

# BOILER

According to "American Society of mechanical engineer (ASME)" it is a steam generating unit which is used for producing <sup>and</sup> furnishing and recovering heat, together with the apparatus for transporting heat, so made available to the fluid being heated and vapourized.

## TYPES OF BOILERS

There are three types of boilers :-

- (1). Shell and tube type boilers
- (2). Fire-tube boilers or "Smoke-tube boilers"
- (3). Water-tube boilers

### 1. SHELL AND TUBE TYPE BOILERS

This type of boiler is used for rising small quantities of heat and hence used on smaller plants, they consist of a cylindrical drum containing one or two fire tubes. The efficiency of this type of boiler may be high as 80%. The Lancashire boilers and Cornish boilers are its types.  
Cornish

### 2. FIRE-TUBE BOILERS

These types of boilers consist of a nest of tubes through which the hot gases flow. The tubes being surrounded by water. Since, the contact area b/w the water & hot gases is greater than in the case of shell & tube type, hence it has the ability to generate larger quantities of steam. It has efficiency definitely greater than shell & tube type. The Marine boilers and locomotive boilers are its examples. Nelox boiler is a modern fire tube boiler.  
scotch

### 3. WATER-TUBE BOILERS

These are the most efficient boilers. Water runs in the tubes and the hot gases surround it, hence the heat transfer area is



low value.

# BOILER ACCESSORIES

Some of the accessories of boilers are given below:-

- 1) ECONOMIZER It is used for heating feed water, thus utilizing the heat in exhaust flow gases.
- 2) SUPER HEATER It is used for super heating of wet steam.
- 3) FEED PUMPS It pumps water at desired pressure to the boiler.
- 4) INJECTOR It is used for pumping water into a vertical or a locomotive boiler to a low-pressure boiler.
- 5) AIR PRE-HEATER It is used for pre-heating of air.
- 6) STEAM TRAP It is used to drain off water resulting from partial condensation steam from steam pipes.
- 7) STEAM SEPARATOR It is used for splitting water particles from steam.
- 8) PRESSURE REDUCING VALVE It is used to maintain desired steam pressure.
- 9) INDUCED DRAFT FAN (ID) It is used to exhaust flue gases from boiler and discharge them into chimneys.
- 10) FORCE DRAFT FAN (FD) It is used to supply air for combustion.
- 11) PRIMARY AIR FAN (PF) It is used to supply air for pulverizing fuel and carrying it to the furnace.

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## STROKE

"A stroke is movement of the piston from top dead centre (T.D.C) to bottom dead centre (B.D.C) or from B.D.C to T.D.C."

## CYCLE

"It is a series of event that repeat themselves."

## FOUR-STROKE ENGINE

Four-stroke cycle engine works on four stroke principle, i.e. there are four strokes in one cycle of such engine. Four-stroke cycle engine is also called "four-cycle engine" or "Otto-cycle engine."

The four strokes of Otto-cycle engine are:

- ✓ ① Intake stroke
- ✓ ② Compression stroke
- ✓ ③ Power stroke
- ✓ ④ Exhaust stroke

### ①. INTAKE STROKE

On the intake stroke, the piston is moving down due to which a partial vacuum is produced inside the cylinder. The intake valve is open, therefore, atmospheric pressure pushes the fresh air-fuel mixture in the cylinder through the intake valve.

### ②. COMPRESSION STROKE

When the piston reaches the B.D.C on the intake stroke, the intake valve closes. Then the piston moves up on the compression stroke. During this stroke, both the valves are closed, therefore, no air-fuel mixture can enter or goes out of the cylinder. Therefore, when the piston moves up,



The mixture inside the cylinder is compressed. In modern engine, it is compressed to one-eighth or one-ninth of the original volume. The amount to which the air-fuel mixture is compressed is called "the compression ratio".

If the mixture is compressed to one-eighth of the original volume, the compression ratio is "8" to "1" (8:1).

### 3. POWER STROKE

During the compression stroke, the piston moves up when it gets near T.D.C, the spark plug produces a spark which ignites the compressed air-fuel mixture. Due to which the temperature and the pressure of gas rises. The pressure becomes about 600 Psi which push the piston down. As during this stroke, we obtain power therefore it is called "power stroke".

The piston transmit this power through the connecting rod to the crank due to which the crankshaft rotates. This rotary motion is carried through shafts and gears to the car wheels due to which wheel turns and car moves.

### 4. EXHAUST STROKE

During the power stroke as the piston reaches B.D.C, the exhaust valve opens. Then the piston moves up on exhaust stroke. When the piston moves up, it pushes out the burnt gases from the cylinder through exhaust valve. When the piston reaches T.D.C, the exhaust valve closes and intake valve opens for the second cycle.

### COMPRESSION RATIO

The volume in which piston reciprocates, i.e. the volume from B.D.C to T.D.C is called "Swept volume ( $V_s$ )".  
The volume in which fresh air-fuel mixture is



Compressed by the piston in the cylinder is called "Clearance Volume".  
Thus the total volume of the cylinder is the sum of  
the swept volume and clearance volume.

$$V_T = V_s + V_c$$

And the compression ratio is the ratio of the total  
volume to the clearance volume.

$$\text{ie. Compression ratio} = \frac{\text{Total volume}}{\text{Clearance volume}} = \frac{V_T}{V_c}$$

## OPENING & CLOSING OF VALVES IN FOUR-CYCLE ENGINE

The opening and closing operation of valves is done with  
camshaft. The camshaft has a lobe, so as the camshaft rotates and  
the lobe comes under the valve lifter it pushes the push rod  
up due to which one open end of rocker arm moves up  
while the other (valve end) moves down (like a see-saw), which  
pushes the valve down, i.e. opens the valve. The valve stem  
has a spring which is called "Valve Spring", which closes  
the valve.



Therefore, the diameter of camshaft gear must be double of crankshaft gear or in other words, the no. of teeth of camshaft gear is double the no. of teeth of crankshaft gear. e.g., If no. of teeth of crankshaft gear are 40, then camshaft gear must have 80 teeth.

## TWO-STROKE ENGINE

In two stroke engine or two stroke cycle engine, there are only two strokes. As in four stroke engine, there is intake stroke, compression stroke, power stroke and exhaust stroke. But in two stroke engine, the intake & compression strokes are combined while the power & exhaust strokes are combined. So it means that in this type of engine, it sucks the fresh air & fuel mixture and at the same time it compresses the mixture in one stroke, while in the second stroke it produces power and at the same time it pushes out the burnt air mixture out of the cylinder. Thus two stroke engine produces a power stroke at every two piston strokes or at every crankshaft rotation. A two stroke engine is shown in figure.

SCAVEN

that slightly contain



Let the piston is at B.D.C. As it moves up in the exhaust port and transfer port, when it is still moving up a partial vacuum (-ve pressure) is created in the crankcase. So fresh air-fuel mixture comes from the carburetor into the crankcase. This process continues till the piston reaches the T.D.C. i.e. the suction of the air-fuel mixture stops, when piston reaches T.D.C. At the same time the fresh air-fuel mixture in the cylinder is compressed. The spark plug produces the spark which ignites the fresh air-fuel mixture and combustion occurs inside the cylinder and power is generated, which pushes the piston down in the power stroke. During the power stroke as the piston moves down first the exhaust port becomes uncovered (open) while the transfer port is still covered (closed) by the piston. As there is a very high pressure inside the cylinder and the exhaust port is open, so this high pressure pushes the burnt air-fuel mixture out of the cylinder through exhaust port. When the piston further moves down it uncovers the transfer port due to which compressed air-fuel mixture in the crankcase (which is compressed by the piston as it moves down in the cylinder during power stroke) goes into the cylinder. Then this whole process is continued in the same manner again for the other cycle.

### SCAVANGING

The process of explosion of burnt gases and the entering of fresh air-fuel mixture is known as scavanging.

The scavanging in two stroke engine is different than that of four cycle engine. The slope of two stroke engine is slightly different, it is somewhat pear-shaped. It do not contain camshaft, push rod, rocker arm and valves. Instead of these have three ports i.e. Exhaust port, Intake port & Transfer port.



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\* The cycle of two stroke is completed in one revolution of crankshaft while in four stroke engine cycle is completed in two revolutions of crankshaft. So it means that two stroke engines provide more power as compared to four stroke engines.

\* As two stroke engine produce more power as compare to four stroke engine, so its weight to power ratio is less while its power to weight ratio is more.

\* As there are less moving parts in two stroke engines, so it is easy to maintain it. i.e. it has less maintainance.

\* It may accelerate rapidly. i.e. it have more pop (pick).

\* In two stroke engine, the turning moment of crankshaft is uniform that's why we need a light fly wheel.

\* The work required to overcome the friction of the exhaust and suction strokes is saved.

\* The scavenging is more complete in low-speed engines as it does not leave the clearance volume full of burnt gases as in the four stroke engine.

DISADVANTAGES OF TWO-STROKE ENGINE

It has the following disadvantages:-

\* It is using more lubricating oil.

\* It produce more noise as compared to four stroke engine.

\* It produces chemical pollution.

\* It uses more fuel as compared to four stroke engine.

\* In two stroke engine, frequent cleaning of spark plugs are required as there is more carbon deposition on them.

\* Its volumetric efficiency is less becoz the air-fuel mixture has less time to move into the cylinder.