International Journal of Advance Research in Engineering, Science & Technology(IJAREST),
ISSN(O):2393-9877, ISSN(P): 2394-2444,
Volume 2, Issue 7, July – 2015, Impact Factor: 2.125

# REDUCING FRICTION LOSSES IN (PRA) SYSTEM OF AN I.C ENGINE.

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***Abstract*** *The tribological scope is focus upon the major frictional components of the automobile engine e.g.: piston ring assembly (PRA). The current position surrounding the modeling of this component will be reviewed and future possibilities identified. The frictional losses are in the PRA vary from 45% to 55% of total frictional losses. To reduce these frictional losses, various parametric approaches are made particularly at design stage and at experimental level. PRA friction is very complex phenomena under dynamic condition. Proper lubrication and selection of material pair also contributes to PRA friction. The theoretical model for PRA friction is being developed by considering different variables. These models are developing either theoretically or experimentally. The models are for specific PRA system with different capacity.*

*The friction force between piston ring and cylinder liner is measured on available an experimental setup-motored driven test ring for single cylinder 150cc piston-cylinder assembly.Graps are plotted between engine speeds and crank angle v/s friction force and engine speed.*

***Keywords***- *(P.R.A) system, IC engine, piston ring, friction losses, pulley, electric motor, tachometer.*

## I. INTRODUCTION

The internal combustion engine in particular the fuel that powers it consists of Main component like piston, crankshaft, cylinder block, connecting rod etc. Following fig shows the main engine components of an i.c engine. The popularity of the reciprocating internal combustion engine is due to its performance, reliability and versatility. The spark-ignited engines are widely used in public transportation.

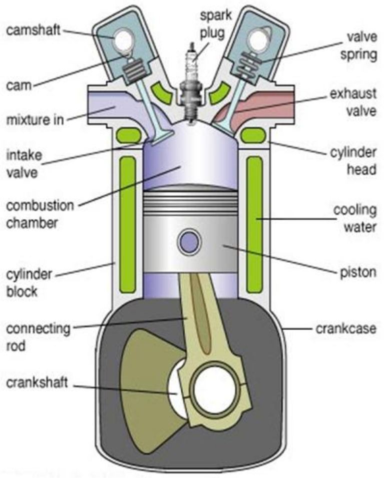



Fig. 1. INTERNAL COMBUTION ENGINE

Piston of an internal combustion engine is the first component of the mechanism converting the chemical energy of the fuel into mechanical work. The heat produced in the combustion of the fuel, a large part of which is conducted to the cylinder liner surface by the piston ring pack, reduces the hardness and wear resistance of the piston and ring materials and causes oxidation and evaporation of the oil on the upper cylinder walls. The piston acts as a seal Between the combustion and the crankcase, and is consequently to gas pressure with strong variations. The gas pressure gradient across the piston is utilized for increasing the contact pressure, and the second, compression ring against the cylinder liner surface, by allowing the cylinder pressure to act on the backside of the rings.

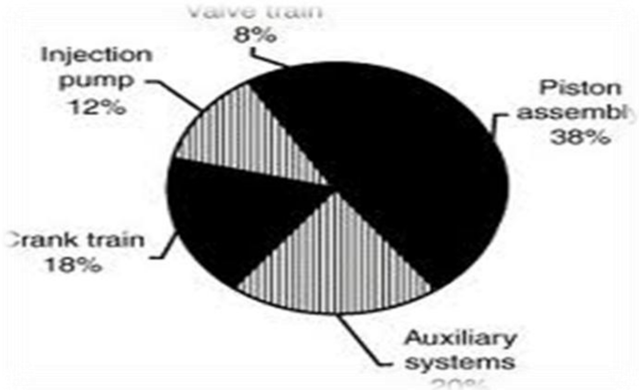
An Engine is defined as a device, which converts energy from one form into another form. A heat engine is a device, which converts heat energy is a device, which converts heat energy into mechanical energy. The heat engine in which this conversion from heat energy to mechanical energy takes place inside the engine is known as an I.C engine. In conversion of energy from one form into another form, there is always some kind of losses of energy. These energy losses are due to the relative motion of various dynamic elements of an engine like crankshaft, connecting rod, rocker arm, push rod, valve mechanism, piston cylinder assembly etc. The power losses are generally in the pumping, exhaust, mechanical etc.The contribution of various dynamic systems is identified by number of scientists and estimated system wise in an I.C. Engine are as under:

| SR.NO | TYPE OF SYSTEM | CONTRIBUTION PERCENTAGE |
|---|---|---|
| 01 | Cylinder-Piston Ring System | 35% TO 45% |
| 02 | Crankshaft Bearing System | 20% TO 30% |
| 03 | Engine Valve System | 7% TO 10% |
| 04 | Engine Auxiliaries | 20% TO 25% |

The fig. It self indicates the major contribution is to of PRA assembly into total friction losses of the engine. So, it is important to understand the mechanism of friction and wear of the PRA of an I.C engine. The main contributing components of PRA friction are compression ring, oil control ring, piston pin. Piston ring width, ring face, ring profile, surface roughness ring tension, ring gap, ring land width, clearance between cylinder liner and piston, liner temperature, and finally the viscosity of lubrication oil are the major design factors over and above material property of the 'pair' in PRA.

## II. FRICTION LOSSES IN AN I.C. ENGINE:

The various friction losses in an I.C. engine are shown in following fig. From fig. it is clear that major friction losses are found are found in PRA system. Only 12% of the available energy in the fuel is available to drive the wheels. Based on fuel consumption data, 10% to 18% reduction in mechanical losses, and the friction losses is the major portion 385 of the energy consumption developed in an engine. The other portions are the auxiliary systems 20%. The major part @50% of friction losses occurs between piston ring and liner assembly (PRA).




## III. PISTON MATERIAL:

The material used for piston is mainly **aluminum alloy**. Aluminum pistons can be either cast or forged. **Cast iron** is also used for piston. In early year cast iron was almost universal material for piston because it processes excellent wearing qualities co-efficient of expansion and general suitability for manufacturing parts the use of aluminum for piston was essential. To obtain equal strength a greater thickness of metal is necessary but some of the advantage of light metal is lost.

Aluminum is inferior to cast iron in strength and wearing qualities and its greater co-efficient of expansion necessities greater clearance in the cylinder to avoid the risk of seizer. The aluminum alloy piston to run at much lower temprature than a cast iron one(200°C to 250°C as compare with 400°C to 450°C)

## THE ORIGINE AND DEVELOPMENT OF PISTON RINGS:

Various form of piston 'packing' which preceded the modern piston ring have been in use for thousands of years. One of the earliest applications was to tie a tuft of feathers to the plunger of a blower used by metal workers. The romance used unshorn sheepskin to seal water pumps and as late as 1700, leather was used as a seal in the newcomer steam engine. In 1785, watt used a rope and tallow packing in his steam engine.

The first metallic packing appeared in the early nineteenth century and most of these were spring backed segmental or multispecies rings.

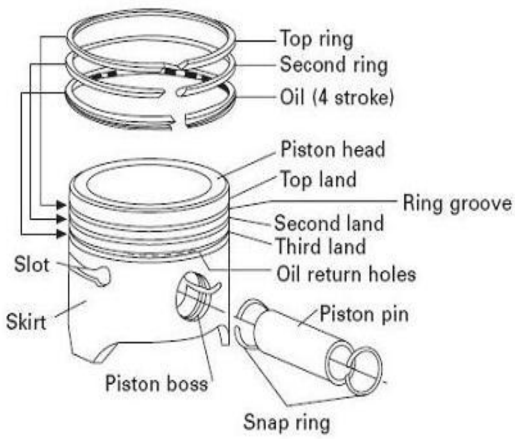



Fig: PISTON

## IV. TYPES OF THE RINGS

THERE ARE TWO TYPES OF PISTON RINGS:

1) **COMPRESSION RINGS**
2) **OIL CONTROL RINGS**

Compression rings seal in the air-fuel mixture as it is compressed and also the combustion pressure as the mixture burns. In two stroke engines, there is no oil ring. Oil ring control scrape off excessive oil from the cylinder wall and return in to the oil pan.

### NEED OF TWO COMPRESSION RINGS:

Usually two compression rings are installed on the piston. During the power stroke the pressure increases as high as 70 kgf/ and would be difficult for a single compression ring to hold this much pressure. If there are two rings this pressure will be divided between two rings. Thus the pressure partly on the upper rings is reduced. The load on the upper ring is reduced. The load on the upper ring is also reduced so that it does not press quite so hard on the cylinder wall. As result wearing and cylinder is also reduced.

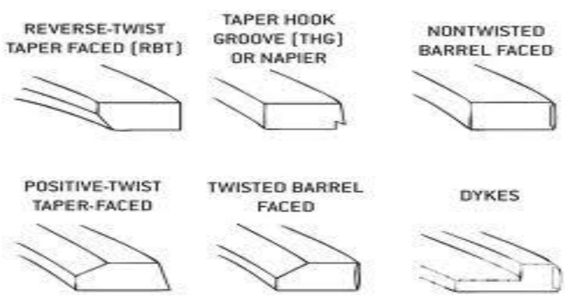



FIG. TYPES OF COMPRESSION RINGS

## NEED OF ONE OIL CONTROLRING:

Usually our piston rings were installed on the long skirt piston of earlier passenger car engine. The lower two rings were oil control rings. But the use of lower hood lines reduced the number of rings to three. Because two compression rings are necessary to withstand the high combustion pressure hence three remains one oil ring. It is quite possible to use one oil control ring because of engineering and manufacturing improvement and the more effective action of the modern oil controlled ring in four stroke engine usually two compression rings are used and oil ring. The outer diameter of the ring is somewhat larger than the cylinder bore and the split joint is open.

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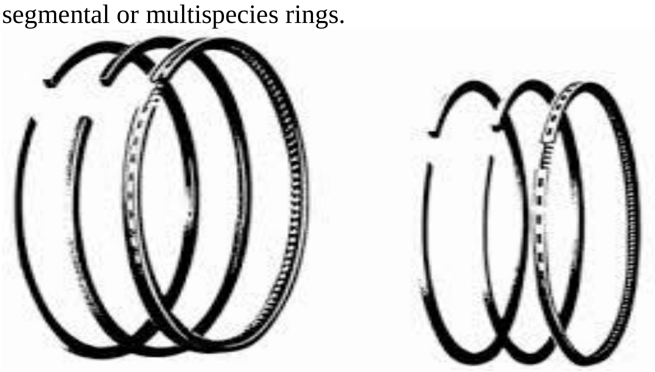

## VI. FRICTION MECHANISM IN PRA:

Different scientists have studied and explained friction phenomenon in PRA different theories and develop mathematical formula either based on experimental result or by simulation of model.

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Explains the PRA mechanism and region of lubrication with the help of Stribeck's diagram as shown i

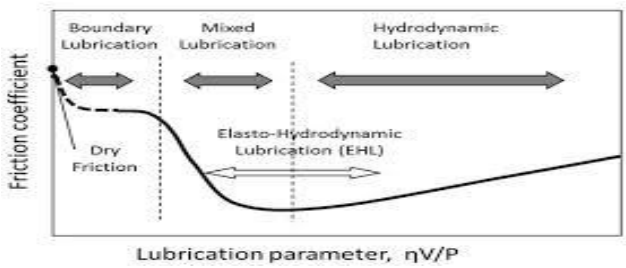



FIG. STRIBECK'S DIAGRAM

The Stribeck's diagram illustrates the variation of friction co-efficient vs. Duty parameter for various regimes of lubrication in different part of the engine.

## VII. OBJECTIVE OF THE WORK:

(1) To measure PRA friction force on test ring.
(2) To study the various methods for measuring friction force and oil film thickness.
(3) To compare the experimental result with theoretical result.
(4) To study the effect of various parameters on PRA friction i.e. piston ring tension, piston ring geometry lubricant viscosity, engine speed and engine capacity.
(5) To analyses various friction losses in I.C. Engine.

## VIII. LUBRICATION SYSTEM:

The 4-stroke automobile vehicle as such in PRA having no specific lubricant is being circulated. Due to crankshaft motion, only the splash lubricating can be possible, but the poor lubrication is found in piston ring and cylinder liner. During the experiment work, we have considered lubricant-15W40. The obtained viscosity values are as under.

| **LUBRICANT** | **DYNAMIC VISCOSITY** (N.sec/m$^2$) at room temp. | **KINEMATIC VISCOSITY** (m$^2$/s) at room temp. |
|---|---|---|
| SAE 15W40 grade | 0.05377 | 60.96 10^-6 |

### TEST PARAMETERS:

1) A 150cc engine system on which the test parameters are considered. First speed variation in the range of 500 to 2000rpm in step of increment of 250rpm.

2) The second test parameter was considered as piston ring geometry. After survey from the market, the piston ring are available with the flat face , we had provided different chamfering angle on both side of the piston rings in the range of 15°.20°and 25° with increment of 5°.

3) All detail of the piston ring geometries are mention in following table.

| **Profile** | **Ring type** | **Angle** |
|---|---|---|
| Flat | **A** | **0** |
| One side chamfer | **B** | **15** |
| Both side chamfer | **C** | **20** |

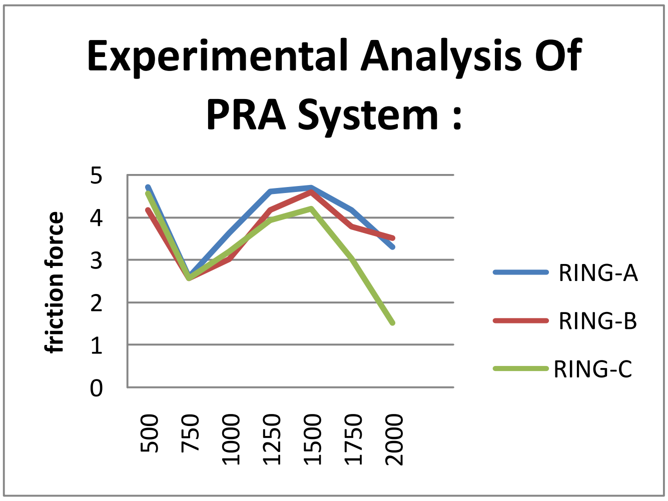
## IX. RESULTS AND DISCUSSION:

Experimental set-up to determine the friction force and co-efficient of friction piston ring and cylinder liner obtain using lubricant at all available speed.

**Experimental Analysis:**

- **Friction force vs. RPM: (with lubrication-150cc) FOR 15W40 OIL.**

| RPM | RING-A | RING-B | RING-C |
|---|---|---|---|
| 500 | 4.714 | 4.175 | 4.577 |
| 750 | 2.600 | 2.574 | 2.573 |
| 1000 | 3.640 | 3.027 | 3.216 |
| 1250 | 4.615 | 4.186 | 3.949 |
| 1500 | 4.693 | 4.600 | 4.219 |
| 1750 | 4.18 | 3.793 | 3.044 |
| 2000 | 3.31 | 3.520 | 1.528 |




## XI. RESULTS AND CONCLUSION

In This Project Work, We Have Considered To Measure Friction Force Of A Single Cylinder I.C. Engine (150cc) By Varying Engine Speed And Lubricating Oils. The Following Conclusions Were Derived After Performance Of Engine.
1.) The System Was Affected By Vibration During Running Condition; Adopting Suitable Design Of Frame Structure Should Minimize The Vibration.
2.) At Higher Engine Speeds (RPM) Friction Loss Due To Vibration Was Ignored.
3.) Proper Installation Of Piston Ring Was Important To Reduce Friction.
4.) Friction Force Increase with Increasing Engine Speed.
5.) Normal Piston Ring Generally Offered High Friction Force Value.
6.) Proper Selection Of Material Plays Important Role For Smooth Running Of System And O Minimize Friction Force.
7.) The Controlled Flow Of Lubricating Oil Imparts Important Role To Minimize Friction Force.
8.) The Friction Force Value Also Depends On The Stiffness Of Deflection Springs.
9.) The FF Value Was Comparatively Higher For DRY Condition Due To Absence Of Lubricant.
10.) The Nature of Curve Is as per Well-Know Stribeck's Curve.
11.) Initially The FF Value Is Higher Due To Boundary Lubrication And Then Suddenly Reduced Due To Mixed And Hydrodynamic Lubrication.
12.) At Higher Engine Speeds, the FF Increase.

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