RGPVNOTES.IN

Program : **B.Tech**

Subject Name: **I C Engines**

Subject Code: **ME-501**

Semester: **5th**

Unit-4 Engine Systems

Fuel injection system

Diesel engines are a compression ignition type of internal combustion engine. It is well known technology in achieving major improvement in fuel economy and heavy duty task presently. Diesel engines are commonly used in heavy duty application vehicle such as constructional vehicles, trucks and Lorries. But now it is widely implemented in light vehicle such as cars and vans. Diesel engines can double the fuel economy than spark ignition engines in light vehicles.

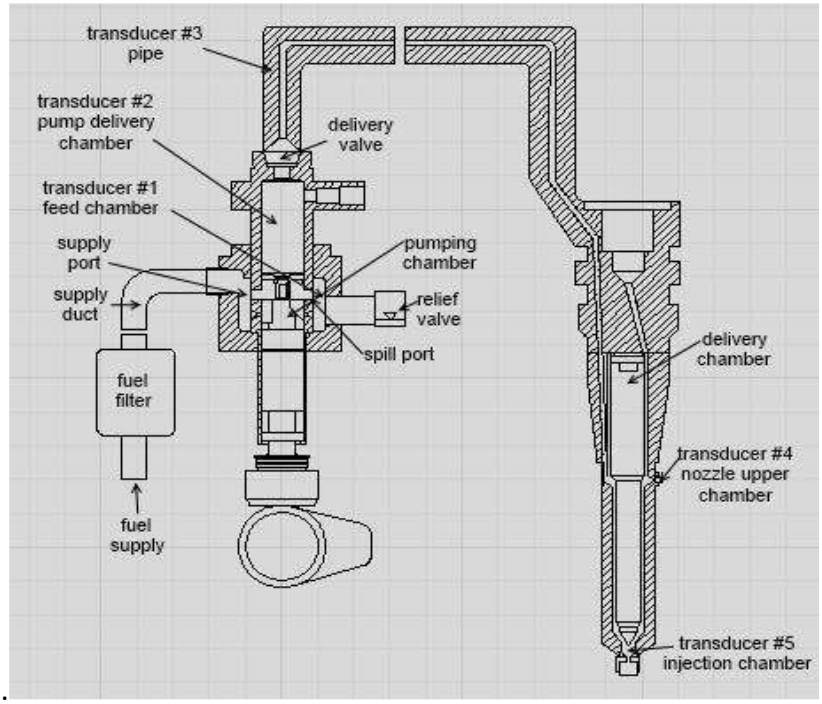
Diesel engines use fuel injection system. The fuel injection system is a system used to supply fuel into internal combustion engine which replaced carburetor function to supply the fuel into the engine. Fuel injector atomizes the fuel by forcibly pumping it through a small injection nozzle under high pressure. It is because diesel engine ignites the fuel by the high temperature created by the compression of air and fuel mixture.

Diesel engines have many advantages such as high fuel efficiency, reliability and durability. The performance of diesel engines depends on many parameters. One of the important parameters which influence the performance of diesel engines is fuel injection pressure. Fuel injection pressure plays an important aspect of power performance of the engine to obtain combustion treatment.

Fuel Injection System

Fuel injection is a technology that is being used in most of cars and other automotive transportation these days. The technology is used to eliminate the need for carburetors. The technology helps the engine to supply fuel directly to the cylinder in the intake manifold, eliminating the use if carburetor to much extent. Overall, the fuel injection is required to supply fuel directly to the engine.

The system works by the fuel is directly supplied to the cylinder in the intake chamber. Sensors located in such engines will regulate the flow of fuel injected and maintains it to appropriate levels. As long as the sensors which are usually electronic are working properly, the possibilities of breakdown and choke are immensely reduced



Fuel injection system

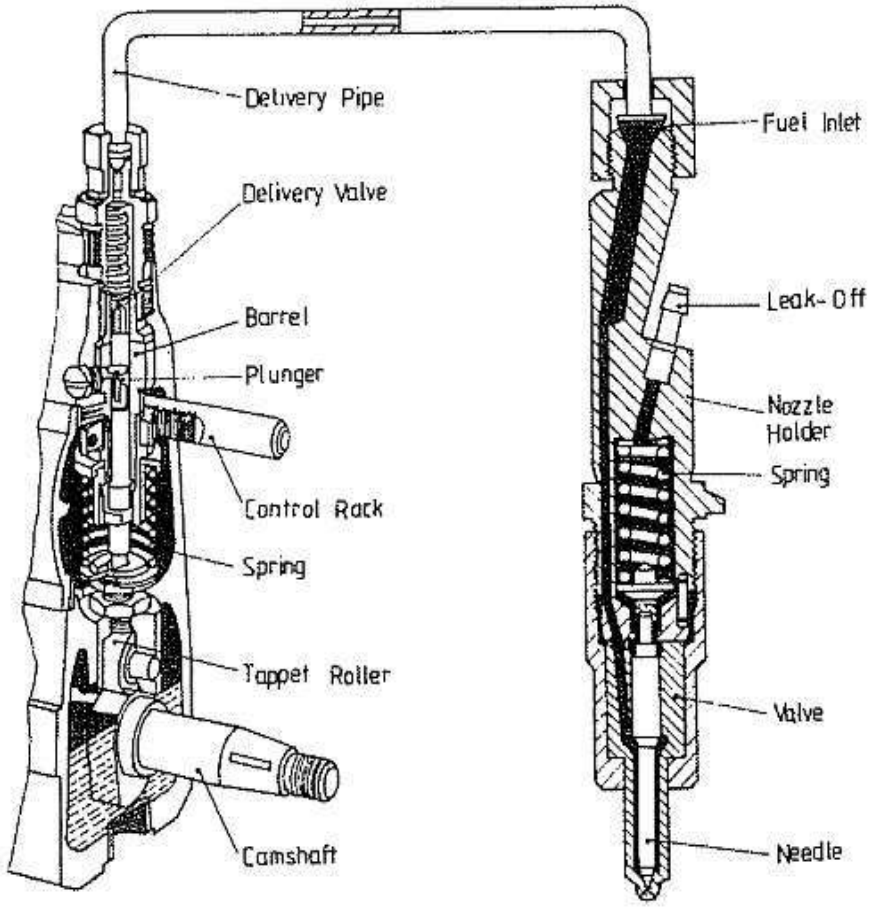
There are a great variety of diesel engine designs for wide range of applications, such as car, truck, locomotive, marine vessel and power generation. The diesel engine is more efficient than the petrol engine because it is fuel efficient in present diesel engines, fuel injection system designed to obtain higher injection pressure. It is aimed to decrease the exhaust emissions by increasing efficiency of diesel engine. It is because when the fuel injection pressure is low, fuel particle diameters will enlarge and ignition delay period during the combustion will increase.

There are several functions of fuel injection such as to filter the fuel, to meter or measure the correct quantity of fuel to be injected, control timing of fuel injection, to control the rate of fuel injection, to atomize or break up the fuel to fine particles and to properly distribute the fuel in the combustion chamber. Though the functional objectives for different types of fuel injections vary, the main task is to supply fuel to the combustion process. The objectives of a fuel injection are fuel efficiency, reliability, emission performance, output power, to accommodate alternative fuels, smooth operation, basic cost, maintenance cost, diagnostic capability and environmental operation. It is practically impossible for a single system to have all these objectives as certain combinations are conflicting. But all the systems try to supply most of these objectives. There are many benefits of fuel injection including, smoother and dependable engine response during quick transitions, easier and faster engine starting, better operation at a high or low ambient temperature, increased fuel efficiency and increased maintenance intervals. Modern electronic fuel injections help in maintaining accurate fuel metering and help in producing less air pollutants. The fuel injection system in a direct injection diesel engine is to achieve a high degree of atomization in order to enable sufficient evaporation in a very short time and to achieve sufficient spray penetration in order to utilize the full air charge. The fuel injection system must be able to meter the desired amount of fuel, depending on engine

speed and load, and to inject that fuel at the correct time and with the desired rate. Further on, depending on the particular combustion chamber, the appropriate spray shape and structure must be produced. Usually, a supply pump draws the fuel from the fuel tank and carries it through a filter to the high-pressure injection pump. The fuel injection pressure in a standard diesel is in the range of 200 to 1700 atm. According to Shimada et al. (1989), low pollution and low fuel consumption are the most important demands imposed on engines and these requirements are becoming ever more stringent, year after year. To satisfactorily reduce smoke and exhaust emissions and also reduce fuel consumption, which generally is adversely affected when lowering pollutant levels, an increase in the fuel injection pressure of direct injection type diesel engines has been conventionally adopted as an overall solution. The effect of high pressure fuel injection was investigated with in-cylinder fuel spray observation and single cylinder engine to reduce exhaust emission and fuel consumption. It is based on spray impingement on the cavity wall which promotes mixing with air and reduction on the nozzle area thus extends the wall impingement as result of increasing both fuel injection and injection period.

Modifying injection rate of fuel pump and nozzle area will increase injection pressure, and also improves smoke and fuel consumption at low and medium speeds in particular. To extend these effects of high pressure injection, more optimized combustion system and minimized injection equipment drive torque required. To resolve the problem of high pressure injection such as higher combustion noise and increase in emissions, the combination with pilot injection can be an effective method.

However, the relationship between fuel injection characteristics and exhaust emissions or fuel consumption performance, such as how the optimum injection pressure or injection duration should be, can hardly be said to have been sufficiently clarified. Therefore, the authors proceeded by first observing fuel spray, which is the basis of diesel combustion, and examining the relationship between fuel injection pressure and engine performance using high pressure fuel injection equipment and a single cylinder engine.



Diesel fuel injection system

ELECTRONIC FUEL INJECTION SYSTEM:

The operation cycle of electronic fuel injection system is as follows:

i. Air enters the engine through the air induction system where it is measured by the air flow meter. As the air flows into the cylinder, fuel is mixed into the air by the fuel injector.

ii. Fuel injectors are arranged in the intake manifold behind each intake valve. The injectors are electrical solenoids which are operated by the Electronic Control Unit or known as ECU.

iii. The ECU pulses the injector by switching the injector ground circuit on and off. When the injector is turned on, it opens, spraying atomized fuel at the back side of the intake valve.

iv. As fuel is sprayed into the intake airstream, it mixes with the incoming air and vaporizes due to the low pressures in the intake manifold. The ECU signals the injector to deliver just enough fuel to achieve an ideal air/fuel ratio of 14.7:1, often referred to as stoichiometric.

v. The precise amount of fuel delivered to the engine is a function of ECU control. The ECU determines the basic injection quantity based upon measured intake air volume and engine rpm.

vi. Depending on engine operating conditions, injection quantity will vary. The ECU monitors variables such as coolant temperature, engine speed, throttle angle, and exhaust oxygen content and makes injection

corrections which determine final injection quantity.

ADVANTAGES OF FUEL INJECTION SYSTEM

There are many advantages of fuel injection system.

First is uniform air/fuel mixture distribution; each cylinder has its own injector which delivers fuel directly to the intake valve. This eliminates the need for fuel to travel through the intake manifold, improving cylinder to cylinder distribution.

Second is high accurate air/fuel ratio control; throughout all engine operating conditions electronic Fuel Injection or EFI supplies a continuously accurate air/fuel ratio to the engine no matter what operating conditions are encountered. This provides better drive ability, fuel economy, and emissions control.

Third is superior throttle response and power; by delivering fuel directly at the back of the intake valve, the intake manifold design can be optimized to improve air velocity at the intake valve. This improves torque and throttle response.

Fourth is excellent fuel economy with improved emissions control; cold engine and wide open throttle enrichment can be reduced with an EFI engine because fuel puddling in the intake manifold is not a problem. This results in better overall fuel economy and improved emissions control.

Fifth is improved cold engine start ability and operation; the combination of better fuel atomization and injection directly at the intake valve improves ability to start and run a cold engine. And the last is simpler mechanics, reduced adjustment sensitivity; the EFI system does not rely on any major adjustments for cold enrichment or fuel metering. Because the system is mechanically simple, maintenance requirements are reduced.

Function of the fuel injection pump

The fuel injection pump is also called the high pressure fuel pump; it is the most important part in the fuel system. The function of the fuel injection pump is to improve the pressure of the fuel, and according to the requirement of working conditions of the diesel engine, gushing out the fuel of a certain amount the combustion chamber within accurate time.

The requisition for the fuel injection pump is:

(1) The amount of fuel supported of the fuel injection pump should meet the need of the diesel engine under various kinds of working conditions, namely the amount of oil supply increases when load is big, the amount of oil supply reduces when load is small. We should guarantee the amount of oil supply to every jar and be equal at the same time.

(2) According to the requirement of diesel engines, the fuel injection pump should be guaranteed supplying the fuel of every jar begin constantly to be the same, namely every jar is for the fuel to advance the angle unanimously, should be guaranteed to be for the fuel to extend time the, and is for the fuel to meet an urgent need and begin rapidly, it should be agile rapidly to stop the oil, avoid dripping the fuel phenomenon.

(3) It is different methods according to the form of combustion chamber and mixed air, the fuel injection pump must offer the fuel of enough pressure to the fuel injector so as to ensure good atomized quality.

We have a look at the work animation of the fuel injection pump first before studying the fuel injection pump.

The structure of the fuel injection pump

The structure of the fuel injection pump

The fuel injection pump can be divided into mono-pump and the synthesized pump according to its ensemble architecture (the whole pump).

1. Mono-pump [Assemble the animation to demonstrate] [The synthesized pump virtual model]

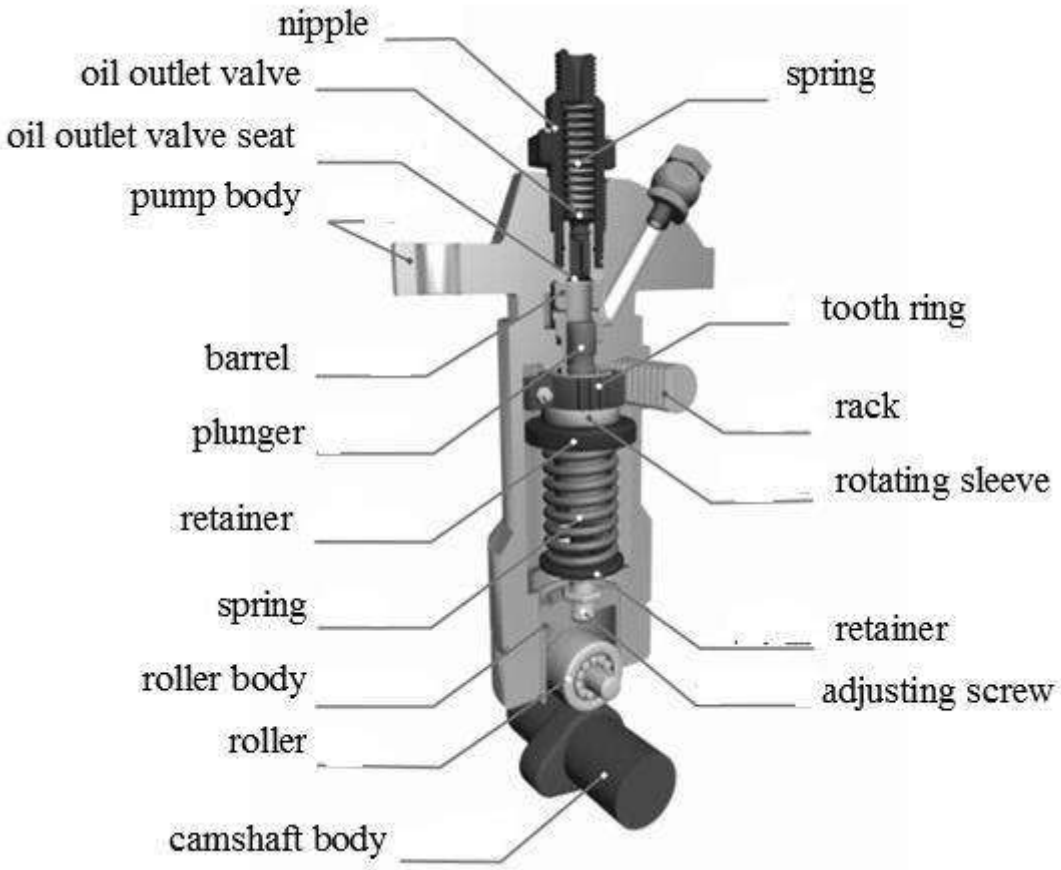
Mono-pump is formed by one plunger and barrel mainly, itself don't bring camshaft and some even don't bring roller transmission part.

Because this kind of mono-pump is easy to be fixed up in the position close to cylinder head, making high pressure fuel pipe shorten greatly, it is applied to the cylinder bore diameter above 200mm of the high-power medium-speed low-speed diesel engine at present.

2.The synthesized pump

The synthesized pump (Example pictures) [The whole pump virtual model]is installed that cylinder numbers are equal to the plunger and barrel assembly in the same pump body, every jar has a group of fuel injection component , by every corresponding cam drive of the camshaft in the body of the pump.

Among the synthesized fuel injection pumps, we take out the synthesized fuel pump group to explain now. The structure chart is as follows:



Its major parts are as follows, the camshaft, roller body, plunger and barrel, plunger return spring, rotating sleeve and tooth ring, oil outlet valve and valve seat, compressing tightly and connecting pipes etc..

Barrel and plunger is a pair of main accurate matching parts in the fuel injection pump, they are processed, ground and mixed each other carefully, their diameter interval is 0.001-0.003mm only, this pair of parts can only be changed in pairs, can't be changed alone .

There are two bores on the barrel, which making barrel inside cavity communicate with oil pipes, there are vertical troughs on the right oil bore place, among them stretching into the screw, which making barrel fixed and can't be rotated in pump body.

The top of plunger has an annular trough, it communicates with terminal surface on plunger with the vertical trough. The spiral hypotenuse begins from the vertical trough and is used to regulate the amount of oil supply.

Plunger under part has two protruding shoulders and flanges. The protruding shoulder of plunger is inserted in the notch of rotating sleeve.

Rotating sleeve is installed on barrel freely. Tooth ring of opening is put with screw in the rotating sleeve to fasten and clenching the teeth by rack.

Rack is put in the vertical bore of pump body and linked with governor gear shift. While rack is moving to the axial direction under the function of gear shift and governor, rotating sleeve and plunger of every oil pimp will turn certain angle thereupon. Retainer of the plunger return spring is equipped on plunger flange. Spring retainer is supported on pump body. The function of spring is to make plunger fall. Cam on camshaft acts on plunger through roller body, which making that go up. Roller body is the transmission body among cam and plunger, it bears side thrust and makes plunger only receive axial force by itself. Equipped with roller on roller body under part axle, it is mounted on rolling needle bearing, twisting the adjusting screw and insurance nut on roller body.

The operation principle of the fuel injection pump

The operation principle of the fuel injection pumps

1. The course of sucking the oil and pressing the oil

Sucking the oil and pressing the oil of the fuel injection pump, is finished by plunger reciprocating motion in barrel. When plunger lies in the under part position, two oil bores on barrel are opened, the inside cavity of barrel communicates with oil passageway in pump body, the fuel is filled with the oil chamber rapidly.

When cam is carried on roller of roller body, plunger rises. Upward movement begins from the plunger to the oil bore and terminates before blocking from top surface of the plunger. Within these periods, because of movement of plunger, the fuel is pushed out of the oil chamber, flows into the oil passageway. So this section lift is called the advance stroke. When plunger blocks the oil bore, it begins to press the oil course. When plunger goes up, the indoor oil pressure rises sharply. When the pressure exceeds out spring elasticity of oil valve and top oil pressure, carrying and opening the oil valve, the fuel is pressed the oil pipe and sent to fuel injector.

The moment is called the initial point of supplying oil in theory when oil inlet bore of plunger is totally blocked by the top surface of plunger. When plunger continues upward movement, supplying the oil continues all the time too, the pressing oil course is not over until the spiral hypotenuse of plunger gets out of the way the oil return bore of barrel, as the oil bore is opened, the high-pressure oil flows back to the oil passageway in pump body from the oil chamber through the vertical trough and the oil return bore of barrel. The oil pressure of oil chamber in barrel is reduced rapidly at this moment; oil outlet valve falls in the valve seat within the function of spring and oil pressure in high-pressure oil pipe, fuel injector stops gushing out the oil immediately. Though plunger still continues up going at this moment, but the oil already stopped. The moment is called the end point of supplying oil in theory when oil return bore of barrel is opened by plunger hypotenuse.

Seen from the sucking the oil and pressing the oil course since above-mentioned, in the whole course of plunger upward movement, just a section of stroke is pressing the oil course, this stroke is called the effective stroke of plunger.

2. Oil adjusting

In order to meet the needs of diesel engine load, the amount of oil supply of the fuel injection pump must be regulated in the range from the amount of maximum fuel (full-load) to zero amount of oil supply (park).For the regulation of oil quantity to realize is made all plungers of the fuel injection pump rotate through rack, rotating sleeve at the same time.

Seen from the animation, when plunger is rotated, oil supply time isn't changed, but the oil supply end time alters, because position of plunger hypotenuse to oil return bore of barrel is changed. As angle that plunger turns being different, the effective stroke of plunger is different too, therefore the change thereupon of the amount of oil supply.

The bigger angle what plunger is rotated to not supplying the oil level is, the hypotenuse distance of the terminal surface which is opened to oil return bore of barrel is bigger, the bigger the amount of oil supply is, if angle that plunger rotates relatively little, Disruption of oil supply begins relatively early, the amount of oil supply is too relatively small. It must be interrupted when the diesel engine parks, for this reason; we

can turn into and make the vertical trough on plunger be facing toward on barrel oil return bore. At this moment, in the whole plunger stroke, the fuel in barrel has been flowing back to oil pipes through vertical trough、oil return bore all the time, there is not pressing the oil course, so the amount of oil supply equals zero.

Therefore, as plunger rotates, we can regulate the amount of oil supply by changing the terminal point of oil supply, this kind of method is called for oil supply terminal point to regulate the law.

Changing the position of the hypotenuse on plunger, we can receive other regulating methods. The plunger hypotenuse shapes of three kinds of regulating method of oil supply are shown in the following diagram.

（a）Regulate the law of oil supply terminal point for above-mentioned, it is suitable for applying to the diesel engine that the rotational speed does not change and applying to the ship supercharged diesel engine too.

（b）Regulate the law for some of supply beginning. Because the spiral hypotenuse slopes upwards, the oil supply initial point isn't changed, but oil supply terminal point is changed while rotating plunger amount of oil regulated. This adjustment method was once thought that it would be suitable for driving the propeller directly on the diesel engine, when it runs according to the promoting performance, load increases with rotational speed, fuel injection advance angle should be increased. But it is unfavorable when it works for low load in fact, so higher turbocharged engines are already few application of marine diesel, we still hope to adopt the first kind of regulation to oil supply terminal point method.

（c）Method to change for initial point and end point of oil supply at the same time . This kind of plunger meets the requirement of reducing the amount of oil injection by properly moving backward initial point and end point ahead of time; therefore, it can control the whole combustion process and go on near the top dead centre no matter in low, high load. This kind of regulating method is suitable for the marine diesel engine that is in high pressurization and changed in rotational speed and load.

In the regulating mechanism of oil supply of the fuel injection pump, besides above-mentioned rack type oil amount controlling organizations, there is a kind of shift fork type oil amount controlling organization. There is one adjusting arm in plunger under part, one of ball head's ends of adjusting arm is put in the trough of adjusting fork, adjusting fork is fixed on pull rod by locking screw, moves pull rod, adjusting fork drives plunger to rotate, so as to achieve the goal of changing oil supply. Its advantage is processing simply, easy repair, oil pump is small in external dimension, and the serial pumps of our country No. 2 adopt this kind of controlling organization.

In above-mentioned the fuel injection pump, the most key part is plunger. There are a lot of structure forms of plunger, but its basic structure is like the Fig:

The form has helix type (b and d) and straight line type (a and c) in the chute (the oil edge) on plunger. The chute of straight line type plunger returns oil through centre bore, processing the advantage such as being simple, and the serial pumps of our country No. 2 adopts plunger of this form.

Spiral troughs or straight line chutes on plunger, according to its slope direction, we can divide it into dextrorotation (c and d) and Left deviation fastened (a and b). The trough direction of the spiral can be judged with the tactics of controlling. The fastening of spiral trough turning towards direction relates to control the movement direction of the tooth pole or arrangement. Spiral trough that dextrorotation turned towards, oil supply reduces when rotating left, it is applied to the fuel injection pump that the whole pump installs governor in the right side. And the fuel injection pump installing governor in the left side fastens the spiral trough with the left.

Cooling system

Need for cooling system

During the process of converting thermal energy to mechanical energy high temp are produced in the cylinder of the engine as a result of the combustion process. A large portion of the heat is transferred to the cylinder head and walls, piston and valves. Unless this excess heat is carried away and these parts are

adequate cooled, the engine will be damaged. A cooling system must be preventing damages to vital parts of the engine, but the temperature of these components must be maintained within certain limits in the order to obtain maximum performance from the engine. Hence a cooling system is needed to keep the engine from not getting so hot as to cause problems and yet to permit it to run hot enough to ensure maximum efficiency of the engine. The duty of cooling system, in other word, is to keep the engine from getting not too hot and at the same time not to keep it too cool either.

Characteristics of efficient cooling system

The following are the two main characteristics desired of an efficient cooling system

1) It should be capable of removing about 30% of heat generated in the combustion chamber while maintain the optimum temp of the engine under all operating conditions of engine.
2) It should remove heat at a faster rate when engine is hot. However during starting of the engine the cooling should be minimum, so that the working parts of engine reach their operating temperature in short time.

Type of cooling system

In order to cool the engine a cooling medium is required. This can be either air or a liquid accordingly there are two type of systems in general use for cooling the IC engine. They are

1) Liquid or indirect cooling system
2) Air or direct cooling system

Liquid cooled systems

In this system mainly water is used and made to circulate through the jackets provided around the cylinder, cylinder-head, valve ports and seats where it extracts most of the heat.

It consists of a long flat, thin-walled tube with an opening, facing the water pump outlet and a number of small openings along its length that directs the water against the exhaust valves. The fits in the water jacket and can be removed from the front end of the block.

The heat is transferred from the cylinder walls and other parts by convection and conduction. The liquid becomes heated in its passage through the jackets and is in turn cooled by means of an air-cooled radiator system. The heat from liquid in turn is transferred to air. Hence it is called the indirect cooling system. Water cooling can be carried out by any of the following five methods

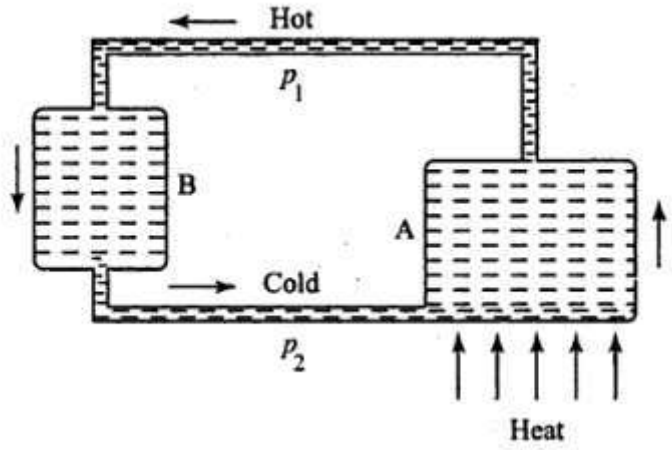
1) Direct or non-return system
2) Thermosyphon system
3) Forced circulation cooling system
4) Evaporative cooling system
5) Pressure cooling system

Direct or non-return system

This system is useful for large installation where plenty of water is available. The water from a storage tank is directly supplied through the inlet valve to the engine cooling jacket. The hot water in not cooled for reuse but simply discharged.

Thermosyphon system

The basic principle of thermosyphon can be explained with respect to fig. heat is supplied to the fluid in the tank A. because of relative lower density, the hot fluid travel up, its place is being taken by comparatively cold fluid from the tank B through pipe p2.



Principal of thermosyphon system

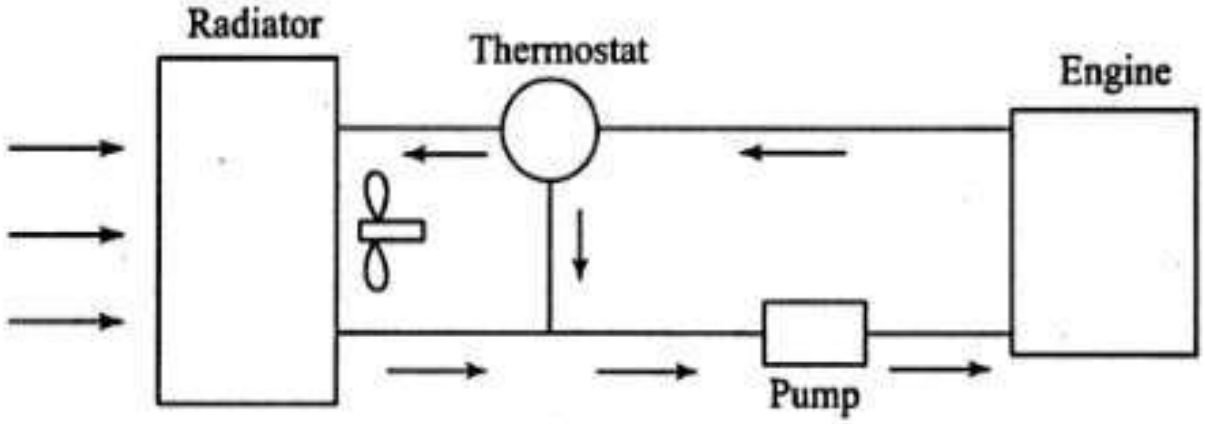
The hot fluid flow through the pipe p1 to the tank B where it get cooled. Thus the fluid circulates through the system in the form of convective current.

For engine application the tank a represent the cylinder jacket while tank B represent a radiator and water act as a circulating fluid. The main advantage of this system is its simplicity and automatic circulating of the cooling water.

Forced circulating cooling system

This system is used in large number of auto-mobile like cars, buses and even heavy trucks. Here, flow of water from radiators to water jacket is by convection assisted by pump.

The main principle of this system is explained with the help of block diagram as shown.

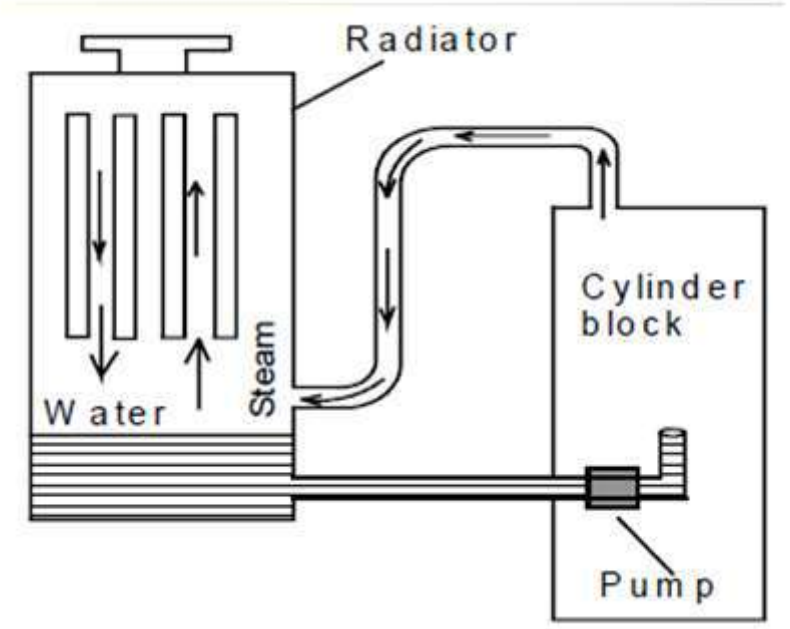


Principal of forced circulation cooling system using thermostat

The water or coolant is circulated through jacket around the part of engine to be cooled, and is kept in motion by a centrifugal pump which is driven by the engine. The water is passed through the radiator where it is cooled by the air drawn through the radiator by a fan and by the air draft to the forward motion of the vehicle. A thermostat is used to control the water temperature required for cooling. It consist mainly four component radiator, fan water pump and a thermostat.

Evaporative cooling system

This is predominately used in stationary engine. In this the engine will be cooled because of the evaporation the water in the cylinder jackets into the steam. Here the advantage is taken from the high latent heat of vaporizing of the water by allowing evaporating in the cylinder jackets. If the steam is formed at a pressure above atmospheric the temperature will be above the normal permissible temperature.



Evaporative cooling with air cooled condenser

In fig. evaporative cooling with air cooled condenser. In this case water is circulated by the pump A and when delivered to the overhead tank B part of it boils out. The tank has portion C. The vapors rise above the portion C and because of the condensing action of the radiator tube D, condensate flow into the lower tank E from which it is picked up and return to the tank B by the small pump F. the vertical pipe G is in communication with the outside atmosphere to prevent the collapsing of the tank B and E when the pressure inside them due to condensation fall below the atmosphere.

Pressure cooling system

In pressure cooling system moderate pressure, say up to 2 bar, are commonly used. As shown in fig a cap is fitted with two valves which are loaded by a compression spring and a vacuum valve. When the coolant is cold both valve are shut but as the engine warm up the coolant temperature rises until it reaches a certain pre-set value corresponding to the desired pressure when the safety valve open. But if the coolant temperature falls during the engine operation the valve will close again until the temperature rises to equivalent pressure value. When the engine is switched off and the coolant cool down vacuum being to form in the cooling system but when the internal pressure fall below atmosphere the vacuum valve is opened by the higher outside pressure and the cooling system then attains atmosphere pressure.

Air cooled system

In the air cooled system a current of air is made to flow past the outside of the cylinder barrel, outer surface area of which has been considerably increased by providing cooling fin as shown in fig. this method will increased the rate of cooling. This method is mainly applicable to the engine in the motorcycles, small cars, airplanes and combat tank where motion of the vehicle gives a good velocity to cool the engine. The value of heat transfer coefficient between metal and air is appreciably low. As a result of this the cylinder wall temperature of the air cooled cylinder are considerably higher than those of water cooled type.

Cooling fins

Comparison of liquid and air cooling system:

In view of the wide spread use of these two alternative cooling system for petrol as well as diesel engine it is of interest to summarize the respective advantage and limitation of these system.

Advantage of liquid cooling system

(1) Compact design of engine with appreciably smaller frontal area is possible.

(2) The fuel consumption of high compression liquid cooled engine is rather lower than for air cooled ones.

(3) Because of the even cooling of the cylinder barrel and due to jacketing makes it possible to reduce the cylinder head and valve seat temperature.

(4) In case of water cooled engines, installation is not necessarily at the front of the mobile vehicle, aircraft etc. as the cooling system can be conveniently located wherever required. This is not possible in case of air cooled system.

(5) The size of engine does not involve serious problem as far as the design of the cooling system is concerned. In case of air cooled engines particularly in high horsepower range difficulty is encounter in the circulation of requisite quantity of air for the cooling purpose.

Limitation

(1) This is a dependent system in which water circulation in the jackets is to be ensured by additional.

(2) Power absorbed by the pump for water circulation is considerable and this affects the power output of the engine.

(3) In the event of failure of the cooling system serious damage may be caused to the engine.

(4) Cost of the system is considerably high.

(5) System requires considerable maintenance of its various parts.

Advantage of Air-cooling System

- The design of the engine becomes simpler as no water jackets are required. The cylinder can have identical dimensions and be individually detachable and therefore cheaper to renew in case of

accident etc.

- Absence of cooling pipes, radiator, etc. makes the cooling system thereby minimum maintenance problems.
- No danger of cooling leakage etc.
- The engine is subjected to freezing troubles etc., usually encountered in case of water coolant engines.
- The weight of the air-cooled engine is less than that of water-cooled engine, i.e., power to weight ratio is improved.
- In this case, the engine is rather a self-contained unit as it requires no external components like radiator, header, tank etc.
- Insulation of air-cooled engines is easier.

Limitations

(1) Can be applied only to small and medium sized engines.
(2) In places where ambient temperature are lower.
(3) Cooling is not uniform.
(4) Higher working temperature compared to water-cooling.
(5) Produce more aerodynamic noise.
(6) Specific fuel consumption is slightly higher.
(7) Lower maximum allowable compression ratios.

Lubrication:-

Lubrication is an art of admitting a lubricant (oil, grease, etc.) between two surfaces that are in contact and in relative motion. The purpose of lubrication in engine is to perform one or several of the following function:-

1) To reduce friction and wear between the moving parts and thereby the energy loss and to increase the life of engine.
2) To provide selling action e.g. the lubrication oil helps the piston rings to maintain an effective seal against the high pressure gasses in the cylinder from leaking out into the crankcase.
3) To cool the surface by carrying away the heat generated in engine components.
4) To clean the surface by washing away carbon and the metal particles caused by wear.

Of all these function, the first function is considered to be the most important one. In internal combustion engines, the problem of lubrication become more difficult because of the high temperature experienced during the combustion process and by the wide range of temperature encounter throughout the cycle. So the energy losses from the friction between different components of the engine can be minimized by providing proper lubrication.

Lubrication of engine component

In the reciprocating engine there are many surfaces in the contact with each other and therefore they should be lubricated to reduce friction. The principal friction surfaces requiring lubrication in an internal combustion engine are:-

1. Piston and cylinder
2. Crankshaft and their bearings
3. Crank pin and their bearing

4. Wrist-pin and their bearing
5. Valve gear

Type of Lubrication system

The function of lubrication system is to provide sufficient quantity of cool, filtered oil to give positive and adequate lubrication to all the moving parts of an engine. The various systems used for internal combustion engine may be classified as:-

1) Mist lubrication system
2) Wet sump lubrication system
3) Dry sump lubrication system

Mist lubrication system

This system is used where crankcase lubrication is not suitable. In two stroke engine, as the charge is compressed in the crankcase, it is not possible to have the lubrication oil in the sump. Hence mist lubrication is used in practice. In such engine, the lubrication oil is mixed with the fuel, the usual ratio being 3% to 6%. The oil and fuel mixture is inducted through the carburetor. The fuel is vaporized and the oil in the form of mist goes via the crankcase into the cylinder. The oil which strikes the crankcase walls lubricates the main and connecting rod bearings and the rest of oil lubricate the piston, piston rings and the cylinder.

The advantage of this system is its simplicity and low cost as it does not require an oil pump, filter, etc. however there are certain disadvantage which are enumerated are following:

1) It cause heavy exhaust stroke due to burning of lubricating oil partially or fully and also forms deposit on piston crown and exhaust port which are affect engine efficiency.
2) Since the oil come in close contact with acidic vapor produced during the combustion process get contaminant and may result in the corrosion of bearing surfaces.
3) This system call for a thorough mixing if effective lubrication. This requires either separate mixing prior to use or use of some additive to give the oil good mixing characteristics.
4) During closed throttle operation as in the case of vehicle moving down the hill, the engine will suffer from insufficient lubrication as the supply of fuel is less. This is an important limitation of system.

Wet sump lubrication system

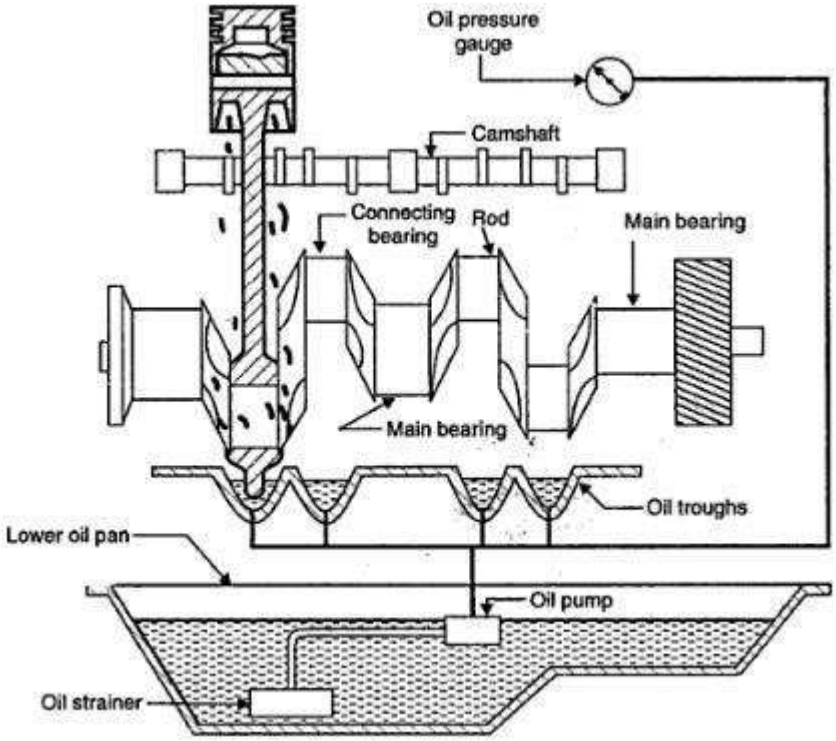
In the wet sump lubrication system, the bottom of the crankcase contains an oil pan or sump from which the lubricating oil is pumped to various engine components by a pump. After lubrication these parts, the oil flow back to the sump by gravity. Again it is picked by a pump and recirculated through the engine lubricating system. There are three varieties in the wet sump lubricating system. They are:

1) The splash system
2) The splash and pressure system
3) The pressure feed system

Splash system

This type of lubricating system is used in light duty engine. The lubricating oil is discharge into the bottom of the engine crankcase and maintained at a predetermined level. The oil is drawn by the pump and delivered through a distributing pipe extending the length if the crankcase into the splash trough located under the big end of all the connecting rods. These troughs were provided with overflows and oil in the trough are therefore kept at a constant level. A splashier or dipper is provided under each connecting rod

cap which dips into the oil in the trough at every revolution of the crankshaft and the oil is splashed all over the interior of crankcase, into the pistons and onto the exposed portion of cylinder walls. The oil dripping from the cylinder is collected in the sump where it is cooled by the air flowing around. The cooled oil is then recirculated.



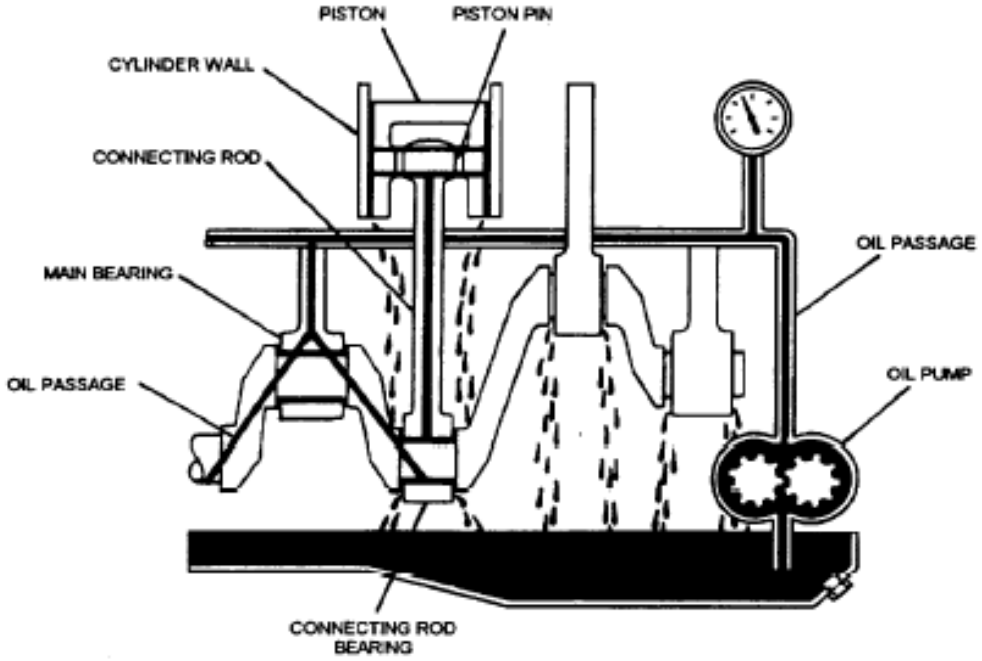
Splash lubrication system

The splash and pressure lubrication system:

In this system, the lubricating oil is supplied under pressure to main and camshaft bearing. Oil is also supplied under pressure to pipes which direct a stream of oil against the dipper on the big end of connecting rod bearing cup and thus the crankpin bearing are lubricated by the splash or spray of oil thrown up by the dipper.

Pressure feed system:

In this system, the oil is drawn in from the sump and forced to all the main bearings of the crankshaft through distributing channels. A pressure relief valve will also be fitted near the delivery point of the pump which open when the pressure in the system attains a predetermine value. An oil hole is drilled in the crankshaft from the center of each crankpin to the centre of an adjacent main journal, through which oil can pass from the main bearing to the crankpin bearing. From the crankpin it reaches piston pin bearing through a hole drilled in the connecting rod. The cylinder wall, tappet roller, piston and piston rings are lubricated by oil spray from around the piston pins and the main and connecting rod bearings. The basic components of the wet sump lubricating system are (1) pump (2) strainer (3) pressure regulator (4) filter (5) breather.



Pressures feed lubrication system

Oil is drawn from the sump by a gear or rotor type of oil pump through an oil strainer. The strainer is a fine mesh screen which prevents foreign particles from entering the oil circulating system. A pressure relief valve is provided which automatically keep the delivery pressure constant and can b set to any value. When the oil pressure exceed that for which the valve is set, the valve open and allow some of the oil to return to the sump thereby reliving the oil pressure in the system.

Dry sump lubrication system

In this system, the supply of oil is carried in an external tank. An oil pump draws oil from the supply tank and circulates it under pressure to the various bearing of the engine. Oil dripping from the cylinder and bearing into the sump is removed by the scavenging pump which in turn the oil is pass through a filter, and is fed back to the supply tank. Thus oil is prevented from accumulating in the base of engine. The capacity of the scavenging pump is always greater than the oil pump. In this system a filter with a bypass valve is placed in between the scavenging pump and the supply tank. If a filter is clogged, the pressure relief valve opens permitting oil to bypass the filter and reaches the supply tank. A separate oil cooler with either water or air as the cooling medium, is usually provided in the dry sump system to remove the heat from the oil.

Properties of lubricants

The duties of the lubricant in an engine are many and varied in a scope. The lubricant is called upon to limit and control the following:

1) Friction between the component and metal to metal contact
2) Overheating of the component
3) Wear of component
4) Corrosion
5) Deposit

To accomplish the above function, the lubricant should have

1) Suitable viscosity
2) Oiliness to ensure adherence to the bearing, and for less friction and wear when the lubrication is in

the boundary region , and as a protective covering against corrosion

3) High strength to prevent the metal to metal contact and seizure under heavy load
4) Should not react with the lubricating surface
5) A low pour point to allow floe of the lubricant at low temperature to the oil pump
6) No tendency to form deposit by reacting with air, water, fuel or the product of combustion
7) Cleaning ability
8) Non foaming characteristics
9) Non toxic and non inflammable

Additives for lubricants

The modern lubrication for heavy duty engines are highly refined which otherwise may produce sludge or suffer a progressive increase in viscosity. For these reasons the lubricant are seasoned by the additive of certain oil soluble organic compound containing inorganic elements such as phosphorus, sulphur, amine additive. Thus oil soluble organic compound added to the present day lubricant to impart one or more of the following characteristics.

1) Anti oxidant and anti-corrosive agent
2) Detergent dispersant
3) Extreme pressure additives
4) Pour point depressor
5) Viscosity index improver
6) Antifoam agent

RGPVNOTES.IN

We hope you find these notes useful.

You can get previous year question papers at https://qp.rgpvnotes.in .

If you have any queries or you want to submit your study notes please write us at rgpvnotes.in@gmail.com

LIKE & FOLLOW US ON FACEBOOK
facebook.com/rgpvnotes.in