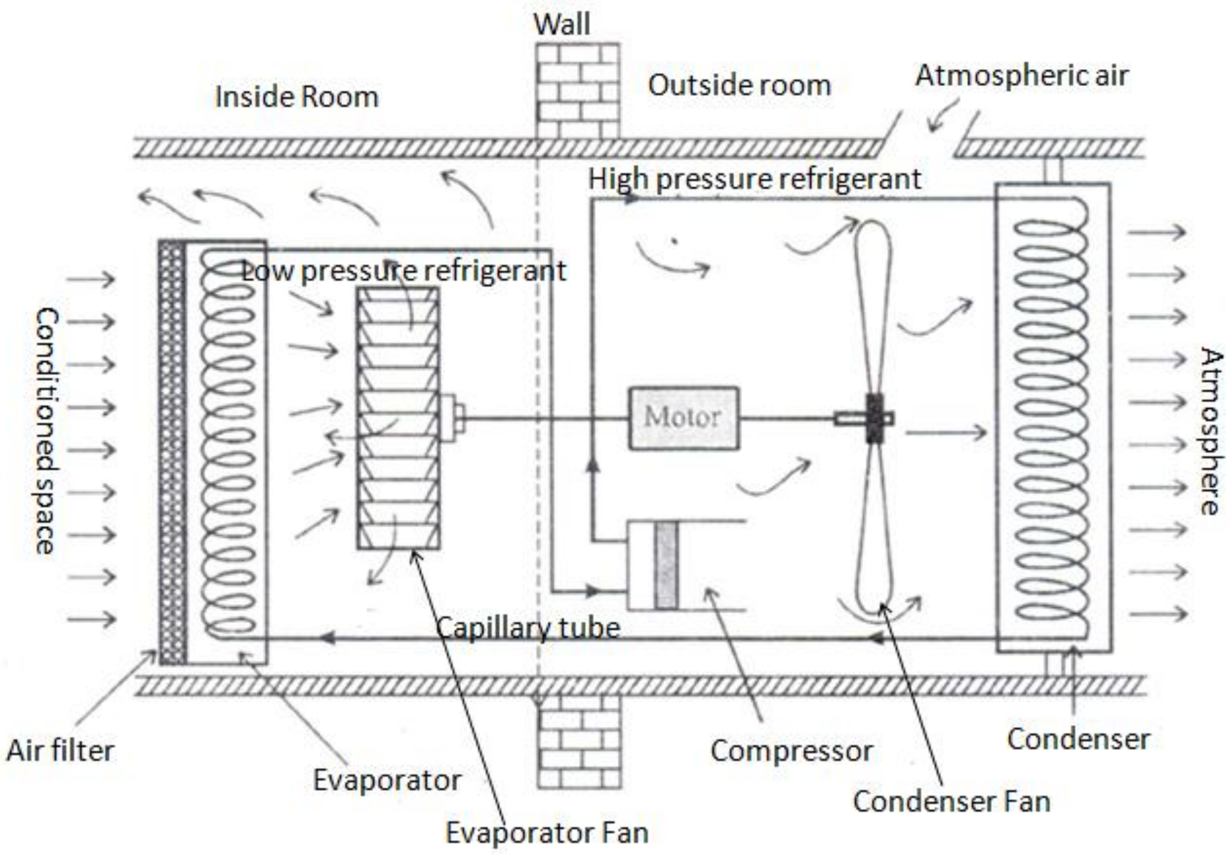
6	COP	The COP of the system reduces at part loads	The COP remains constant at full and part load condition
7	Size	Compact in size	Bulky in size

PRINCIPLE AND WORKING OF ROOM AIR CONDITIONER

CONSTRUCTION

An air conditioner operates on the principle of refrigeration by cooling the air drawn from the conditioned space and returning the cool, fresh air to the conditioned space. A simple room air conditioner is shown in Figure using block diagram.

The system consists of a compressor, a condenser, an evaporator, a capillary tube, condenser and evaporator fans driven by the same motor. The evaporator fan and the evaporator coils of the unit always lie inside the building or space which is to be conditioned. Condenser and the condenser fan of the unit projects outside the building or space to enable heat transfer with the atmosphere.



ROOM AIR CONDITIONER

WORKING

The high pressure refrigerant leaving the compressor enters the condenser coils. The latent heat of the refrigerant vapour is given to the surrounding atmosphere. Condensation takes place due to this heat transfer as the condenser fan draws air from outside the building and circulates it over the condenser coils. The high temperature liquid refrigerant enters the capillary tube and expands in it. Partial evaporation of the refrigerant takes place in the capillary tube reducing the pressure to evaporator pressure. The cold refrigerant enters the evaporator coils. The evaporator fan continuously draws hot air from the conditioned space and circulates it over the evaporator coils. The hot air passing through the air filter comes in contact with cold evaporator coils and exchanges its heat. The cool fresh air enters the conditioned space. As a result, complete evaporation of the refrigerant takes place which enters the compressor again. The cycle repeats again and again. Desired temperature inside the room can be adjusted by thermostatic control device.

AIR CONDITIONING APPLICATIONS

Air conditioning provides comfort for human beings and also a controlled environment for industrial activities. Hence, applications of air conditioning can be broadly divided into comfort applications and process applications.

A. **Comfort applications**: Aim to provide an indoor environment that remains relatively constant in a range (preferred by humans) despite changes in external weather conditions or in internal heat loads. Applications include

- In Residential buildings - single house and apartments.
- Institutional buildings - offices, hospitals, large complex buildings etc.
- Commercial buildings - shopping centers, malls etc.
- Transportation - in aircrafts, automobiles. Ships etc.

B. **Process application:** Aim to provide a suitable environment for a process being carried out, regardless of internal heat loads and external weather conditions. Applications include

- Hospitals - in operation theatres (to reduce infection risk, to limit patient dehydration etc.).
- Clean rooms - for production of integrated circuits, pharmaceuticals and the like in which very high cleanliness and control of temperature and humidity are required.
- For breeding laboratory animals.
- Textile factories
- Nuclear facilities
- Food cooking and processing areas
- Data processing centers etc.

The End