COOLING SYSTEM

Fuel is burnt inside the cylinder of an internal combustion engine to produce power. The temperature produced on the power stroke of an engine can be as high as 1600°C and this is greater than melting point of engine parts.

The cylinder and cylinder head are usually made of cast iron and piston in most cases are made of aluminium alloy. It is estimated that about 40% of total heat produced is passed to the atmosphere via the exhaust, 30% is removed by cooling system and only about 30% is used to produce useful power.

Bad effect of high temperature in the engine:

1. Cylinder and piston may expand to such an extent that the piston would seize in the cylinder and stop the engine.
2. Lubricating quality of the oil inside the cylinder would be destroyed due to high temperature and there may not be sucking of air in the cylinder.
3. Pre-ignition of fuel mixture would take place and would cause engine knocking as well as loss of power. For satisfactory performance of the engine, neither overheating nor over-cooling is desirable. Experiments have shown that best operating temperature of I.C. engine lies between 140°F to 200°F, depending upon types of engines and load conditions.

Purpose of cooling:

1. To maintain optimum temperature of engine for efficient operation under all conditions.
2. To dissipate surplus heat for protection of engine components like cylinder, cylinder head, piston, piston rings and valves.
3. To maintain the lubricating property of the oil inside the enginecylinder for normal functioning of the engine.

There are two different methods of cooling:

1. Air cooling and
2. Water cooling

AIR COOLING:

Air cooled engines are those engines, in which heat is conducted from the working components of the engine to the atmosphere directly In such engines, cylinders are generally not grouped in a block.

Principle of air cooling:

The cylinder of an air cooled engine has fins to increase the area of contact of air for speedy cooling. The cylinder is normally enclosed in a sheet metal

casing called Cowling. The flywheel has blades projecting from its face, so that it acts like a fan drawing air through a hole in the cowling and directing it around the finned cylinder. For maintenance of air cooling system, passage of air is kept clean by removing grasses etc. This is done by removing the cowling and cleaning out the dirt etc. by a stiff brush or compressed air. When separate fan is provided, the belt tension is to be checked and adjusted if necessary.

Advantages of air cooled engine:

1. It is simpler in design and construction.
2. Water jackets, radiators, water pump, thermostat, pipes, hoses etc. are not needed.
3. It is more compact.
4. It is comparatively lighter in weight.

Disadvantages

1. There is uneven cooling of the engine parts.
2. Engine temperature is generally high during working period

WATER COOLING

Engines, using water as cooling medium is called "water cooled engines". The liquid is circulated round the cylinders to absorb heat from the cylinder walls. In general, water is used as cooling liquid.

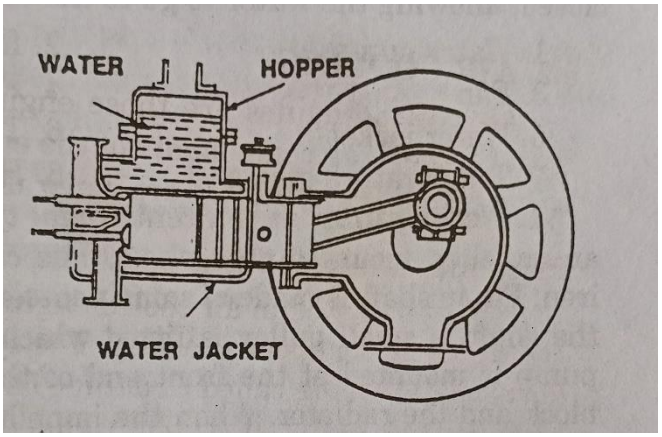
The heated water is conducted through a radiator which helps in cooling the water.

There are three common methods of water cooling.

1. Open jacket or hopper method
2. Thermosiphon method
3. Forced circulation method

1. Open jacket or hopper method:

There is a hopper or a jacket containing water, which surrounds the engine cylinder. So long as the hopper contains water, the engine continues to operate satisfactorily. As soon as the water starts boiling, it is replaced by cold water. The hopper is large enough to run for several hours without refilling. A drain plug is provided in a low accessible position for draining water as and when required. This system is not common in present days.



Open jacket or hopper system

2. Thermosiphon method:

It consists of radiator, water jacket, fan, temperature gauge and hose connections. The system is based on the principle that heated water which surrounds the cylinder becomes lighter in weight and it rises upwards in liquid column. Hot water goes to the radiator, where it passes through tubes surrounded by air. Circulation of water takes place due to the reason that water jacket and the radiator are connected at both sides i.e. at the top and the bottom. A fan is driven with the help of a V-belt to suck air through tubes of the radiator unit, cooling radiator water. The disadvantage of the system is that circulation of water is greatly reduced by accumulation of scale or foreign matter in the passage and consequently it causes overheating of the engine.

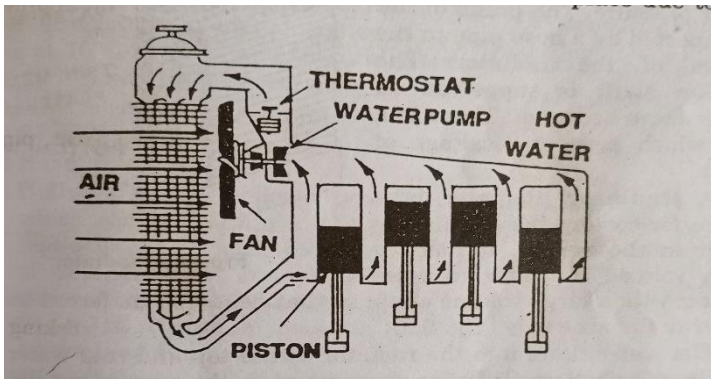
3. Forced Circulation method:

In this method, a Water pump is used to force water from the radiator to the water jacket of the engine. After circulating the entire run of water jacket, water comes back to the radiator where it loses its heat by the process of radiation. To maintain the correct engine temperature, a thermostat valve is placed at the outer end of cylinder head. Cooling liquid is by-passed through the water jacket of the engine until the engine attains the desired temperature. Then thermostat valve opens and the by-pass is closed, allowing the water to go to the radiator. The system consists of

1. Water pump
2. Radiator
3. Fan
4. Fan-belt
5. Water jacket
6. Thermostat valve
7. Temperature gauge

8. Hose pipe.

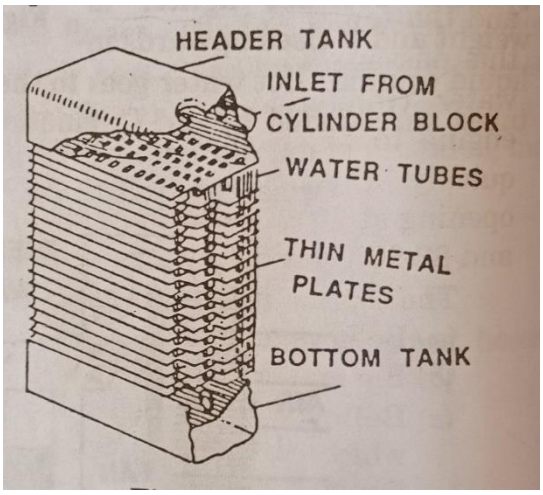
Water pump: It is a centrifugal type pump. It has a casing and an impeller, mounted on a shaft. The casing is usually made of cast iron. Pump shaft is made of some non-corrosive material. At the end of the shaft, a small pulley is fitted which is driven by a V-belt. Water pump is mounted at the front end of the cylinder block between the block and the radiator. When the impeller rotates, the water between the impeller blades is thrown outward by centrifugal force and thus water goes to the cylinder under pressure. The pump outlet is connected by a hose pipe to the bottom of the radiator. The impeller shaft is supported on one or more bearings. There is a seal which prevents leakage of water.



Forced circulation system

Radiator: Radiator is a device for cooling the circulating water in the engine. It holds a large volume of water in close contact with a large volume of air, so that heat is transferred from the water to the air easily.

Hot water flows into the radiator at the top and cold water flows out from the bottom. Tubes or passages carry the water from the top of the radiator to the bottom, passing it over a large metal surface. Air flows between the tubes or through the cells at right angles to the downward flowing water. This helps in transferring the heat from the water to the atmosphere.



Radiator

On the basis of fabrication, the radiator is of two types:

(a) Tubular type and

(b) Cellular type

(a) Tubular type radiator: It has round or flat water tubes, leading from the top to the bottom of the radiator. They may be soldered, brazed or welded in place or fastened by means of a stuffing box at each end. Fins or folded strips of light sheet metal, placed between the tubes, increase the radiating surface and improve the heat transfer.

(b) Cellular type radiator: It has a core made of short air tubes which are laid horizontally and soldered together at the ends with space between them to allow water to flow. It is also called Honey comb type radiator.

Thermostat valve: It is a control valve, used in the cooling system to control the flow of water when activated by a temperature signal. It is a special type of valve, which closes the inlet passage of the water connected to the radiator. The thermostat is placed in the water passage between the cylinder head and the top of radiator. Its purpose is to close this passage when the engine is cold, so that water circulation is restricted, causing the engine to reach operating temperature more quickly. Thermostats are designed to start opening at 70°C to 75°C and then fully open at 82°C for petrol engine and 88-90°C for diesel engine.

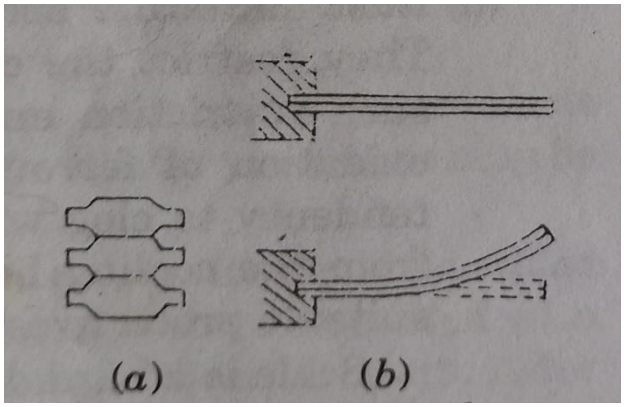
The thermostat valves are of two types:

(a) Bellows and

(b) Bimetallic

(a) Bellows type: Bellows type thermostats have got bellows, which contain a liquid like alcohol or ether. The liquid expands with the increase of temperature and raises the valve off its seat. This permits the water to circulate between the engine and the radiator.

(b) Bimetallic type: It consists of a bimetallic strip. Unequal expansion of two metallic strips causes the valve to open and allows the water to flow to the radiator.



Thermostat valve (a) bellows type (b) bimetallic type

Water jackets: Water jackets are cored out around the engine cylinder so that water can circulate freely around the cylinder as well as around the valve opening.

Fan: The fan is usually mounted on the water pump shaft. It is driven by the same belt that drives the pump and the dynamo. The purpose of the fan is to provide strong draft of air through the radiator to improve engine cooling.

COOLING SYSTEM TROUBLES

Due to defective cooling system, several adverse effects are noticed, such as:

1. Overheating and
2. Slow warm-up of the engine.

Overheating is mostly due to:

(a) Accumulation of rust and scale in the radiator and water jacket.
(b) Defective hose pipe
(c) Defective thermostat
(d) Defective water pump and
(e) Loose fan belt.

(a) Rust and scale accumulate in the radiator and water jacket. They restrict the circulation of water in the passage. Due to such restriction engine is overheated. Rust is caused by the oxidation of ferrous parts of the cooling system. It has got tendency to clog water passage and to insulate the iron part from the cooling liquid. Rust can be prevented by the use of suitable protectives.

Scale is a hard deposit inside the water passage. It acts as a barrier to the flow of heat from the cylinder to the water. Sometimes, electrolysis occurs in the cooling system. It is a chemical process which takes place when dissimilar metals are used in the system, one of the metals will be partially completely dissolved. Precautions should be taken to get rid of these elements to prolong the life of the cooling system.

(b) Sometimes, there is leakage in the hose pipe and consequently the water in the radiator is exhausted very quickly.

(c) Sometimes the Thermostat is stuck up in its seat due to some distortion and it does not function properly. Slow warm-up the engine is mainly due to defective thermostat.

(d) Defective water pump disturbs completely the circulation of water in the system.

(e) Loose fan belt causes slippage on the pulley and reduces effectiveness of cooling.

CARE AND MAINTENANCE OF COOLING SYSTEM

1. Clean and fresh water should be filled in the radiator.

2. Lime free water should be used in the radiator as far as possible for prevention of scale formation.

3. Rotten or soft hose pipe should not be used in the system.

4. The tension of the fan belt should be checked very frequently. A loose belt will cause: (a) overheating (b) reduce charging current and (c) high wear of the belt. If the belt is very tight, it will cause wear on the pulley of pump and dynamo. The maximum permissible V-belt sag when applying average finger pressure is 15 mm. If it is more than this limit, the belt should be adjusted.

5. Oil and grease should always be kept away from the belt. Greasy belts should be wiped clean with a rag.

6. The bearing of the water pump should be lubricated regularly.

7. Very hot engines should never be filled with cold water, to avoid fracture in the cylinder wall and the cylinder head.

8. Radiator and water jackets should be flushed out with special air pressure guns. Radiator can be cleaned by blowing air with compressed air. This process will remove bugs, leaves and dirt from the radiator.

9. The cooling system should be cleaned at suitable intervals to remove Rust and scale. The following suitable procedure may be followed to remove scale from the system.