International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 09 | Sep -2017 www.irjet.net p-ISSN: 2395-0072

# Tribological aspects of Internal combustion engine

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**Abstract -** This paper presents studies related to engine tribology in internal combustion engine. Friction loss is the main portion of the energy consumption developed in an engine. The friction loss is made up of the friction between the piston and the cylinder walls, piston rings and the cylinder wall, and between the crankshaft and camshaft and their bearings, as well as by the loss incurred by driving the essential accessories, such as the water pump, ignition unit etc. Lubricants are used to reduce the friction and wear and fuel consumption, increased power output of the engine, reduced oil consumption, a reduction in exhaust emissions in the engine. The oil used in an engine serve as a lubricant, a coolant an agent for removing impurities. It must be able to withstand high temperatures without breaking down. The oil must operate over a good range of temperature. The lubricating oil should have the correct viscosity so that it flows easily to all the moving parts. Because the surface engineering is becoming an increasingly viable alternative to the constructive changes made to improve the efficiency of internal combustion engines to attain high levels of asset availability

***Key Words*: Friction, wear, lubrication, viscosity, scavenging, blowby etc.**

## 1. INTRODUCTION

The automobile Engine is one of the most common machines in use today, and it is no exaggeration to state that it is crucial to the economic success of all the developing and developed nations of the world and to the quality of life of their citizens. The motor car itself consists of thousands of component parts, many of which rely on the interaction of their surfaces to function. There are many hundreds of tribological components, from bearings, pistons, transmissions, clutches, gears, to wiper blades, tires, and electrical contacts. The application of tribological principles is essential for the reliability of the motor vehicle, and mass production of the motor car has led to enormous advances in the field of tribology. For example, many of the developments in lubrication and bearing surface technology have been driven by requirements for increased capacity and durability in the motor industry. For the purpose of classifying the tribological components, one can divide the motor vehicle into engine, transmission, drive line, and ancillaries such as tires, brakes, and windshield wipers. [1,2]

### 1.1 Tribology

#### 1.1.1 What is Tribology?

Tribology comes from the Greek word, "tribos", it meaning is "rubbing" or "to rub" And from the suffix, "ology" means "the study of" Therefore, Tribology is the study of rubbing, or "the study of things that rub". [3,4]

#### 1.1.2 Definition:

Tribology is the science and technology of interacting surfaces in relative motion (and the practices related thereto), including the subject of friction, wear and lubrication. [5]

This includes the fields of:

- Friction
- Wear
- Lubrication

## 2. FRICTION

When one solid body is slid over another so there is a some resistance to the motion which is called friction**.** In an IC engines almost all machines parts have relative motion and rub against each other that in general refers to friction. Considering friction as a nuisance, attempts are made to eliminate it or to diminish it to as small a value as possible, increase in friction is ultimately dissipated as heat to the cooling water and it further increases the pump and fan power requirements also, to reduce this friction lubrication is required, which increases the life of the engine. The friction resistance between two moving parts having relative motion is mostly dependent on the lubricating properties, surface condition, materials of the surfaces, rate of relative motion and quality of lubricating oil. Friction accounts for 15–20% of all the internal-combustion engine losses. The share of frictional losses increases at idling and low speeds such as those in crawling congested traffic. This is the case in the urban

areas and even increasingly on major trunk routes. Therefore, a reduction in friction is seen as essential in the development of new engines, which is driven by a number of key concerns: the fuel efficiency, the emission levels, the noise, vibration and harshness refinement and the cost. It should be the aim of a good designer to reduce friction and wear of the parts subjected to the relative motion. In this paper the various losses associated with friction, effect of engines parameters on engine friction and methods of lubrication is enumerated . [2,6]

### 2.1 Engine Friction Loss

A significant part of the power developed by the expansion of the gas in the cylinders is used for overcoming friction (between piston and cylinder and in the bearing of the connecting rod and crankshaft) and for driving the water-circulation pump, oil pump, alternator, camshaft and valves. Hence only a certain proportion of the theoretical power output is available as effective output. This proportion is termed the "mechanical efficiency" of the engine. Depending on the type and design of the engine and on its state of maintenance, the mechanical efficiency is usually between 0.75 and 0.85. The difference between the I.P. and B.P. is known as total engine friction loss. This includes Direct friction losses, pumping losses, blowby losses, valve throttling losses, combustion chamber pump losses and power loss to drive the auxiliaries.

### 2.1.1 Direct friction Losses

It is the power absorbed due to relative motion of different bearing surfaces such as piston rings, main bearings, cam shaft bearings etc. In reciprocating I.C. engines the frictional losses are comparatively higher.

### 2.1.2 Pumping losses

In case of four stroke cycles engines an ample amount of power is used during intake and exhaust processes. The pumping loss is the net power spent by the piston on the working medium

during intake. The pumping loss is negligible in two-stroke cycles engines since the incoming fresh mixture is used for scavenging the exhaust gases and charging the cyclinder

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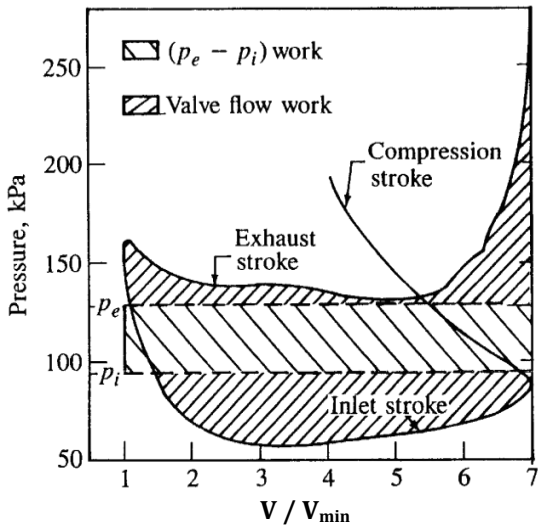



**Fig1.**Puming loop diagram for SI engine under firing conditions, showing throttling work $V_d(p_e-p_i)$, and valve flow work

### 2.1.3 Blowby Losses

It is the phenomenon of leakage of the combustion products from the engines cylinder to the crankcase past the piston and the piston rings. It depends upon the compression ratio, inlet pressure and the condition of the piston rings. This loss increase directly with the compression ratio but reduced with the increase in engine speed.

### 2.1.4 Valve throttling losses

The standard practice for sizing the exhaust valve is to make them a certain percentage smaller than the inlet valves. This usually results in an insufficiently sized exhaust valve and hence, results in exhaust pumping losses. If due attention is not given to the valve size, valve timing and valve flow coefficients there may be a substantial loss with the increase in engine speed. The inlet throttling loss occurs due to the restrictions imposed by the cleaner, carburetor venturi , throttle valve, inlet manifold and intake valve. All these restrictions lead to pressure loss. Similarly some pressure loss is necessary to exhaust the combustion products.

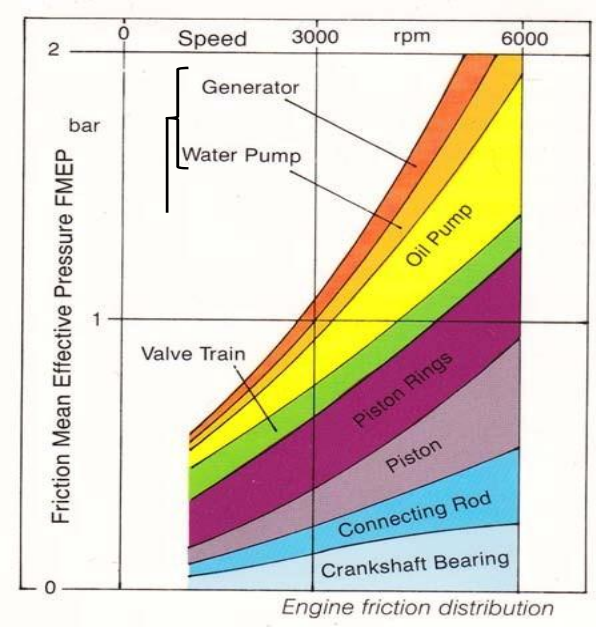
### 2.1.5 Combustion chamber pump loss

This type of loss is caused due to the pumping work required to pump the gases into and of the pre-combustion chamber. Its exact value depends upon the orifice size and

the speed. Higher the speed greater is the loss and smaller the orifice size greater is the loss.

### 2.1.6 Power loss to drive the auxiliaries

In order to drive auxiliaries such as water pump, oil pump, fuel pump, cooling fan and generator some power is needed. This is also considered as loss since a part of engine power developed is used for these purposes.



Engine friction distribution

## 3. WEAR

The process of particles wearing surfaces and generating new particles that in turn cause more wear is known as the chain-reaction of wear. . It produced by the processes of abrasion, adhesion, erosion, tribo chemical reaction and metal fatigue. [2] **,** It is the actual removal of surface material due to the frictional force between two mating surfaces. This can result in a change in component dimension which can lead to looseness and subsequent improper operation. The adhesion mechanism of friction enables us to understand the basic mechanism of metallic wear, when a junction shears during sliding it may shear in one or other of four ways. There are five forms of wear that occur in IC engine components: abrasion, fatigue, adhesion, corrosion, and lubricant breakdown. Abrasion, fatigue, and adhesion involve mechanical damaging of surfaces. Metallic wear particles accelerate oil oxidation, resulting in sludge's and oil acidity. Soot, a product of incomplete fuel combustion, is similar to lamp black. By virtue of its tremendous total surface area, soot can leach out additives from the engine oil. [8]

| ***Type*** | ***Primary source*** | ***Major problems*** |
|---|---|---|
| Metallic particles | Engine wear Abrasion | fatigue and lubrication breakdown |
| Sand &dust | Combustion blow by | Abrasion and fatigue corrosion |
| Metal oxides | Engine wear and corrosion | Abrasion and fatigue |
| Soot breakdown | Combustion blow by Lubrication | Lubrication breakdown |
| Exhaust gases | Combustion blow by Lubrication | Lubrication breakdown |
| Fuel water | Combustion blow by Lubrication | Corrosion and Lubrication breakdown |
| Acids | Combustion blow by and lubricant breakdown | Corrosion |

**Table1**.Contamination of Diesel Lube Oil

## 4. LUBRICATION

It is evident that lubrication is required to minimize sliding friction resistance of the engine to a minimum to ensure maximum mechanical efficiency. An additional function of the lubricant is to act as a protection for the accurately-ground and highly-polished surfaces of the balls, rollers and rings. If free moisture is allowed to contact the bearing elements, corrosion and pitting will follow and the bearing life will be considerably shortened. At the same time, a suitable lubricant should prevent the entry of external contaminating matter in the form of dirt or abrasive dust. [7]

### 4.1 Lubrication Systems

- Mist lubrication system
- Wet sump lubrication system
- Dry sump lubrication system

Mist lubrication system is mainly employed in two- stroke cycle engines, whereas wet and dry sump systems are used in four-stroke cycle engines. The wet sump system is employed in relatively small engines, such as automobile engines, while the dry sump system is used in large stationary, marine and aircraft engines. In two-stroke

engines, the charge is compressed in the crankcase, and as such it is not suitable to have the lubricating oil in the sump. Therefore, such engines are lubricated by adding 3 % to 6 % oil in the fuel tank itself. The oil and fuel mixture is inducted through the carburetor. The fuel gets vaporized and the oil, in the form of mist, goes into the main advantage with this system lies in the simplicity and low cost as the system does not require any oil pump, filter etc. In the wet sump system, the bottom of the crankcase contains an oil sump (or pan) that serves as the oil supply reservoir. Oil dripping from the cylinders and bearings flows by gravity back into the wet sump where it is picked up by a pump and re-circulated through the engine lubricating system. The cylinder through the crankcase. The oil that impinges the crankcase walls lubricates the main and connecting rod bearings, and the rest of the oil lubricates the piston, piston rings and cylinder.

## 5. CONCLUSION

The wear internal combustion engines is caused by complex combined solicitations: thermal (thermal condition with temperatures between 300 and 900°C), mechanical solicitations caused by the high-speed operation and very high operating pressures in the combustion chamber, high temperature corrosion and abrasive wear caused by hard particles dragged along in the working. In order to minimize friction between the moving parts and hence wear, lubrication system in an engine plays a significant role. The lubrication system is designed to deliver clean oil at the correct temperature and pressure to every part of the engine. Lubricating oil can be supplied to the various engine components by a splash system or by a pressurized system or a by a combination of both. From all this paper finally concludes that all the main reason of engine performance is depend on the wear and friction of the engine components so if lubrication is good than almost many problems is solved so lubrication is very important parameter in engine tribology.

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