Unit 8

Engine Lubrication System

Contents

Learning Objectives

- To learn about the various grades of lubricating oils used (SAE 20, SAE 40, SAE 90, SAE 120) in cars, buses and trucks.
- To learn the importance of engine oil and lubrication system to avoid friction and overheating.

8.0 INTRODUCTION

The process of using lubrication oil to reduce friction between two moving parts is called as lubrication. Metallic contacts between two moving pats lead to friction, heat, wear, noise and seizure of the engine. To overcome this problem, lubricating system is needed in all automobiles. Lubrication is also helpful for smooth functioning of the moving parts in contact. Automobiles have many moving and rotating parts. If lubrication system is not present in vehicles, the durability of the components will be reduced due to wear and tear caused by friction. Hence to increase the life time of the engine, lubrication system is essential in automobiles.

8.1 ADVANTAGES OF LUBRICATION

The Engine Lubrication system

1. Reduces the friction between moving parts.
2. Reduces the damage of parts due to moving in contact.
3. Removes/Decreases the heat due to friction.
4. Cleans the tiny metal particles and dust that are present between two moving parts.
5. Acts as a seal between piston ring and cylinder to provide compression.
6. Reduces the vibrations and makes the parts of the engine to function silently.
7. Increases the strength of engine.
8. Prevents rusting.
9. Helps in increasing the lifetime of engine components.

8.2 PROPERTIES OF LUBRICATING OIL

The lubricating oil or paste used for reducing friction is known as lubricant. The related properties of the Engine Lubricants are

1. Viscosity.
2. Oiliness or Adhesiveness.
3. Fluidity.
4. Volatility.
5. Flash point.
6. Fire Point.
7. Stability.
8. Corrosiveness.
9. Cleanliness.
10. Emulsification.
11. Cloud point.
12. Foaming.

What is SAE International?

- SAE stands for Society of Automotive Engineers.
- It is a global association of more than 1,28,000 engineers and technical experts in the field of aerospace and automotive industries for the benefit of society.

8.2.1 Viscosity

Viscosity of a liquid is the ability that describes a fluid's resistance to flow. Oils with high density are highly viscous in nature. Viscosity decreases with increase in temperature of lubricating oil and increases with decrease in temperature. Society of Automotive Engineers has classified the lubricating oils based on the nature of viscosity. Viscosity of the oil increases with increase in SAE unit. Viscosity is more important among the properties of lubricating oil. It is measured by using the instrument called as viscometer. Viscosity is always measured along with the temperature. For example: SAE 40 at 210° F. This represents that the oil at 210° F has 40 units of viscosity. The higher the viscosity, the higher the SAE viscosiy grade number is.

8.2.2 Oiliness or Adhesiveness

Oiliness and adhesiveness are the properties of making an oily layer at the surfaces of metals in contact. This property should be high for lubricating oil. It is helpful in making the thin oil layer even at high temperatures in minute gaps.

8.2.3 Fluidity

Fluidity is the property of easy flow of lubricating oil in very small gaps. It helps in making a soft layer on the surfaces of junctions even at high temperature.

8.2.4 Volatility

Volatility is the ability of the oil to evaporate at high temperatures developed due continuous functioning of engine. Lubricating oil should have low volatility even at very high temperatures. Otherwise during the functioning of engine lubricating oil will evaporate which may lead to wastage of the lubricating oil, sometime even causing fire accidents.

8.2.5 Flash Point

The flash point is the minimum temperature, at which the oil produces the flash when an ignition source is brought close to the oil vapour and the flash will not continue when the ignition source is removed.

8.2.6 Fire Point

The fire point is the temperature at which the vapour of the oil continues to burn for atleast 5 seconds after ignition by open flame. The fire point will be generally at 10^0 to20^0C above the flash point. Lubricating oils should have higher fire point, to avoid evaporation and ignition.

8.2.7 Stability

During engine's functioning, the lubricating oil should reduce the friction without any oxidation. If lubricating oil is oxidised, it produces acids which leads to dirt and corrosion of the engine parts.

8.2.8 Corrosiveness

During engine's functioning, several parts of the engine are subjected to corrosion due to the chemicals present in the lubricating oil. Hence, lubricating oils should have very less amount of acids and chemicals which will cause corrosion. This is called corrosiveness.

8.2.9 Cleanliness

Lubricating oils should possess the property of cleanliness so that dusts and unwanted materials in the lubricant could be removed. This property helps in cleaning the carbon deposits in the lubricant due to burning of fuels. This is called cleanliness. Normally inorganic lubricants have this property more than organic lubricants.

8.2.10 Emulsification

If lubricating oil is dissolved in water, it results in emulsification. If it dissolves in water, it will lose the property of lubrication. To prevent this additives are added along with the lubricating oil.

8.2.11 Cloud Point

The Temperature at which lubricating oil first changes its phase from liquid state to solid state is known as cloud point.

8.2.12 Foaming

During lubrication action, lubricating oils will have large amount of very small air bubbles to be present. This process is called foaming. It may lead to oxidation and also these bubbles get deposited on the friction surface and prevent the lubricant to flow through the surfaces.

8.3 TYPES OF LUBRICANTS

The lubricants used in machines and automobiles are listed below:

1) Solid lubricant.

2) Semi solid lubricant.

3) Liquid lubricant.

8.3.1 Solid Lubricant

Lubricant materials available in solid state are called as solid lubricants. The solid substance like fibre, graphite, carbon, mica, vax are some of the examples for solid lubricants. They are used in places where liquid lubricants can't be used and also used in high temperature places. See Figure shown in 8.3.1 Solid Lubricant

8.3.2 Semi Solid Lubricant

Lubricant materials present at the state in-between solid and liquid are called semi solid lubricants. The places at high stress and where liquid and solid lubricants cannot be used, semi-solid lubricants are used. In automobiles, in all the bearings other than engine bearing the semi solid lubricants are used. The following table shows the examples for semi solid lubricants and their applications in automobiles. See Figure shown in 8.3.2, Semi Solid Lubricant.

Figure 8.3.1 Solid Lubricant

Figure 8.3.2 Semi Solid Lubricant

Table 1. List of Semisolid lubricants and their applications.

S. No	Lubricant Materials	Using Places
1	Calcium based grease	In joints of vehicles, In cooling pumps.
2	Sodium based grease	Suitable for high temperature, to prevent corrosion.
3	Aluminium based grease	In chain joints, in vehicle joints.
4	Lithium based grease	In all joints of vehicles, in base joints of vehicles

8.3.3 Liquid Lubricants

Lubricants in liquid state are called as liquid lubricants. They are suitable for operating the engines at the required temperature and also for high speed engine's operation. The following are the examples for the liquid lubricants. See Figure shown 8.3.3 Liquid Lubricants.

1) Animal oils.
2) Vegetable oils.
3) Mineral oils.

Figure 8.3.3 Liquid Lubricants

8.3.3.1 Animal Oils

Animal oils are produced from fats of the animals. They mostly vaporise easily and have the tendency to produce gum

What is a Piston Valve?

- Piston valve was developed in 19th century.
- It is a device used to control the motion of a fluid along a tube or pipe by means of the linear motion of a piston.
- They are ideally recommended for critical and hazardous media, including Steam, Heat transfer oils, acids and gases.

like products when used. Hence they are not generally used in motor vehicles.

8.3.3.2 Vegetable Oils

They are obtained from vegetable seeds. For example: Linseed oil, castor oil and palm oil. Except castor oil all the vegetable oils easily get converted into gum like materials. At high temperatures viscosity of the castor oil decreases. Castor oils were used in old vehicles. However it is not used in modern vehicles.

8.3.3.3 Mineral Oils

These are the oils mostly used in all vehicles. These lubricating oils are obtained as lubricants in the separating processing of petroleum refining. Their important properties do not vary significantly even at high temperatures. They do not dissolve in water, acid free and corrosion free. Hence they are largely used in all automobiles.

8.4 TYPES OF LUBRICATION SYSTEM

All the parts of engine such as crankshaft, bearings, crank pin, both ends of connecting rod, piston pin and inner wall of cylinder, piston rings, valve mechanism, timing gears and camshaft bearings are made to function along with the engine. Hence the above parts must be lubricated to avoid friction in these moving parts. The following are the types of lubricating systems used in engines.

Lubricant Systems:

1. Petrol oil (mist) lubricating system.
2. Splash lubricating system.
3. Pressure lubricating system.
4. Semi pressure lubricating system.

- Oil sump
- Oil pump
- Pick-up screen
- Pressure regulator
- Oil filter
- By-pass valve
- Oil galleries
- Dipstick
- Pressure indicator

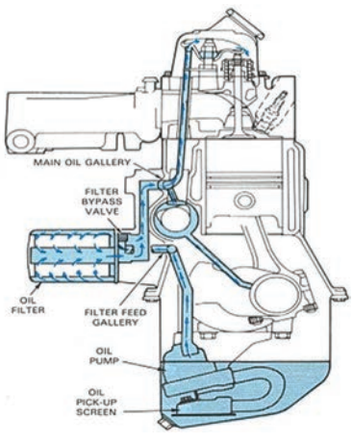

Figure 8.4 Parts of Lubrication System

8.4.1 Petrol System

This type of lubricating system is used in small vehicles like in two wheelers (e.g. TVS 50 and other mopeds and also in Motor cycles with two stroke engines. In this system lubricating oil is of about 2% to 3% is mixed along with petrol and used. It is a simple lubricant system commonly used in two stroke two wheelers and small size engines.

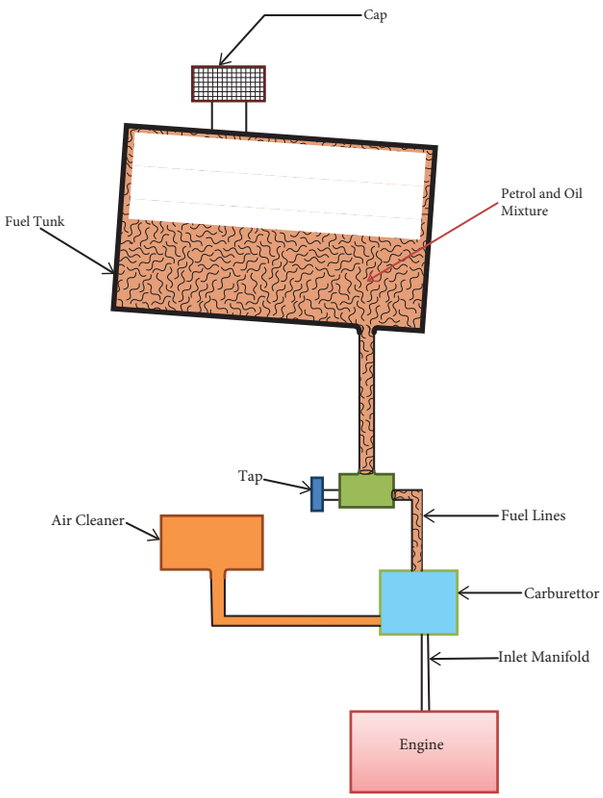

Figure 8.4.1 Petrol Oil Lubrication System

8.4.2 Splash Lubrication System

In this system, at the bottom of the crank case, oil sump will be present and filled with the lubricating oil. The engines with this type of system have dipper or scoop like arrangement fitted at the bottom of the connection road. When the piston moves towards bottom dead centre, the scoop placed at the connecting rod dips into the oil sump and scoops the oil. When the piston moves up the oil in the scoop will be splashed on all over the interior of the crankcase, into the piston and to the exposed portions of the cylinder wall and other components. See Figure shown in 8.4.2 Splash Lubrication System

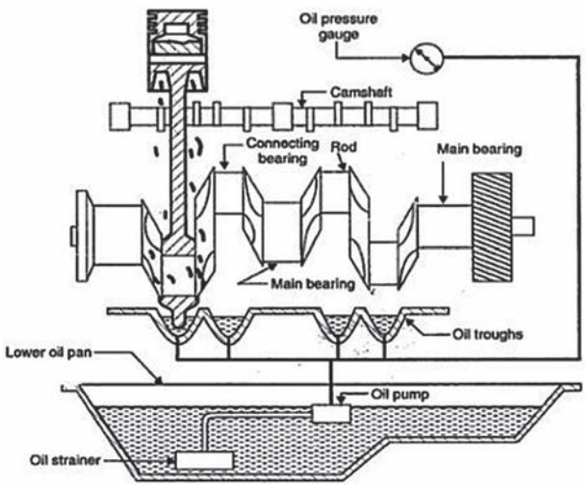

Figure 8.4.2 Splash Lubrication System

8.4.3 Pressure Lubrication

Sending the lubricating oil at high pressure using a pump to all the parts of engines is called pressure lubrication. In this system oil is kept at the base of crank case. During operation of the engine, oil pump sucks the oil from sump through the strainer. This oil is subjected to high pressure of about 200 kPa to 400 kPa and then sent to the oil filter. It is then filtered in the oil filter and sent to main gallery. From the main gallery the oil is sent to main journal bearings and sub journal bearings of the crank shaft for lubrication. The oil is then sent to the piston pin and piston rings via the oil hole of connecting

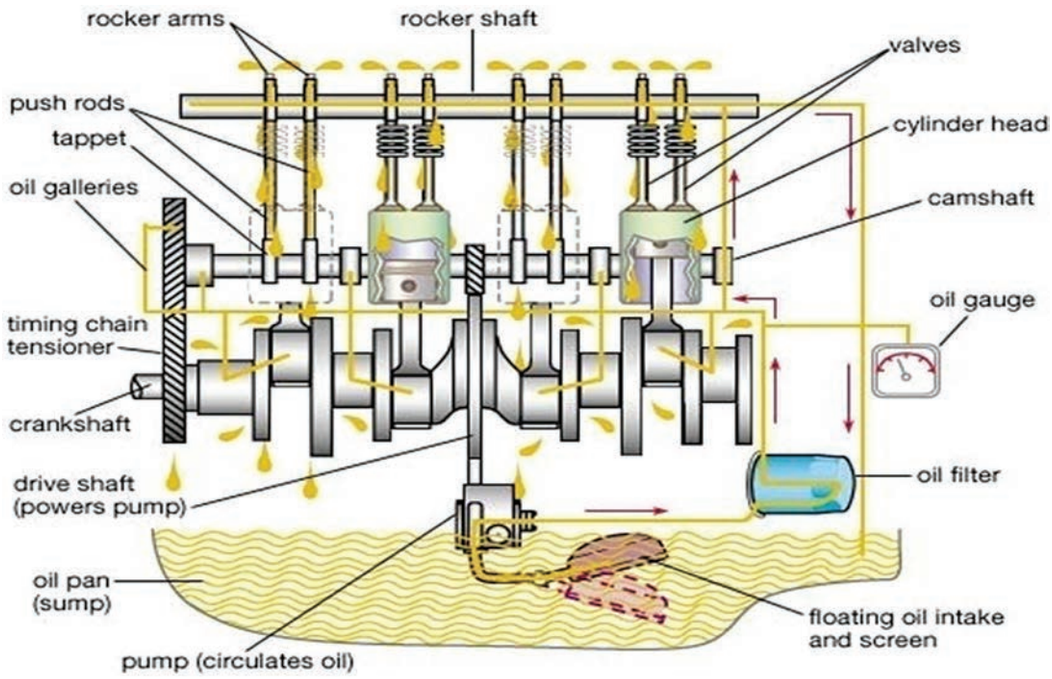

Figure 8.4.3 Pressure Lubrication System

rod. To lubricate the cam shaft and training gear from the gallery, the oil is sent to the rocker arm from oil holder and overhead valve by valve mechanism. In this system the oil pressure can be known and most of the engines use this type of system. See Figure shown 8.4.3 Pressure Lubrication System.

8.4.4 Semi-Pressure Lubrication System

It is the combination of splash and pressure lubrication system. This lubrication system is used in four stroke engines.

8.5 PARTS OF LUBRICATION SYSTEM

8.5.1 Oil Filters

This is used to filter the lubricating oil coming out from the oil pump which contains impurities and dust. The filters used in automobiles are, see fig shown in 8.5.1 Oil Filter.

1. Cartridge filters.
2. Edge filters.
3. Centrifugal filters.

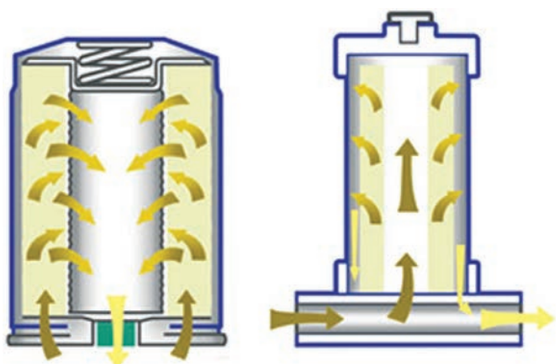

Figure 8.5.1 Oil Filter

8.5.1.1 Catridge Filters

It is used in almost all automobiles. This filter cleans very minute dust particles in the oil up to 5 microns. The oil is passed through the filter and taken out

at the outlet by which the dust particles of more than 5 microns are removed. This type of filter uses cloth or fibre material. There is a need for replacement of cloth or the filter material from time to time. See fig shows in 8.5.1(a) Catridge Filters.

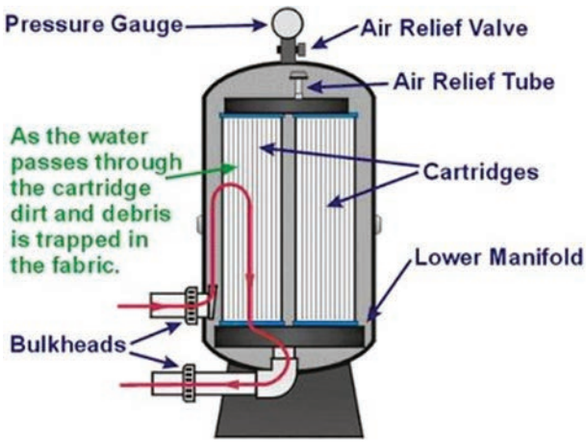

Figure 8.5.1(a) Cartridge Oil Filter

8.5.1.2 Edge Type Oil Filters

This filter contains a soft disc made up of brass material. This filter is divided into two parts. One part is attached to the spindle which is at the centre of the filter and the other part is supported by the square rod at the edge of the filter. The gap in between the disc is in few microns. When the oil flows through the each disc, the dirt gets deposited on the upper surface of the discs and then it passes out through the outlet. During this, the dirt in the spindle and square rod gets deposited at the bottom of filter body. See fig shows in 8.5.1(b) Edge Type Oil Filters.

8.5.1.3 Centrifugal Type Oil Filters

In this type of filter, the impure oil coming from the oil pump reaches the hollow spindle at the centre of a rotor. The hollow sphere is surrounded by the pillars. The oil coming from the pillars fills the rotor and then goes through the tube of the rotor and comes out via jet at the base of the tube. Because of this, the rotor casting rotates in the opposite direction. During the rotation of the rotor

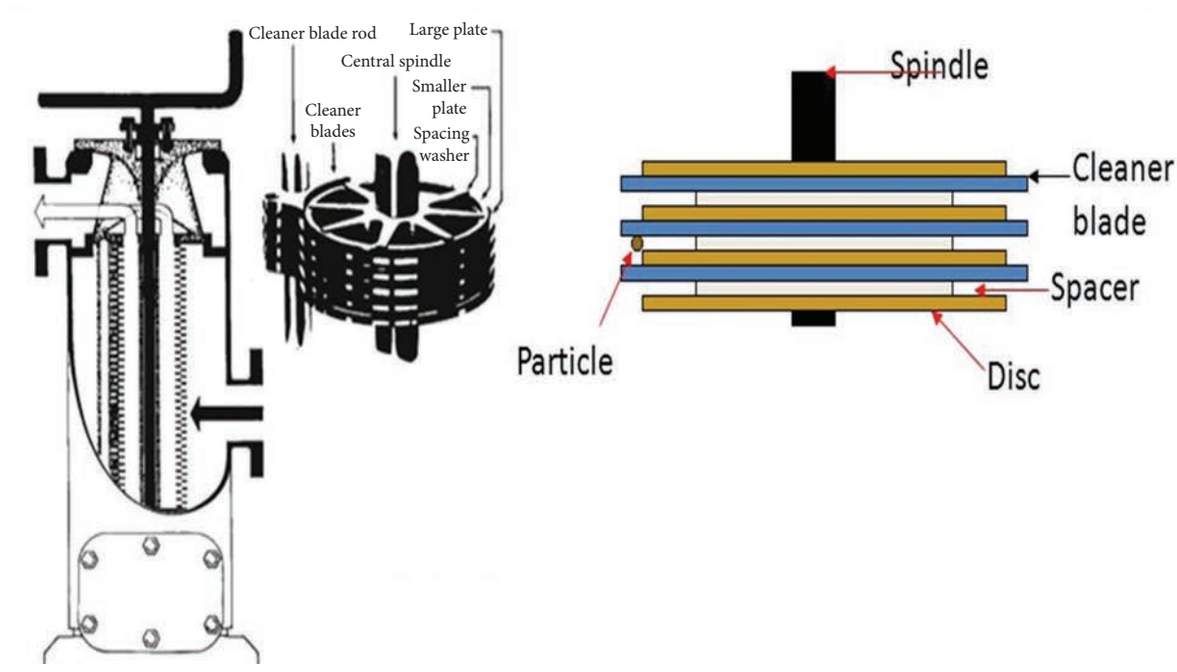

Figure 8.5.1(b) Edge Type Oil Filters

casing, the impurities in the oil from the jet get sprayed from the stationary casing due to centrifugal force. Finally the purified oil comes out through the outlet. See fig shows in 8.5.1(c) Centrifugal Type Oil Filter.

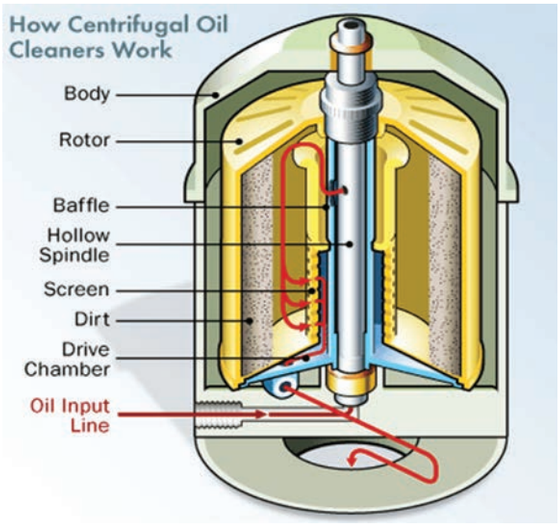

Figure 8.5.1(c) Centrifugal Type Oil Filter

8.5.2 Oil Pump

In lubrication system after the oil strainer, oil pump is placed which is the very important component of the system. Sending the oil with high pressure to the engine parts is the function of the oil pump. The oil pump is located at the crank case below the oil level. It is generally operated from the tip of distributer shaft. It gets the power from the skew gear of camshaft through distributer extension shaft. The speed of the oil pump increases with increase in the speed of the engine. This increases the pressure in the shaft. High pressure is controlled by using a pressure relief valve. The pump supplies sufficient oil to all the engine parts. Minimum pressure for the oil is maintained as 100 kPa. Normally to lubricate the engine, the lubricating oil of about 15 to 20 litres is circulated per minute. The oil is sent in large amount at high pressure through the oil pump. Hence selecting the suitable oil pump is very important. Due to bearing damage caused by friction and leakage of the oil from the engine parts there will be reduction in pressure of the oil. Hence to reduce damage of the components and to maintain sufficient pressure, suitable oil pump is needed. Figure shown in 8.5.2 Oil Pump.

Figure 8.5.2 Oil Pump

TYPES OF OIL PUMP:

The following are the types of oil pumps generally used in automobiles,

1. Gear pump.
2. Rotor pump.
3. Plunger pump.
4. Vane pump.

8.5.2.1 Gear Pump

In present automobiles, gear type oil pumps are generally used. This pump is a very simple one. It has two parts called as drive gear and driven gear. These two gears rotate together in a housing. Sufficient gap is maintained between the inner side of

housing and the tip of gear. In gear pumps two types of gears are generally used, they are 1) Spur gear and 2) Helical gear. To reduce noise in pump, helical gear is preferred.

During functioning of engine, the drive gear gains the power from the skew gear of the camshaft via distributor extension shaft. The driven gear attached to it also rotates due to the rotation of the drive gear as it is in mesh with the drive gear. However the rotation is opposite. Because of opposite rotation of the two gears, inner side of the pump creates vacuum. Due to this vacuum the oil in the sump tries to fill the empty space. The oil sucked into the housing of the pump through the inlet. In this way, the oil passes through the gears and housing gaps to fill the empty space via inlet. The oil pressure is increased here to about 2 kg/cm^2 to 4 kg/cm^2 and it comes out through the outlet. Since outlet is connected to the oil gallery, the oil is circled through all the moving parts of engine. Figure 8.5.2(a) shows the view of the gear type oil pump.

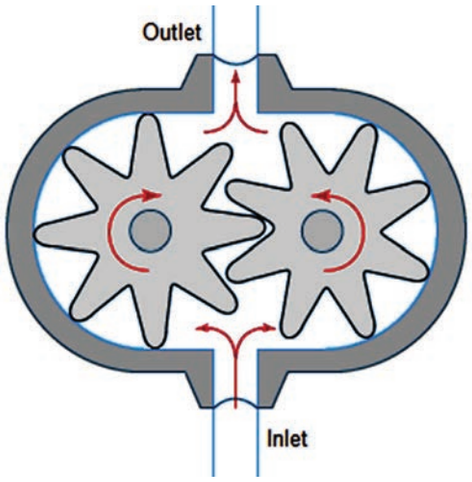

Figure 8.5.2(a) Gear pump

8.5.2.2 Rotor Pump

Rotor pump is similar to the gear type pump. But in this pump two rotors are present instead of gears. These two rotors are attached to the inner side. One of the rotors is called inner rotor and the other called as outer rotor. The inner rotor rotates inside the outer rotor. The outer rotor has one lobe more than that of the inner rotor. The rotating arrangement of the rotors in this pump varies. So the size of the gap in between the two rotors varies. Inner shaft is rotated by attaching to the skew shaft of the cam shaft through the distributor extension shaft. Hence both the rotors rotate. Because of opposite rotation of the two rotors, inner side of the pump creates vacuum. Due to the vacuum pressure, the oil in the sump is forced to enter into the empty space. The oil attains high pressure of about 2 kg/cm^2 to 5 kg/cm^2 at the pump and comes out via the outlet port. Figure 8.5.2(b) shows the view of a rotor pump

1. This pump has 25% more power than gear pump and the construction is very simple.
2. For every rotation as less number of lobs is meshing it is noise free operation.

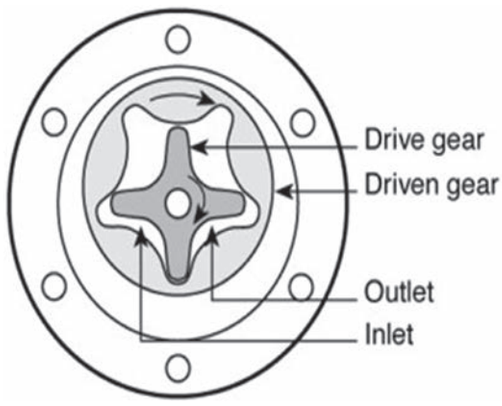

Figure 8.5.2(b) Rotor pump

8.5.2.3 *Plunger Pump*

This pump consists of the essential components such as barrel, plunger and two one way spring loaded ball valves etc., The plunger is designed to operate in reciprocating motion inside the barrel. Power required to drive the pump is drawn from the eccentric disc coupled with the cam shaft or by means of a small connecting rod coupled with the crank shaft of the engine. Among the two spring loaded ball valves in the pump, one is connected to the inlet of the barrel whereas the other one is connected to the outlet of the barrel. The figure 8.5.2(c) shows the view of a plunger type oil pump.

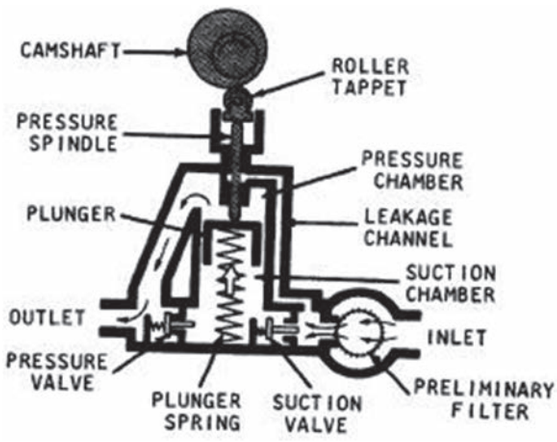

Figure 8.5.2(c) plunger pump

When plunger moves in the upward direction, a partial vacuum is created in the bottom portion of the plunger. So the inlet valve is opened and the oil is sucked and allowed to occupy the vacuum portion. When the plunger moves in downward direction the oil pressure gets increased in the barrel. Now the outlet valve is opened and inlet valve is closed. So the pressurized oil in the pressure chamber is expelled out through the outlet valve. This type of pump is generally not used in automobiles as it does not produce enough amount of pressure. This type of pump is used in stationary oil engines and in few automobile engines.

8.5.2.4 *Vane Pump*

This type of pump has a circular housing. Inside which an eccentric motor is present. The rotor shaft is connected to a skew gear. Surface of the rotor has equally spaced slots, which has many vanes connected. This vanes move to and fro in the slots. Two rings are placed at the center so that the vanes are kept close to the housing. Figure 8.5.2(d) shows the arrangement of the van pump.

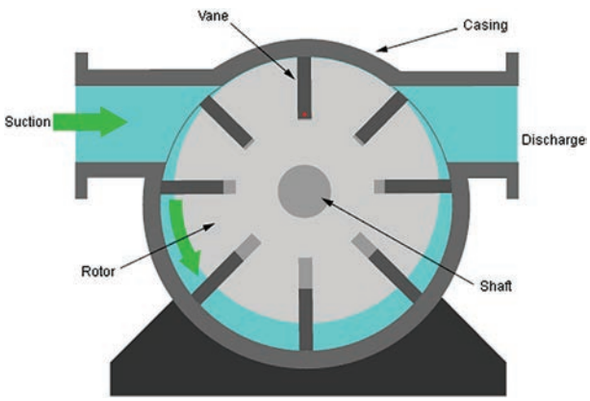

Figure 8.5.2(d) Vane Pump

When the pump is started the shaft rotates and due to the centripetal force vanes are forced outwards. Due to which oil enters into the casing through the inlet. Now the vanes move in the small space between the housing and eccentric rotors. When the vanes move again to the same place the oil in that place moves out through the outlet.

8.6 PRESSURE RELIEF VALVE

The oil pump is designed in such a way to send the fixed amount of oil when

the engine runs at the idling speed. So that when the engine speed gets raised, pump speed also get raised and sends oil with high pressure. This causes more oil to get wasted if the oil seals and joints are damaged. To avoid this, pressure relief valve is fixed in this pump. This valve releases the excess pressure developed inside the pump. The following are the different types of pressure relief valves used in automobiles.

Based on design it is classified into two types they are

1. Ball type pressure relief valve
2. Plunger type pressure relief valve

8.6.1 Ball Type Pressure Relief Valve

In this type a ball valve, spring and adjustment screw are present. The ball valve will be placed in its seat supported with a spring. All these above components are placed inside the pump housing. The figure 8.6.1 shows the view of the ball type pressure relief valve.

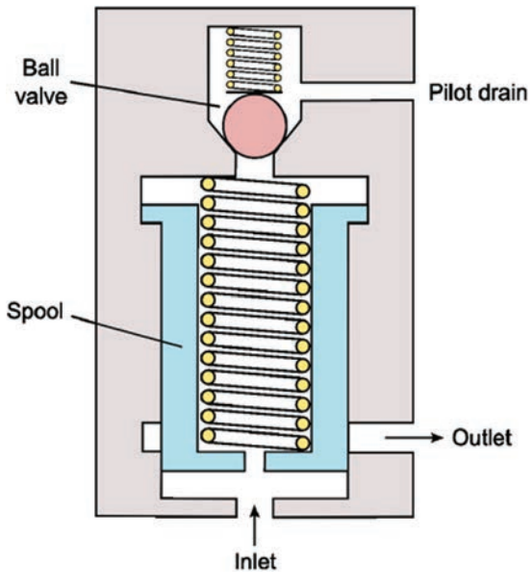

Figure 8.6.1 Ball Type Pressure Relief Valve

Working:

When the engine is off, the spring forces the ball to seat on its seat tightly. When the engine is started, based on the oil pressure and the spring tension the ball value will be in the opened or closed position. When the engine speed is increased, the pressure of oil is also increased. The increased pressure once if it reaches the fixed level, it presses the spring so that it moves the ball from the seat and releases the pressure and the excess oil reaches the inlet via bypass or to the oil sump.

Adjusting Screw And Lock Nut:

Adjusting screw is used to maintain the required level of pressure. If the screw is tuned inwards it increases the spring tension and allows more pressure to open the ball valve. If the screw is tuned outwards it reduces the spring tension and makes the pressure of oil to open the ball valve easily. Normally for the engines when runs at 1000 rpm at 43 degree Celsius the spring tension will be of 2.5 kg/cm^2.

8.6.2 Plunger Type Pressure Relief Valve

It is similar to the ball type valve but has a plunger, spring and adjustment shims. The plunger is placed on the seat with the help of the spring tension (Fig 8.6.2).

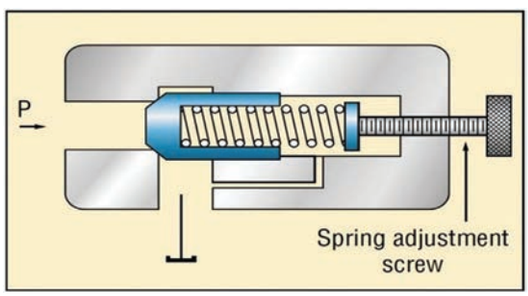

Figure 8.6.2 Plunger Type Pressure Relief Valve

When the engine is off, the spring makes the plunger to sit on the seat. Once the engine is started, depending on the pressure and spring tension, spring will open or close the path by moving the plunger. When the engine speeds up, the oil pressure also increases and if the increasing pressure level reaches beyond the fixer level the spring presses the plunger from its seat so that the extra oil will reach the inlet via bypass or reaches the oil sump.

With the help of the adjusting shim and lock nut the tension of the spring can be adjusted. By adding or removing the shim the spring tension is increased or decreased

Oil Dipstick or Oil Level Indicator:

Oil dipstick is used to measure the oil level in the oil sump. A cap is placed at the top and the Steel rod or a blade is placed at the bottom. This rod will have two Limits as maximum and minimum level lines. Apart from this many small graduations are drawn below the minimum level line; oil should be maintained above minimum level line.

The dip stick is inserted through the engine block into the oil sump. Before starting the engine the dipstick has to be taken out and checked for the oil level and should be seen that the oil level should not go below the minimum level. Lubricating failures and reason for failures have to be taken in care for proper maintenance of the engine

8.7 FAILURES IN LUBRICATING SYSTEM

Following are the some of the failures in lubricating system

1. Low engine oil level
2. Interior cracks
3. Poor lubrication efficiency
4. Blockage of filters
5. Impurities in the Engine oil

8.8 REASONS FOR FAILURE IN LUBRICATING SYSTEM

There are many reasons for failures of lubricating system

1. Internal and external leakage of oil leads to reduced oil level
2. Low pressure in oil, the oil pump may get damaged
3. Failure of oil pump belt or chain
4. Blockage in filter or bend in pipe
5. More blocks in oil filter
6. Damaged compounds
7. Broken or burnt gasket
8. Broken or worn out Piston rings

8.9 METHODS TO TROUBLESHOOT

1. By correcting the oil leakage
2. By changing the gaskets in oil sump
3. By changing the head gasket
4. By changing the paper gasket cover
5. By changing the drain block
6. By changing the piston rings
7. By maintaining the correct oil level

Student Activity

1. Students should visit the nearby workshops to study the process of engine lubrication system.
2. Students should dismantle any on of the lubrication system and sketch the complete system and then describe their function in detail.

Glossary

Solid Lubricant	-	திடநிலை உயவு பொருள்
Liquid Lubricant	-	திரவநிலை உயவு பொருள்
Fluidity	-	உயவு திரவம் படர் நிலை
Flash Point	-	வெடிப்பு நிலை
Fire Point	-	எரிதல் நிலை
Corrosion	-	துருப்பிடித்தல் / அரித்தல்
Foaming	-	நுரைத்தல்
Animal Oil	-	விலங்கு உயவு எண்ணெய்
Vegetable Oil	-	தாவர உயவு எண்ணெய்
Mineral Oil	-	தாது பொருள் உயவு எண்ணெய்

References

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SAMPLE QUESTIONS

Choose the correct answer

1. The oil pressure level of outlet oil in the oil pump?
   a) 2kg/cm^2 to 4 kg/cm^2
   b) 3kg/cm^2 to 4 kg/cm^2
   c) 5kg/cm^2 to 7kg/cm^2
2. Types of lubrication methods in engine.
   a) 2
   b) 3
   c) 4
3. Which lubrication system is mostly used in now a days?
   a) Petroil system
   b)Pressure lubrication system
   c) Splash system
4. The outlet oil from the oil pump is goes to.
   a) Main gallery
   b) Main bearing
   c) Oil filter
5. How many types of lubricants in the engine?
   a) 2
   b) 3
   c) 4

Answer the following questions

1. What is the necessity of the lubrication?
2. What are the properties of a Lubrication oil?
3. What is meant by S.A.E.?
4. What is meant by Fluidity?
5. What is meant by Volatility?
6. What is meant by Viscosity?
7. What is meant by Flash point?
8. What is meant by Foaming?
9. What are the types of the lubricant?
10. What are the solid lubricants?
11. What are the liquid lubricants?
12. What are the types of the lubrication system?
13. What are the different parts in the lubrication system?
14. What are the types of filters?
15. What are the types of oil pump?
16. Explain the working of any one type of the Oil pump with a sketch.
17. Mention any five types of troubles in the lubrication system and rectify them.
18. Explain the defects and remedies in the lubrication system.