CHAPTER-04

NAME- COOLING AND LUBRICATION

Introduction

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.

There are mainly two types of cooling systems :

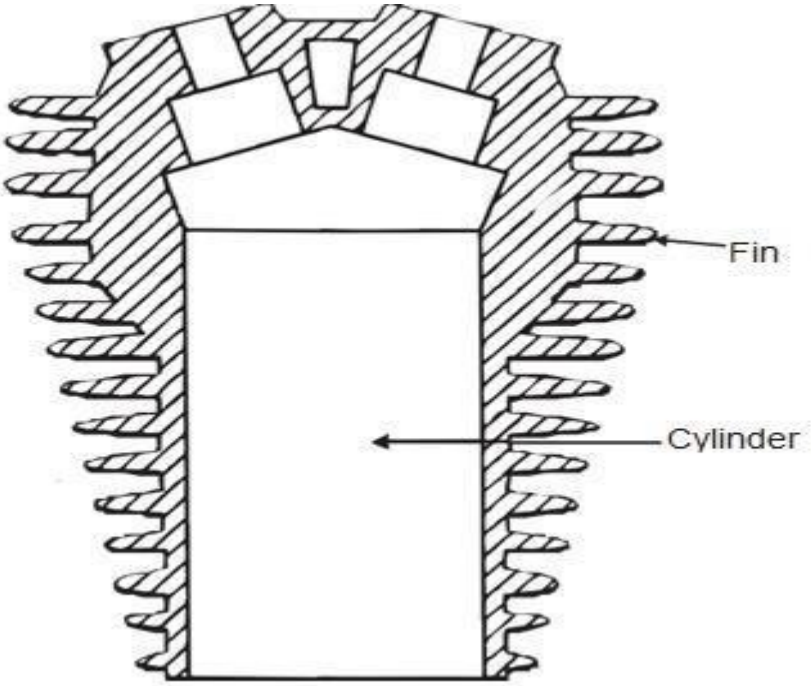
(a) Air cooled system, and
(b) Water cooled system.

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.



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.

WATER COOLING SYSTEM

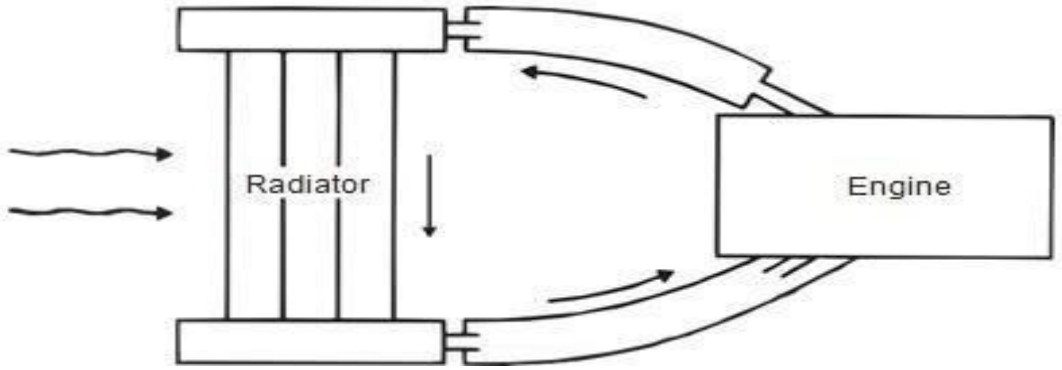
In this method, cooling water jackets are provided around the cylinder, cylinder head, valve seats etc. The water when circulated through the jackets, it absorbs heat of combustion. This hot water will then be cooling in the radiator partially by a fan and partially by the flow developed by the forward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

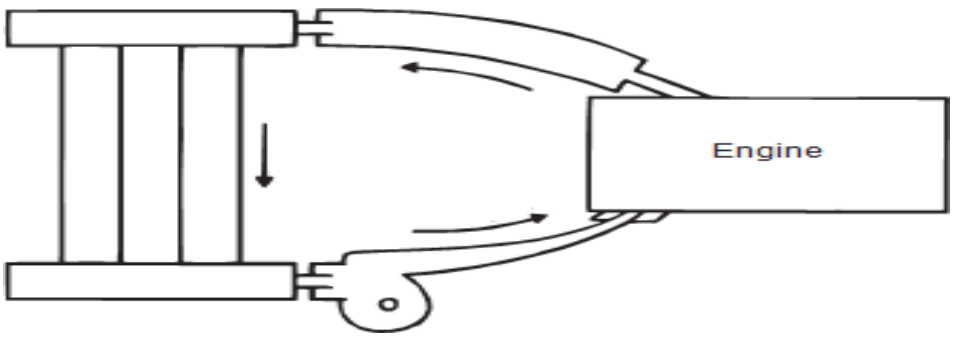
Thermo Siphon System

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.



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



Components of Water Cooling System

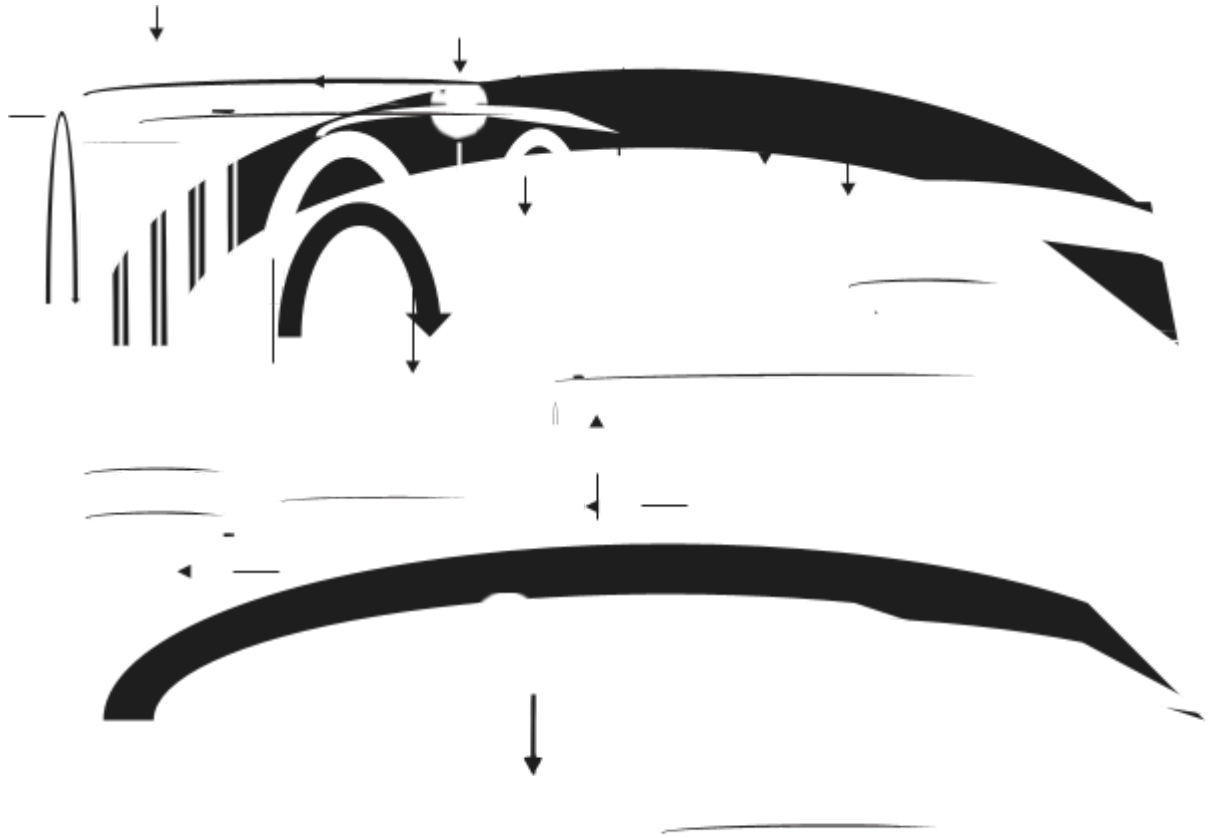


Fig: Water Cooling System of a 4-cylinder Engine

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 lover tank is connect to the jacket inlet through water pump by means of hose pipes.

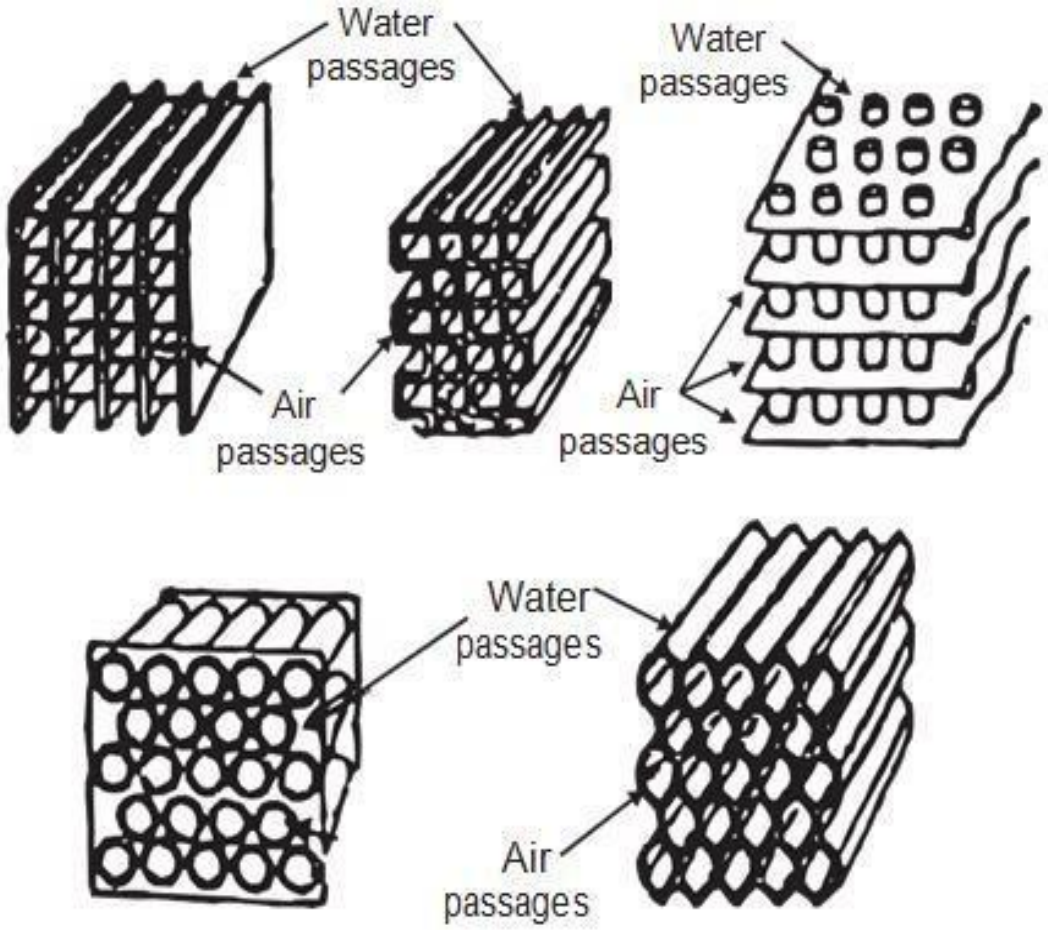
There are 2-types of cores :

(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.



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

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. 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.

Definition of lubrication

Lubrication is the action of applying a substance such as oil or grease to an engine or component so as to minimize friction and allow smooth movement.

Lubrication System

Lubricating system is a mechanical system of lubricating internal combustion engines in which a pump forces oil into the engine bearings.

PURPOSE OF LUBRICATION

1. ➢ To reduce the friction between moving parts
2. ➢ To increase the efficiency
3. ➢ To minimize the vibrations
4. ➢ To reduce the corrosion and carbon deposits
5. ➢ To reduce the heat of moving parts
6. ➢ To minimize power loss due to friction
7. ➢ To reduce the noise created by moving parts

8. ➢ To provide cooling to the engine.

TYPES OF LUBRICANTS

➢SOLID LUBRICANTS

❑ e.g. graphite ,molybdenum ,mica

➢ SEMI-SOLID LUBRICANTS

❑ e.g. heavy greases

➢ LIQUID LUBRICANTS

❑ e.g. mineral oil obtained by refining petroleum

TYPES OF LUBRICATION SYSTEM

1. ➢MIST LUBRICATION SYSTEM
2. ➢WET SUMP LUBRICATION SYSTEM
3. ➢DRY LUBRICATION SYSTEM

1. MIST OR PETROIL |PETROL PLUS OIL| LUBRICATION SYSTEM

➢ This system is used in 2 stroke cycle engines

➢ The lubrication oil (2% to 3%) is mixed with the petrol in the fuel tank

➢ The oil and the fuel mixture is inducted through carburetor

➢ The optimum fuel oil ratio used is 50:1

➢ Petrol gets evaporated and the oil lubricates the main parts of cylinder

➢ Fuel oil ratio used is important for the good performance of engine

ADVANTAGES of mist lubrication system

➢ separate lubricating system is not required

➢ No maintenance cost for lubrication system

➢ Weight of engine is reduced by avoiding separate lubricating system

DISADVANTAGES of mist lubrication system

➢If oil is less then there is chance of seizure of the engine

➢More oil makes excess air in the exhaust

SPLASH LUBRICATION SYSTEM

➢ The lubricating oil is filled in the sump

➢ Scoop are attached to the end of connecting rod

➢ When system moves to Bottom Dead Centre (BDC) scoop splashes lubricating oil to the piston ,cylinder ,big end of connecting rod ,main bearing and cam shaft bearing

➢ The splashed oil settles on engine parts and then to sump again

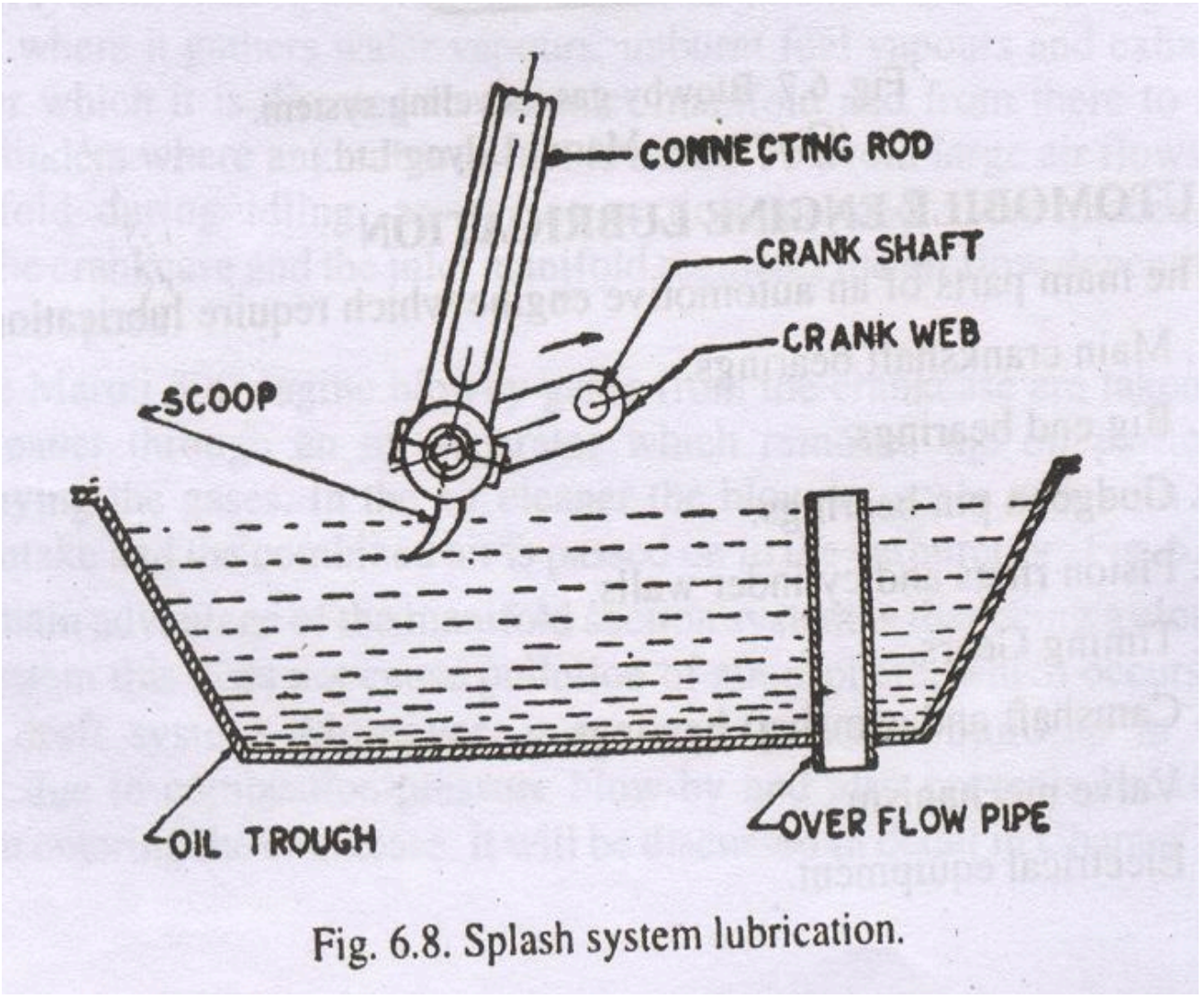


Fig. 6.8. Splash system lubrication.

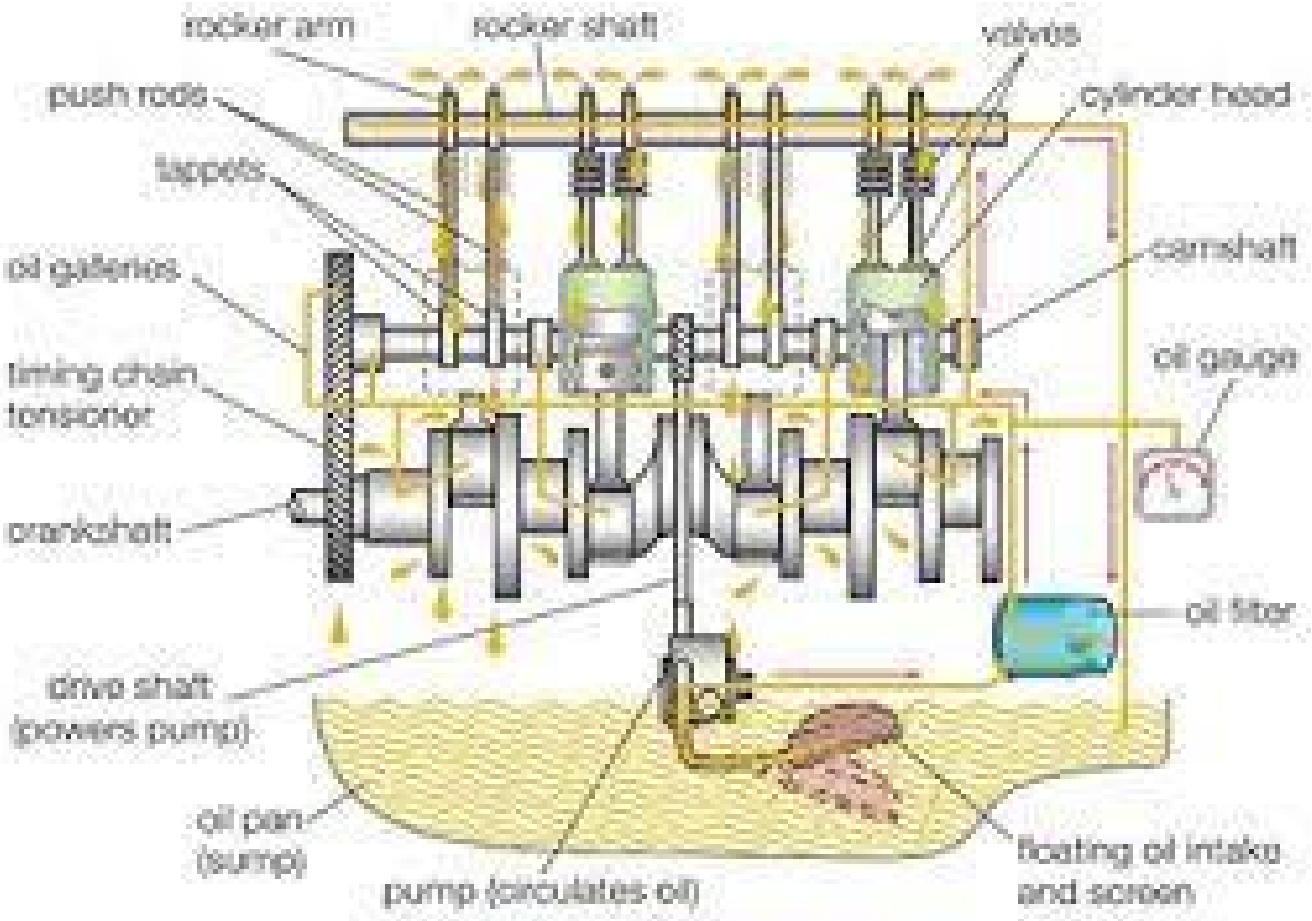
PRESSURE LUBRICATION SYSTEM

➢ In this system , lubrication is done with the help of pressure pump which is submerged in the sump

➢ With the help of pressure pump after filtration ,oil is forced under pressure to different parts of the engine through oil tubes

➢ From the bearing oil floats to connecting rod through oil holes between connecting rod and cam shaft

➢ Then this oil flows to piston pin through oil holes and sprayed over piston ,piston rings ,cylinder valves and other parts



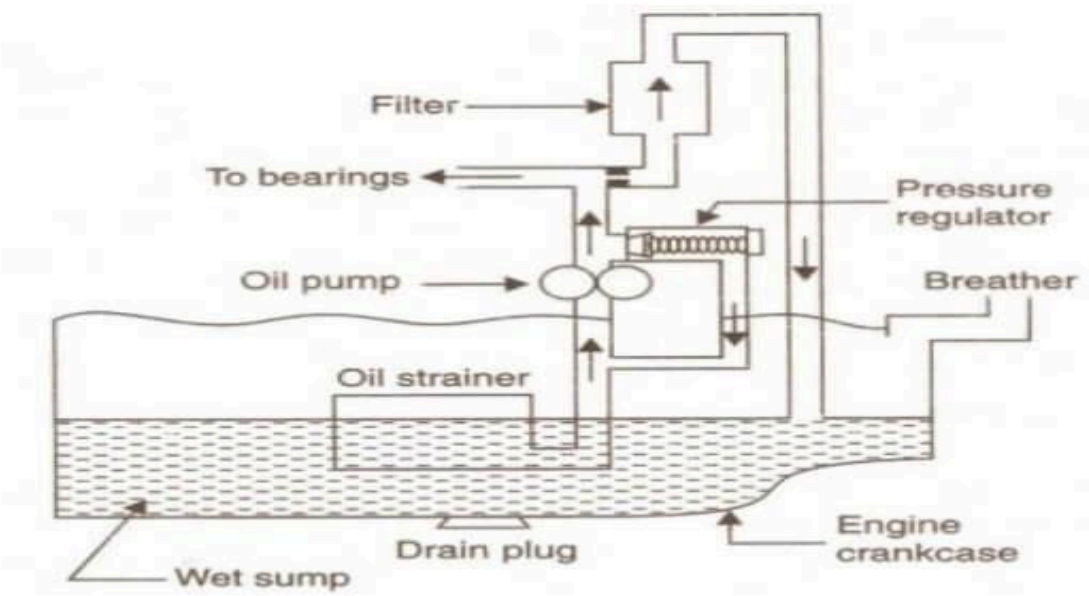
SPLASH AND PRESSURE LUBRICATION SYSTEM

➢ Splash system is not sufficient when bearing loads are higher hence lubricating oil under pressure is supplied by oil pump to main and crankshaft bearings

➢ Oil pump also supplies oil under pressure to pipes which directs a stream of oil against the dippers (scoop) on the connecting rod bearing cups

➢ Other parts are lubricated by splash of oil by scoop

Lubrication System – Wet Sump



DRY SUMP LUBRICATION SYSTEM

➢ In dry sump , extra oil is stored in a tank outside the engine rather than oil pan

➢ In this system ,the lubrication oil is passed through the pipes using scavenging pumps

➢ After lubrication ,the oil is again collected by special connecting sections and passed to heat exchanger for cooling

➢ Scavenging pump has greater capacity than oil feed pump and it is placed externally to sump

ADVANTAGES OF DRY SUMP LUBRICATION SYSTEM

➢ Improvements to vehicle handling and stability. The vehicle's center of gravity can be lowered by mounting the engine lower in the chassis due to a shallow sump profile. A vehicle's overall weight distribution can be modified by locating the external oil reservoir away from the engine

➢ Improved engine reliability due to consistent oil pressure. This is the reason why dry-sumps were invented

➢ Increased oil capacity, by using a larger external reservoir than would be practical in a wet-sump system

➢ Having the pumps external to the engine makes them easier to maintain or replace

DISADVANTAGES OF DRY SUMP LUBRICATION SYSTEM

➢ Dry-sump systems add cost, complexity, and weight

➢ The extra pumps and lines in dry-sump engines require additional oil and maintenance

➢ The large external reservoir and pumps can be tricky to position around the engine and within the engine bay due to their size

➢ Inadequate upper valve train lubrication can also become an issue if too much oil vapor is being pulled out from the area, especially with multi-staged pumps

Group – A: 2 Marks

Group – B: 5 Marks

Group – C: 10 Marks

Sl. No.	Group	Ch. No.	Ques. No.	Question
1	A	6	1	Write the function of lubrication. [2012(S),2013(S)]
2			2	What is the function of oil filter in lubricating system? [2012(S),2013(S)]
3			3	What is water cooling?
4			4	What is air cooling?
5			5*A	What is the necessity of cooling of an engine? [2013(S)]
6			6*A	What is the function of an oil pump? [2015(W)]
7			7*A	What do you mean by gravity type lubrication
8			8*A	What is the difference between gravity type and pressure type?
9			9*S	What is the function of fins in air cooling
10			10*S	Write any two advantages of air cooling?
11			11*s	Give four examples of lubricants? [2018().W]
1	B	6	1	Describe necessity of engine cooling. [2012(S), 2013(S)]
2			2	Describe water cooling with advantages and disadvantages.
3			3*A	What are the types of cooling system & explain the water cooling system In detail? [2015(S)]
4			4*A	Describe the lubrication in case of 2 stroke petrol engine.
5			5*A	Describe the lubrication in case of 4 stroke petrol engine
6			6*S	Describe about gravity type lubrication system?
7			7*s	Explain briefly pressure lubrication system? [2018(W)]
1	C	6	1	Describe the lubrication system of I.C engine. [2013(S),2014(S),2016(S),2017w]
2			2	Describe the pressure lubrication system used in automobile with neat sketch. [2012(S),2018(W)]
3			3*A	Why cooling of engine is very much necessary? Write down difference type of cooling process, its defects and their radical measure.[2011(S), 2016(S)]
4			4*A	Explain the water cooling of automobile engines with neat sketch.[2017(S)]
5			5*S	With the help of a neat sketch explain pump circulation water cooling system? [2018(w)]