Reference: - eagri.org

HEAT ENGINES

A heat engine **is a system that converts** heat **or** thermal **energy to mechanical energy, which can then be used to do mechanical work.**

CLASSIFICATION OF HEAT ENGINES

1. Based on combustion of fuel:

(i) External combustion engine

(ii) Internal combustion engine.

External combustion engine

Here, the working medium, the steam, is generated in a boiler, located out side the engine and allowed in to the cylinder to operate the piston to do mechanical work.

Internal combustion engine

In internal combustion engine, the combustion of fuel takes place inside the engine cylinder and heat is generated within the cylinder. This heat is added to the air inside the cylinder and thus the pressure of the air is increased tremendously. This high-pressure air moves the piston which rotates the crank shaft and thus mechanical work is done

2. Based on fuel used

1. Diesel engine
2. Petrol engine
3. Gas engine

Diesel engine – Diesel is used as fuel

Petrol engine – Petrol is used as fuel

Gas engines – propane, butane or methane gases are used

3. Based ignition of fuel

1. Spark ignition engine (Carburetor type engines)
2. Compression ignition engine (injector type engines)

- **Spark ignition engine** – a mixture of air and fuel is drawn in to the engine cylinder. Ignition of fuel is done by using a spark plug. The spark plug produces a spark and ignites the air- fuel mixture. Such combustion is called constant volume combustion (C.V.C.).
- **Compression ignition engine** – In compression ignition engines air is compressed in to the engine cylinder, Due to this the temperature of the compressed air rises to 700–900-degree C. At this stage diesel is sprayed in to the cylinder in fine particles. Due to a very high temperature, the fuel gets ignited. This type of combustion is called constant pressure combustion (CP.C.) because the pressure inside the cylinder is almost constant when combustion is taking place.

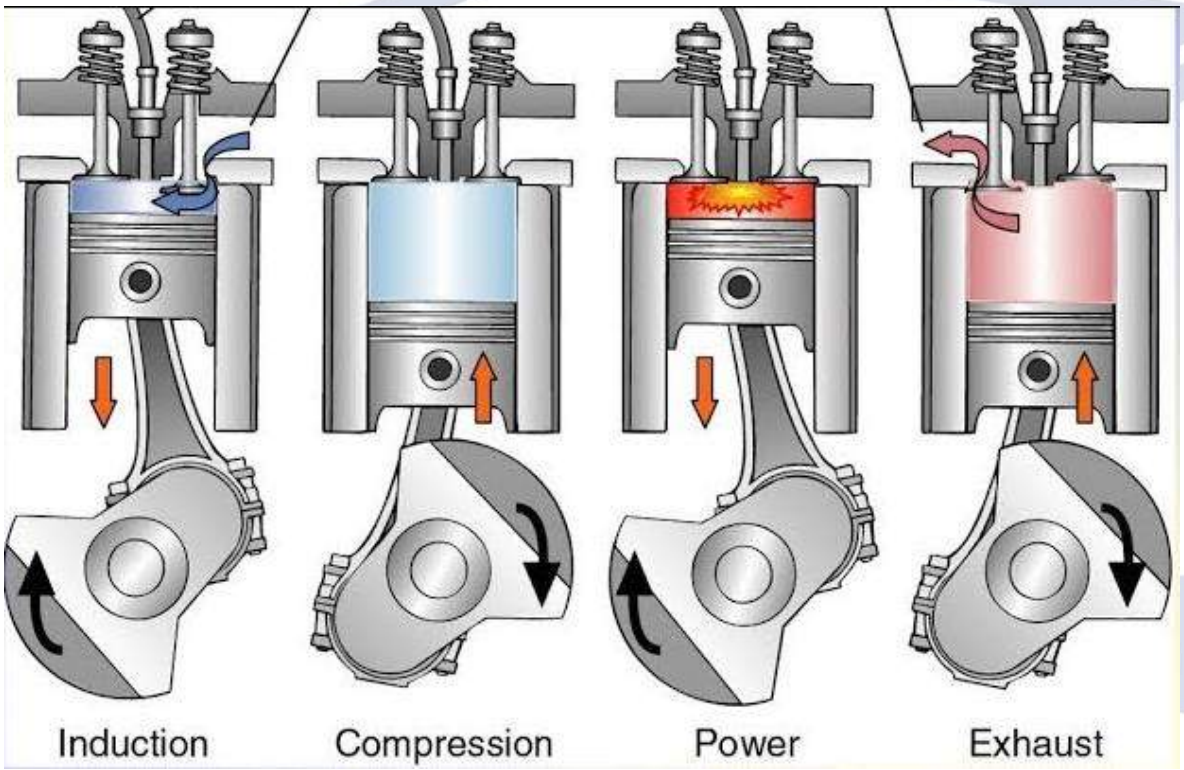
4. Based on working cycle

1. **Four stroke cycle engine** - When the cycle is completed in two revolutions of the crankshaft, it is called four stroke cycle engines.
2. **Two stroke cycle engines.** - When the cycle is completed in one revolution of the crankshaft, it is called two stroke cycle engines

WORKING PRINCIPLE OF I.C. ENGINE/ FOUR STROKE CYCLE ENGINE / TWO STROKE CYCLE ENGINE

FOUR STROKE CYCLE ENGINES (DIESEL/ PETROL ENGINE)

- ✓ In four stroke cycle engines the four events namely suction, compression, power and exhaust take place inside the engine cylinder. The four events are completed in four strokes of the piston (two revolutions of the crank shaft).



1. Suction stroke

- ✓ During suction stroke inlet valve opens and the piston moves downward. Only air or a mixture of air and fuel are drawn inside the cylinder. The exhaust valve remains in closed position during this stroke. The pressure in the engine cylinder is less than atmospheric pressure during this stroke

2. Compression stroke

- During this stroke the piston moves upward. Both valves are in closed position. The charge taken in the cylinder is compressed by the upward movement of piston. If only air is compressed, as in case of diesel engine, diesel is injected at the end of the compression stroke and ignition of fuel takes place due to high pressure and temperature of the compressed air. If a mixture of air and fuel is compressed in the cylinder, as in case of petrol engine, the mixture is ignited by a spark plug.

3. Power stroke

- After ignition of fuel, tremendous amount of heat is generated, causing very high pressure in the cylinder which pushes the piston downward (Fig.1b). The downward movement of the piston at this instant is called power stroke. The connecting rod transmits the power from piston to the crank shaft and crank shaft rotates. Mechanical work can be taped at the rotating crank shaft. Both valves remain closed during power stroke.

4. Exhaust stroke

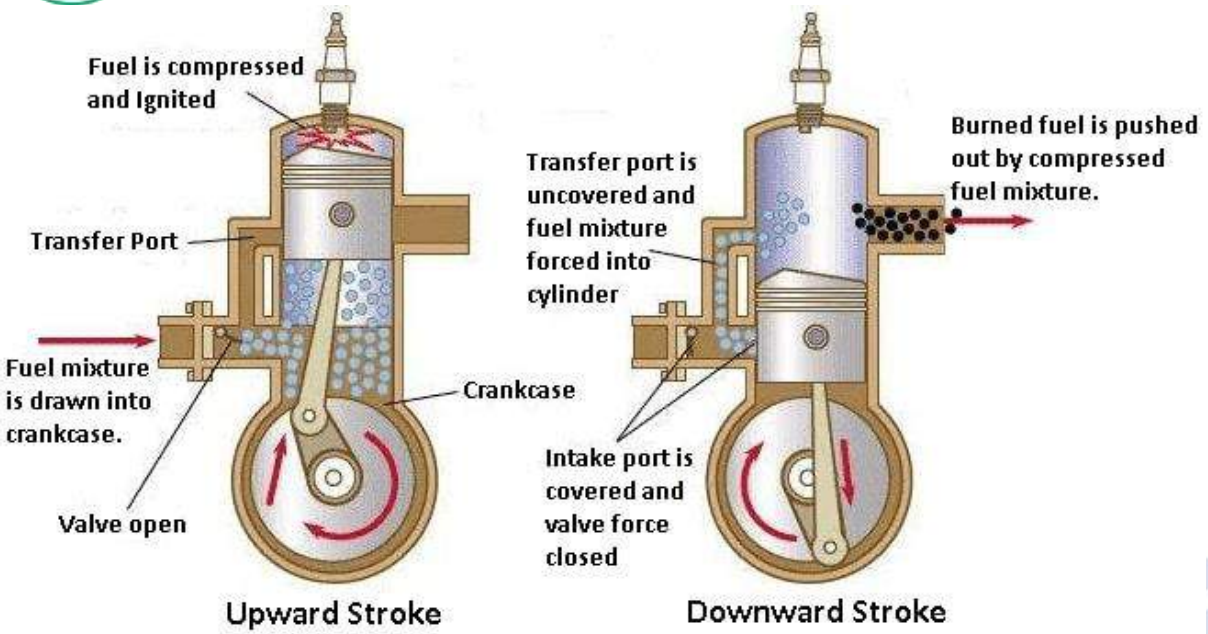
- During this stroke piston moves upward. Exhaust valve opens and exhaust gases go out through exhaust valves opening. All the burnt gases go out of the engine and the cylinder becomes ready to receive the fresh charge. During this stroke inlet valve remains closed
- Thus, it is found that out of four strokes, there is only one power stroke and three idle strokes in four stroke cycle engines. The power stroke supplies necessary momentum for useful work.

TWO STROKE CYCLE ENGINES (PETROL ENGINE)

- In two stroke cycle engines, the whole sequence of events i.e., suction, compression, power and exhaust are completed in two strokes of the piston i.e., one revolution of the crankshaft.

Two stroke cycles:

1. Upward stroke of the piston (Suction +Compression)
2. Downward stroke (Power + Exhaust)



TWO-STROKE PETROL ENGINE

COMPARISON BETWEEN TWO STROKE AND FOUR STROKE ENGINES

Four stroke engine	Two stroke engine
1. One power stroke for every two revolutions of the crankshaft.	One power stroke for each revolution of the crankshaft.
2. There are inlet and exhaust valves in the engine.	There are inlet and exhaust ports instead of valves.
3. Crankcase is not fully closed and air tight.	Crankcase is fully closed and air tight.
4. Top of the piston compresses the charge.	Both sides of the piston compress the charge.
5. Size of the flywheel is comparatively larger.	Size of the flywheel is comparatively smaller.
6. Fuel is fully consumed.	Fuel is not fully consumed.
7. Weight of engine per hp is high.	Weight of engine per hp is comparatively low.
8. Thermal efficiency is high.	Thermal efficiency is comparatively low.
9. Removal or exhaust gases easy.	Removal of exhaust gases comparatively difficult.

10. Torque produced is even.	Torque produced is less even.
11. For a given weight, engine would give only half the power of two stroke engine.	For same weight, two stroke engine gives twice the power that of four stroke engines.
12. All types of speed are possible (high and low).	Mostly high-speed engines are there.
13. It can be operated in one direction only.	It can be operated in both direction (clockwise and counter clockwise).

Special features of diesel engine

1) Engine has high compression ratio ranging from 14:1 to 22:1.
2) During compression stroke, the engine attains high pressure ranging from 30 to 45 kg/cm^2 and high temperature of about 500°C.
3) At the end of the compression stroke, fuel is injected into the cylinder through injectors (atomizers) at a very high pressure ranging from 120 to 200 kg/cm^2.
4) Ignition takes place due to heat of compression only.
5) There is no external spark in diesel engine.
6) Diesel engine has better slogging or lugging ability i.e. it maintains higher torque for a longer duration of time at a lower speed.

COMPARISON OF DIESEL ENGINE WITH PETROL ENGINE

Diesel engine	Petrol engine
i) It has got no carburetor, ignition coil and spark plug.	It has got carburetor, ignition coil & spark plug.
ii) Its compression ratio varies from 14:1 to 22:1	Its compression ratio varies from 5:1 to 8:1.
iii) It uses diesel oil as fuel.	It uses petrol (gasoline) or power kerosine as fuel.
iv) Only air is sucked in cylinder in suction stroke.	Mixture of fuel and air is sucked in the cylinder in suction stroke.
v) It has got 'fuel injection pump' and injector	It has got no fuel injection pump and injector, instead it has got carburetor and ignition coil.
vi) Fuel is injected in combustion chamber were burning of fuel takes places due to heat of compression.	Air fuel mixture is compressed in the combustion chamber when it is ignited by an electric spark.

vii) Thermal efficiency varies from 32 to 38%	Thermal efficiency varies from 25 to 32%
viii) Engine weight per horse-power is high.	Engine weight per horsepower is comparatively low.
ix) Operating cost is low.	Operating cost is high.
x) Compression pressure inside the cylinder varies from 35 to 45 kg/cm^2 and temperature is about 500°C.	Compression pressure varies from 6 to 10 kg/cm^2 and temperature is above 260°C.