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# UNIT 5 COOLING SYSTEMS OF IC ENGINES

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## 5.1 INTRODUCTION

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We know that in case of Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be around 2300-2500°C. This is a very high temperature and may result into burning of oil film between the moving parts and may result into seizing or welding of the same. So, this temperature must be reduced to about 150-200°C at which the engine will work most efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency. So, the object of cooling system is to keep the engine running at its most efficient operating temperature.

It is to be noted that the engine is quite inefficient when it is cold and hence the cooling system is designed in such a way that it prevents cooling when the engine is warming up and till it attains to maximum efficient operating temperature, then it starts cooling.

It is also to be noted that :

- (a) About 20-25% of total heat generated is used for producing brake power (useful work).
- (b) Cooling system is designed to remove 30-35% of total heat.
- (c) Remaining heat is lost in friction and carried away by exhaust gases.

## Objectives

After studying this unit, you should be able to

- understand the methods of cooling of IC engine,
- explain the air cooling system, and
- know the water cooling system of IC engine.

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## 5.2 AIR COOLING SYSTEM

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There are mainly two types of cooling systems :

- (a) Air cooled system, and
- (b) Water cooled system.

### Air Cooled System

Air cooled system is generally used in small engines say up to 15-20 kW and in aero plane engines.

In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc. Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins, heat will be dissipated to air.

The amount of heat dissipated to air depends upon :

- (a) Amount of air flowing through the fins.
- (b) Fin surface area.
- (c) Thermal conductivity of metal used for fins.

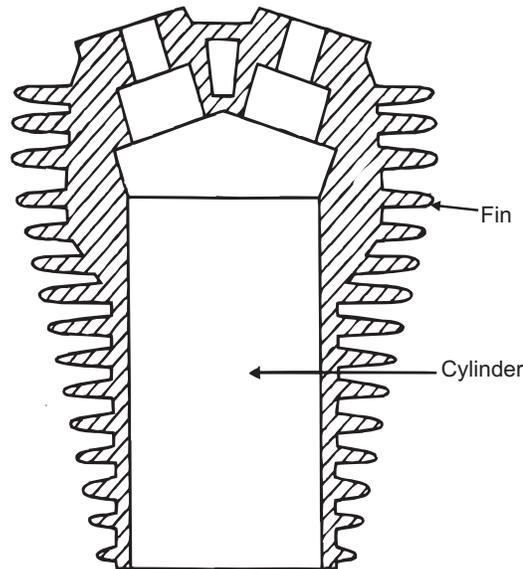


Figure 5.1 : Cylinder with Fins

### Advantages of Air Cooled System

Following are the advantages of air cooled system :

- (a) Radiator/pump is absent hence the system is light.
- (b) In case of water cooling system there are leakages, but in this case there are no leakages.
- (c) Coolant and antifreeze solutions are not required.
- (d) This system can be used in cold climates, where if water is used it may freeze.

### Disadvantages of Air Cooled System

- (a) Comparatively it is less efficient.
- (b) It is used in aero planes and motorcycle engines where the engines are exposed to air directly.

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## 5.3 WATER COOLING SYSTEM

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In this method, cooling water jackets are provided around the cylinder, cylinder head, valve seats etc. The water when circulated through the jackets, it absorbs heat of combustion. This hot water will then be cooling in the radiator partially by a fan and partially by the flow developed by the forward motion of the vehicle. The cooled water is again recirculated through the water jackets.

## Types of Water Cooling System

There are two types of water cooling system :

### *Thermo Siphon System*

In this system the circulation of water is due to difference in temperature (i.e. difference in densities) of water. So in this system pump is not required but water is circulated because of density difference only.

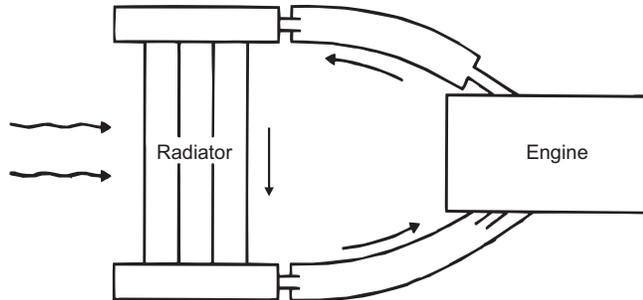


Figure 5.2 : Thermo Siphon System of Cooling

### *Pump Circulation System*

In this system circulation of water is obtained by a pump. This pump is driven by means of engine output shaft through V-belts.

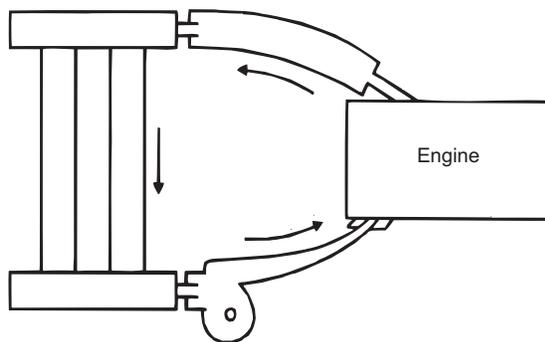


Figure 5.3 : Pump Circulation System

## 5.3.1 Components of Water Cooling System

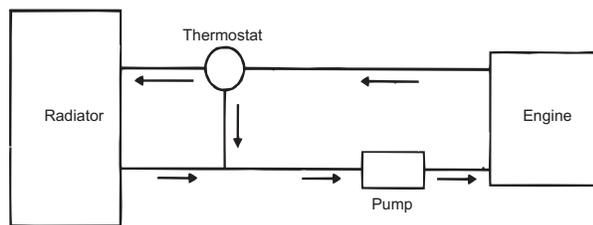


Figure 5.4 : Water Cooling System using Thermostat Valve

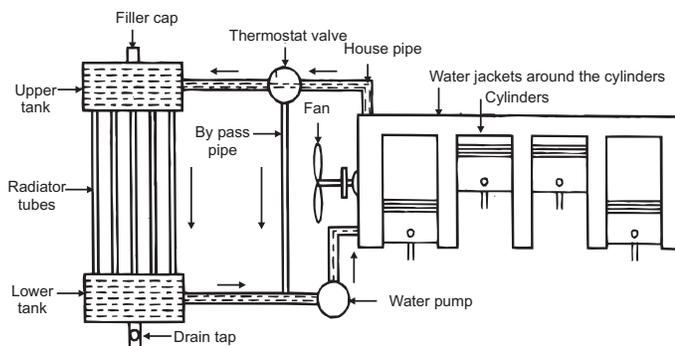


Figure 5.5 : Water Cooling System of a 4-cylinder Engine

Water cooling system mainly consists of :

- (a) Radiator,
- (b) Thermostat valve,
- (c) Water pump,
- (d) Fan,
- (e) Water Jackets, and
- (f) Antifreeze mixtures.

### Radiator

It mainly consists of an upper tank and lower tank and between them is a core. The upper tank is connected to the water outlets from the engines jackets by a hose pipe and the lower tank is connect to the jacket inlet through water pump by means of hose pipes.

There are 2-types of cores :

- (a) Tubular
- (b) Cellular as shown.

When the water is flowing down through the radiator core, it is cooled partially by the fan which blows air and partially by the air flow developed by the forward motion of the vehicle.

As shown through water passages and air passages, wafer and air will be flowing for cooling purpose.

It is to be noted that radiators are generally made out of copper and brass and their joints are made by soldering.

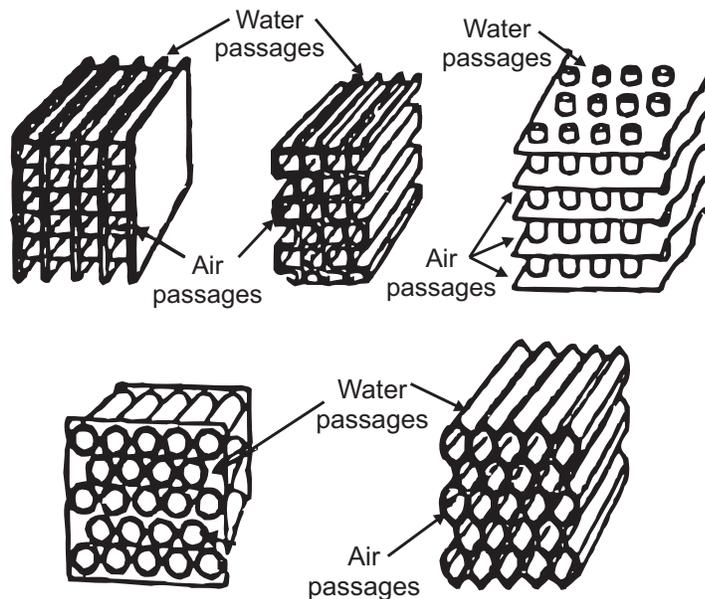
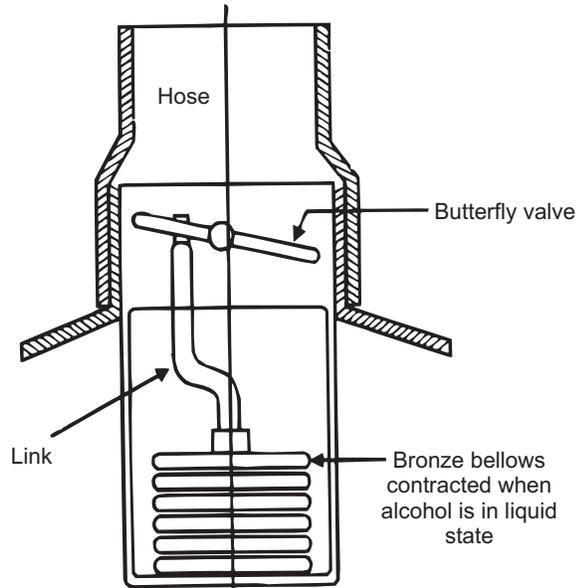


Figure 5.6 : Types of Cores (a) Tabular Radiator Sections and (b) Circular Radiator Sections

### Thermostat Valve

It is a valve which prevents flow of water from the engine to radiator, so that engine readily reaches to its maximum efficient operating temperature. After attaining maximum efficient operating temperature, it automatically begins functioning. Generally, it prevents the water below 70°C.



**Figure 5.7 : Thermostat Valve**

Figure 5.7 shows the Bellow type thermostat valve which is generally used. It contains a bronze bellow containing liquid alcohol. Bellow is connected to the butterfly valve disc through the link.

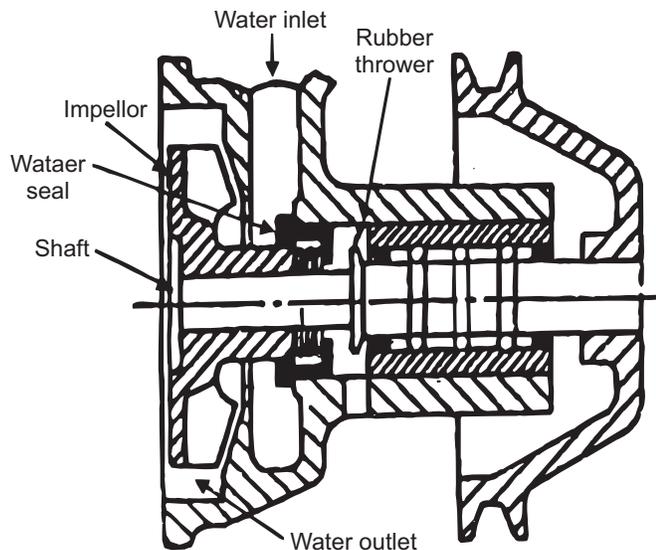
When the temperature of water increases, the liquid alcohol evaporates and the bellow expands and in turn opens the butterfly valve, and allows hot water to the radiator, where it is cooled.

### Water Pump

It is used to pump the circulating water. Impeller type pump will be mounted at the front end.

Pump consists of an impeller mounted on a shaft and enclosed in the pump casing. The pump casing has inlet and outlet openings.

The pump is driven by means of engine output shaft only through belts. When it is driven water will be pumped.



**Figure 5.8 : Water Pump**

### Fan

It is driven by the engine output shaft through same belt that drives the pump. It is provided behind the radiator and it blows air over the radiator for cooling purpose.

## Water Jackets

Cooling water jackets are provided around the cylinder, cylinder head, valve seats and any hot jackets which are to be cooled. Heat generated in the engine cylinder, conducted through the cylinder walls to the jackets. The water flowing through the jackets absorbs this heat and gets hot. This hot water will then be cooled in the radiator (Referred Figure 5.9).

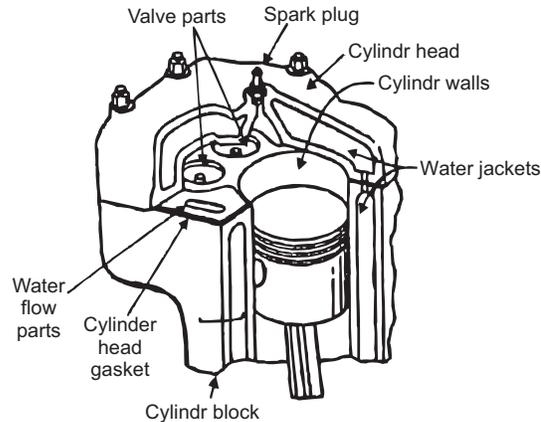


Figure 5.9 : Water Jackets

## Antifreeze Mixture

In western countries if the water used in the radiator freezes because of cold climates, then ice formed has more volume and produces cracks in the cylinder blocks, pipes, and radiator. So, to prevent freezing antifreeze mixtures or solutions are added in the cooling water.

The ideal antifreeze solutions should have the following properties :

- (a) It should dissolve in water easily.
- (b) It should not evaporate.
- (c) It should not deposit any foreign matter in cooling system.
- (d) It should not have any harmful effect on any part of cooling system.
- (e) It should be cheap and easily available.
- (f) It should not corrode the system.

No single antifreeze satisfies all the requirements. Normally following are used as antifreeze solutions :

- (a) Methyl, ethyl and isopropyl alcohols.
- (b) A solution of alcohol and water.
- (c) Ethylene Glycol.
- (d) A solution of water and Ethylene Glycol.
- (e) Glycerin along with water, etc.

### 5.3.2 Advantages and Disadvantages of Water Cooling System

#### Advantages

- (a) Uniform cooling of cylinder, cylinder head and valves.
- (b) Specific fuel consumption of engine improves by using water cooling system.

- (c) If we employ water cooling system, then engine need not be provided at the front end of moving vehicle.
- (d) Engine is less noisy as compared with air cooled engines, as it has water for damping noise.

#### Disadvantages

- (a) It depends upon the supply of water.
- (b) The water pump which circulates water absorbs considerable power.
- (c) If the water cooling system fails then it will result in severe damage of engine.
- (d) The water cooling system is costlier as it has more number of parts. Also it requires more maintenance and care for its parts.

#### SAQ 1

- (a) Why is cooling necessary for IC engine?
- (b) Explain in brief the methods of cooling of IC engine.
- (c) Differentiate between air cooling system and water cooling system.
- (d) What is the purpose of the fins in an air-cooled system?

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## 5.4 SUMMARY

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Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. In air cooling system, heat is carried away by the air flowing over and around the cylinder. Here fins are cast on the cylinder head and cylinder barrel which provide additional conductive and radiating surface. In water-cooling system of cooling engines, the cylinder walls and heads are provided with jacket through which the cooling liquid can circulate.

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## 5.5 KEY WORDS

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- Cooling System** : A cooling system in an internal combustion engine that is used to maintain the various engine components at temperatures conducive to long life and proper functioning.
- Air Cooling System** : In this system, heat is carried away by the air flowing over and around the cylinder.
- Water Cooling System** : In this system, the cylinder walls and heads are provided with jacket through which the cooling liquid can circulate.

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## 5.6 ANSWERS TO SAQs

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Refer the preceding text for all the Answers to SAQs.