ENGINE OIL CONSUMPTION-REVIEW TO CONTROL THE AUTOMOTIVE EXHAUST EMISSION

PORAG KALITA*

ABSTRACT

Blow by means, “Leakage of gases from the engine cylinder into the crank-case because of unsatisfactory action of the position rings”.

An engine is a prime mover with the help of which heat energy obtained from the fuel, is converted into mechanical energy. Internal Combustion Engine (I.C.) that engine which combustion takes place outside the engine. Piston means that the reciprocating part of the engine is directly moved by the exploding fuel air mixture. However, petrol supplied to the engine should be completely vaporized before actual combustion and it is possible when it is broken up to a fine spray, i.e. atomized and atomization process takes place normally in the inlet manifold. The complete combustion of fuel requires 15 parts by weight of air to mix with 1 part by weight of petrol is called air fuel ratio.

Piston rings are made of a high grade of cast iron, centrifugal cast and precision ground. Piston blow-by occurs when the cylinder wears down owing to high temperature. The rings are not able to seal both the compression and combustion pressure. Such a leakage past the piston to combustion chamber is known as piston blow-by. Oil and gases get past the piston.

KEYWORDS: Crankcase Ventilation, Combustion, Excessive Blow By, Engine Oil Consumption Green Chemistry.

INTRODUCTION

A piston is cylindrical in shape and forms the movable portion of the combustion chamber.
The gas pressure acts on the head of the piston or crown. The force due to this pressure is transmitted to the connecting rod helps to change revolving one at the crankshaft.

THE MAIN FUNCTION OF PISTON

- It helps to transmit the forces due to explosion to the crankshaft.
- It serves as a movable gas tight plug to keep the gases inside the cylinder.
- It acts as a carrier for piston rings and rings are sealing the piston in the cylinder.
- It transmits the force of explosion to the connecting rod, etc.

Piston rings are made of a high grade of cast iron and precision ground. This gives good elastic properties and minimizes ring vibration. In automobiles there are two types available, i.e. Compression and Oil rings.

Compression Rings the piston rings placed in the upper part of a piston, to seal against loss of compression pressure and against blowing.

Oil rings, it is a simple device commonly used to feed oil to a journal bearing. The commonly adopted materials for the piston are cast iron and aluminum. The chief advantages of aluminum piston are the low thickness of the head \( t \), which is given as example:

\[
t = D \frac{3p}{\sqrt{16f}}
\]

Where, \( p \) = maximum combustion pressure,

\( D \) = cylinder diameter,

\( f \) = permissible stress in tension.

The following empirical formula can also used for the calculation of thickness of piston head:

\[
T = 0.032 + 1.5 \text{ mm}
\]

The thickness of piston \( t \) under rings is to be taken equal to the thickness of piston head and decreases towards the end of piston down to 0.25 \( t \), in order to make the piston lighters.

In generally, piston rings i.e. top most ring is placed at a distance equal to the thickness at a distance equal to the thickness of the piston head and the width of lands in between the axial thicknesses of ring. The length of piston is taken from 1.25 \( D \) to 1.75 \( D \).

LITERATURE REVIEW

We know that the piston looks like a bucket, which carries rings at the upper part to provide a good seal between the cylinder walls. Inside the open end is made with it through the gudgeon pin. The lower part ring groves are known as skirt which provides a bearing and guiding surface in contact with the cylinder wall. The top the piston is called Head or Crown. The piston made of cast iron or all minimum alloy and piston can be divided into the following two classes:
Solid skirt pistons, these pistons are used in compression ignition (Diesel) engines or heavy petrol engine. This design can take up the heavy loads or thrusts due to angularity of connecting rod. In modern engines use slipper Piston because of the reasons:

- Increased area of contact at thrust faces,
- Compact engines size,
- Lesser piston weight and hence inertia load, etc.

Split skirt piston is used scooter and mopeds pistons are of split skirt type. The engines are at the range of 2.5 Bhp to 9.5 Bhp at 5500 rpm. Piston ovality may measured by the help of external micrometer or venire caliper. Measuring the piston, difference between the major and minor diameters by the micrometer or venire caliper to take the correct reading. Before, measuring the piston has to clean first and meter to check the zero mark at difference between thrust side and non-thrust side is called ovality.
**Figure 5. Split skirt piston**

**Figure 6. Ovality piston measuring procedure**

- **External micrometer reading:**
  - Reading non thrust side: 79.60
  - Reading thrust side: 79.80
- **Difference:** (79.80 - 79.60) = 0.20.
- **Venire caliper reading:**
  - Non thrust side reading: 79.65
  - Thrust side reading: 79.65
  - Difference: 79.82 - 79.65 = 0.17

**METHODOLOGY**

- **Aim:** Excessive blow by and high engine consumption (4 liters for 600 kms):
  - Engine No: xxxx xxxx xxxx
  - Chassis No: xxxx xxxx xxxx
  - Kms: xxxxxx

- **Observation:**
  - **Water Level:**
    - Found OK.
  - **Fen belt tension:**
    - Found OK.
  - **Temperature of cooling system:**
    - Found 80°C
  - **Engine oil per at idling speed:**
    - 4 bar.
  - **Engine oil per at maximum speed:**
    - 7.5 bar
  - **Cylinder head bolt:**
    - Found tight within specific limit.
  - **Inspection Sheet:**
    - 7.5 bar
### Piston Rings Inspection Sheet

<table>
<thead>
<tr>
<th>Piston Ring No</th>
<th>Piston Ring Butt Clearance (mm)</th>
<th>Piston No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>0.130</td>
<td>0.135</td>
</tr>
<tr>
<td>2</td>
<td>0.100</td>
<td>0.104</td>
</tr>
<tr>
<td>3</td>
<td>0.082</td>
<td>0.085</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(N.B. Check butt clearance at unworn piston of Cylinder in bore (bottom))

### Piston Ring Lateral Clearance (mm)

<table>
<thead>
<tr>
<th>Piston No</th>
<th>Piston Ring Lateral Clearance (mm)</th>
<th>Piston No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1.</td>
<td>0.015</td>
<td>0.016</td>
</tr>
<tr>
<td>2.</td>
<td>0.025</td>
<td>0.026</td>
</tr>
<tr>
<td>3.</td>
<td>0.015</td>
<td>0.016</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
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<tr>
<td>5.</td>
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<td>6.</td>
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</tbody>
</table>

(N.B. Piston rings and grooves should be properly cleaned of carbon and other deposit).

**Conclusion/Recommendation:**
Cylinder bore No. 1, 2, 3, 5, and 6 found main line crack.
RESULT AND METHODOLOGY

Automobile piston rings have compression rings for four stroke engines and the radial thickness of the ring can be calculated by,

\[ t_r = D \frac{s_{pw}}{f_t} \]

Where,

- \( P_w \) = radial wall pressure (0.3 to 0.4 Kg/cm²)
- \( f_t \) = permissible stress for piston ring (850 to 1100 kg/cm²)

Axial thickness of the ring is taken 0.7 \( t_r \), to \( t_r \).

However, piston rings are made of a high grade of cast iron and chromium plate rings are used with ordinary cast iron cylinders. Inserted at the top piston ring groove, they prevent scuffing corrosion and bore wear. The bedding down period is normally 1500 kms for a new vehicle. The chromium plated molybdenum coated rings avoid scuffing during running in period.

Compression rings in the first grooves from the piston head and these rings effectively seal the gas pressure and transfer excess heat to the cylinder. The internal step in the ring helps to twist the ring a little during the power stroke. Such twisting action creates high pressure on the cylinder wall and the piston groove. The combustion gases are effectively sealed and excess oil does not enter the combustion chamber. Piston blow-by occurs when the cylinder wears down owing to high temperature. The rings are not able to seal both the compression and combustion pressure. Such a leakage past the piston to combustion chamber is known as piston blow-by. Oil and gases get past the piston, the following figure:
For example, Design a cast iron piston for I.C. Engine having 10 cm as cylinder bore. The maximum explosion pressure may be taken as 40 kg/cm².

Solution: The thickness of piston head is calculated from the equation:

\[ t = D \sqrt[3]{\frac{3p}{16f}} \]

the permissible stress fore cast iron piston is taken 385 kg/cm²,

\[ \therefore t = 10 \sqrt[3]{\frac{3 \times 40}{16 \times 385}} \]

= 1.4 cm

Radial thickness of ring:

\[ = D \sqrt{\frac{3pw}{ft}} \]

Taking, \( P_w = 0.4 \) kg/cm² and \( f_t = 1000 \) kg/cm²,

\[ t_r = 10 \times \sqrt{\frac{3 \times 0.4}{1000}} = 0.35 \) cm,

Axial thickness of ring = 0.3 cm (taken),

Distance of first ring from top of piston = 1.5 cm,

Width of piston land between rings,

\[ = \frac{3}{4} \times \text{axial thickness} \]

\[ = \frac{3}{4} \times 0.3 = 0.225 \) cm

Take, \( = 0.225 \) cm,

Length of piston = 1.5 \( D = 15 \) cm,

Contd...P/5

Length of skirt = 15-1.5-4 \times 0.25 -5 \times 0.3

= 11 \) cm.

Adopted 5 compression rings and 1 oil ring.

The centre of piston pin above the centre of the skirt equals \( 0.02 \) \( D = 0.02 \times 10 = 0.2 \) cm hence the distance from the bottom of the piston to the axis of gudgeon pin is \( \frac{11}{2} + 0.2 = 5.7 \) cm.

Thickness of piston wall below the ring = 1.4 cm,

Thickness of piston wall at open end = 0.6 cm,

Gudgeon pin:

Bearing area provided by skirt = \( 11 \times 10 \)

= 110 cm²,

Maximum gas load = \( \frac{\pi}{4} (10)^2 \times 40 = 3.140 \) kg.

Let the length of the pin in the connecting rod be,

\( 0.45D = 0.45 \times 10 = 4.5 \) cm,

Let us assume the permissible bearing stress as 200 kg/cm²

If \( d \) be the outside diameter of the pin,

\[ d \times 0.45 \times 200 = 3.140 \]

\[ \therefore d = 3.5 \) cm
The pin is assumed to a beam uniformly loaded for a distance 4.5 cm and supported at the centers of the bosses. The maximum bending moment,

\[ \frac{p \times d}{8} = \frac{3.140 \times 10}{8} = 3.925 \text{ kg.cm} \]

\[ \therefore \frac{\pi}{32} (3.5)^2 f = 3.925 \]

\[ \therefore f = 935 \text{ kg/cm}^2 \text{ which is within limits,} \]

Let us consider a hollow gudgeon pin of 4.25 cm diameter and 3.5 cm inside diameter.

Modulus of section,

\[ = \frac{\pi}{2} \left[ (4.25)^2 - (3.5)^2 \right] = 4.1 \text{ cm}^2 \]

Bending stress \[ \frac{3.925}{4.1} = 960 \text{ kg/cm}^2 \]

Thus making the gudgeon pin hollow, the piston can be made lighter.

**CONCLUSION**

Data has been collected as view points on the subject of, “What does blow by gas in a diesel Engine?” and the following:

- Blow by; it can increase due to various factors like oversize bore, bad ring profile, ring opposite direction, more end gap in rings and late opening of exhaust valve.
- For the new engine high blow by which reduces considerably with running as the high points of bore honing wears away and thus improving piston rings sealing.

**ADDITIONAL APPROACHES**

Positive Crankcase Ventilation (PCV): Unvaporized fuel vapour, water vapour, sulphuric acid and sludge cause corrosion of Components parts.

Crankcase ventilation is employed to reduce and to prevent a pressure build up in the crankcase. A constant stream of air is passed through the crankcase which carries with it most of the harmful vapors to the atmosphere.
Positive Crankcase Ventilation method is directly allow the unborn vapours to be drawn from the crankcase to the intake manifold, if partial vacuum create in the intake manifold during suction stroke to the piston. In between outlet crankcase tube and the manifold control vacuum in the intake manifold, a regular valve (PCV valve) is located. At low speeds, it restricts the flow of the vapours into the intake manifold and thus preventive dilution of air fuel mixture.

CONCLUSION

Compression rings of some engines are chromium plated to increase their life. There are different designs of ring joints such a butt, angled, lapped or a sealed type. Some compression rings contain vertical lines at shorter distances at the inside wall.

As per study, it was found that the maximum combustion is about 70 kg/cm² and as such, one compression ring is inadequate. Two compression rings and oil ring are generally used. Better material and design of oil rings enables the reduction of their number to one only.

ACKNOWLEDGEMENT

I would like to thanks my son Mr. Alakesh Kalita, Student of B. Tech in Engineering Physics (7th Semester-Dual) in Indian Institute of Space Science & Technology, Government of Space, Kerala for the valuable cooperation.

REFERENCES

DEFINITION/ACRONYMS/ABBREVIATION

DEFINITION

Compression Ratio: It is the ratio of the volumes of the combustion chamber: When the piston is at the bottom of its travel and when the piston is at the top of its travel.

Compression Ratio

\[
\frac{\text{Sweapt Volume} + \text{Clerance Volume}}{\text{Clerance Volume}}
\]

Throttle valve: The butterfly valve of a petrol engine.

Timing: Ignition timing the correct timing of the spark relative to the engine rotation or valve timing, the opening and closing of the valves relative to the engine rotation.

Idle: Engine running without a load at the lowest speed possible.

Volumetric Efficiency: Ratio of the volume discharged from a pump to the piston displacement of the pump, called Volumetric Efficiency.

ACRONYMS

Throttle: A valve in the carburetor that permits the driver to vary the amount of air-fuel mixture entering the engine, thus controlling the engine speed.

ABBREVIATION

CARB = California Air Resource Board.
CCR = California Code of Regulations.
DTC = Diagnostic Trouble Code.
FTP = Federal test Procedure.
TPS = Throttle Position Sender.
I.C. ENGINE = Internal Combustion Engine.
MIL = Malfunction Indicator Light.
MAP = Manifold Air Pressure.