REDUCTION OF LUBE OIL CONSUMPTION AND BLOWBY IN A DIESEL ENGINE BY STUDY AND DEVELOPMENT OF PISTON RING PARAMETERS.

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Abstract: Advances in modern engine development have become more and more challenging due to the intense increase of mechanical and thermal loads interacting in the combustion chamber as a result of higher power requirement for flawless functioning of piston rings especially with blowy and lube oil consumption reduction technology. In internal combustion engines, piston rings play a vital role in the performance and endurance of the engine by sealing the combustion chamber, controlling the lubricating oil as well as working as heat flow path from the piston into the cylinder.
Blow by in a diesel engine is the amount of compressed air/fuel mixture in the combustion chamber leaking past the piston, piston rings and entering the crankcase. Blow by is a drawback as it lessens engine power. All diesel engines have some degree of blowy due to wear of contact surfaces in piston rings assembly, which cannot be avoided as long as movement exists between the two surfaces in interaction. At the same time due to more wear, the consumption of lubricating oil will also increases. The central objective of this work is to reduce lube oil consumption and blowy in a diesel engine. The two parameters considered are face profile and Coating material of piston rings. Engine testing is done to see the effect of lube oil consumption and blowy by implementing the changes made for piston rings. The results are obtained in the form of reduced LOC and blowy.

Keywords: Lube oil consumption, Blow by.

Introduction: In internal combustion engines, piston rings play an important role in the performance and endurance of the engine. Piston rings should have optimum sealing function, heat flow passage from the piston into the cylinder and low friction. In internal combustion engine, a major friction loss occurs during piston rings working and may count up to for 17% of total energy loss. Due to this friction the wear on contact surfaces is seen.
Wear of a cylinder liner results in the increase of clearances between the clearances in the ring-end gaps. This causes increase of gas leakage to the crankcase from the combustion chamber, this phenomena is called as Blow-by. Decrease of combustion chamber tightness causes drop of engine performance and results in increase of fuel consumption and emission of toxic exhaust gasses and affects the cold start properties of the engine. Excessive increase of blow-by and oil consumption can be identified by proper examination of the engine is usually identified with the wear of the whole engine. Therefore, the durability of whole engine depends on the wear of piston rings.
Wear is result of several natural conditions like the movement of the surface relative speed of the slide, type of material used , surface roughness, hardness, relative humidity, as well as lubrication, among these factors speed of the slide and a normal load are considered important factors. The natural wear is unavoidable but can be controlled by proper mechanical design, proper setting the arbitrator of the equipment and carry out preventive maintenance periodically. The piston top compression ring plays a vital role in an efficient engine running as it prevents the combustion gas leakage and allows heat dissipation but contributes towards mechanical friction. As the

piston is always in an unsteady state, the frictional behavior of the top piston ring is very complex.

As there will be variation in oil supply to the piston rings throughout the engine cycle, each ring comes across different modes of lubrication while traveling along the liners. The sufficient amount of oil on the liner to support a load ensures hydrodynamic lubrication conditions. Otherwise the load from the ring on the liner is supported by contact between the asperities on the contact surfaces and boundary lubrication condition is seen.

II. Problem Identification

The piston rings used in an engine have the task of acting as a sealing for the combustion chamber, thus preventing the combustion gases from passing into the crankcase which results in improved engine performance. Piston rings also have the task of providing low wear and friction all at the same time. In the existing system more wear is observed on the contact surfaces of piston, piston rings and liner, due to which Lube Oil Consumption and blow-by in the is increasing. Because of this increase in LOC and blow-by, the efficiency of engine is being restrained.

III. Problem definition

On study of diesel engine the major observation was that the LOC and blow-by are very high. The major reason is wear on contact surfaces of piston rings and liner assembly resulting in less engine efficiency. To overcome the high blowy and LOC, the changes in face profile, mechanical design and coating process parameters are the considered in this work.

IV. Engine tested details of existing piston rings

The engine selected is a four cylinder diesel engine having bore of 91mm, stroke length of 110mm, swept volume 2860cc and compression ratio of 17.5.The lube oil grade is SAE 15W-40.Current measure of LOC and blow by is obtained by running the engine for 300hrs.

Table 1 Tested trail details of blow-by and LOC

Trial	Lube Oil Consumption (LOC) (gram/hr.)	Blow-by (lpm)	
		Minimum	Maximum
Ist	21	25	26
IInd	22	26	28
IIIrd	21	25	27
Average	**21.33**	**25.33**	**27**

Table 2 Top ring wear details

SL.NO	Parameters	Wear (µm)			
		I cylinder	II cylinder	III cylinder	IV cylinder
1	Radial thickness	18	15	14	16
2	Axial thickness	7	5	6	7
3	Closed gap	4	4	6	5
4	Chromium thickness	10	9	13	10

Table 3 Mid ring wear details

SL.NO	Parameters	Wear (µm)			
		I cylinder	II cylinder	III cylinder	IV cylinder
1	Radial thickness	9	12	11	8
2	Axial thickness	3	4	7	6
3	Closed gap	5	3	5	4

Table 4 Oil ring wear details

SL.NO	Parameters	Wear (µm)			
		I cylinder	II cylinder	III cylinder	IV cylinder
1	Radial thickness	11	9	9	10
2	Axial thickness	4	5	6	5
3	Closed gap	3	3	5	4
4	Chromium thickness	9	8	7	9

The wear of oil ring is less when compared to top and mid rings which is shown in Table, this is because more load is taken by the top and mid rings than the oil ring and the temperature generated on top of the piston crown is majorly shared by top and mid ring.

V. Piston rings modification details:

In the existing system due to more wear on contact surfaces of piston, piston rings and liners, high blow-by and LOC is obtained. To overcome high blow-by and LOC, Chrome ceramic coated barrelled face top ring and new conformable oil ring with steep land has been selected in the present work.

Table 5 Piston rings modification

Sl.No	Rings	Existing	Modification
1	Top ring	Rectangular faced chromium coated ring	Barreled faced chrome ceramic coated ring
2	Mid ring	Taper faced ring	Taper faced ring
3	Oil ring	Conformable oil ring	New conformable oil ring with steep on face land

Top ring modification:

Barrelled face profile

For rectangular faced profile the contact area with lubricating oil is less. During different strokes of piston in cylindrical liner and piston rings movement in the piston groove, the rectangular piston rings take on a ball shape on their sliding surface during running, during which more wear is seen at that time of running. So the face profile is made slightly curve that is barrelled shape, by this wear during running can be reduced and also more pressure of piston ring on liner surface can achieved which results in improvement of the gas and oil sealing effect. Another affect will be that, the contact area increases due to which proper lubrication and low consumption of lube oil is achieved.

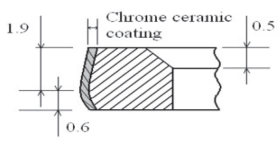

Figure 1. Cross Sectional view of modification done to Top ring

Oil ring modification:

- Typical piston rings apply equal pressure to the cylinder bore on the down-stroke, and on the upstroke. The modification to the oil ring as stated above provides a well-defined pressure to the cylinder wall on the down-stroke and a significantly lesser effect on the upstroke.
- The pressure during down-stroke more effectively returns the oil that lubricates the cylinder to the oil pan .This is very effective in pulling oil away from the combustion chamber and in reducing oil consumption. It also results in improved ring tension and reduced friction.
- Unlike conventional oil rings, the modified also provides consistent low oil consumption over the life of the engine by reducing carbon build-up on critical parts of the piston.

VI. Engine tested details of modified piston rings

Table 6 Tested trail details for blow-by and LOC

Trial	Lube Oil Consumption (LOC) (gram/hr.)	Blow-by (lpm)	
		Minimum	Maximum
Ist	7.1	13	18
IInd	7.4	12	17
IIIrd	7.3	13	18
Average	**7.27**	**12.67**	**17.67**

After implanting the modification work through engine testing, the blow-by and LOC obtained as shown in Table. It is clearly found that both blow-by and LOC are reduced when compared to existing results.

Table 7 Top ring wear details

SL.NO	Parameters	Wear (µm)			
		I cylinder	II cylinder	III cylinder	IV cylinder
1	Radial thickness	14	13	12	13
2	Axial thickness	6	5	4	5
3	Closed gap	5	6	5	6
4	Chromium thickness	9	7	8	6

Table shows the wear of top rings after implementation. The wear is found in the mid region of ring. Since curve surface is extended in mid region, therefore more wear in this area.

Table 8 Mid ring wear details

SL.NO	Parameters	Wear (µm)			
		I cylinder	II cylinder	III cylinder	IV cylinder
1	Radial thickness	5	7	6	5
2	Axial thickness	3	3	2	4
3	Closed gap	5	3	3	4

Mid ring is tested with modified top ring and oil ring, the mid ring wear values are shown in the above Table .when compared to existing mid ring wear and wear is found to be reduced.

Table 9 Oil ring wear details

SL.NO	Parameters	Wear (µm)			
		I cylinder	II cylinder	III cylinder	IV cylinder
1	Radial thickness	9	8	9	10
2	Axial thickness	3	4	3	2
3	Closed gap	4	3	3	4
4	Chromium thickness	5	4	6	4

By using steep surface on oil ring face, the effect of oil scraping is increased and resulted in reduced LOC. There is wear found on oil ring but it is less compared to existing oil ring wear.

VII. Conclusion

In this experimental study modifications were made to the top and oil rings. The reduction in rings wear was achieved and there by blowy and lube oil consumption was reduced. The use of chrome ceramic coating reduced wear on contact surfaces. More ring pressure on liner surface was achieved by designing the barreled face profile to the top ring, thereby sealing function is improved at the top area of the piston with reduction in blow-by .The new oil ring with steep surface on contact face will effectively returns the oil that lubricates the cylinder to the oil pan, due to which reduction of oil consumption is reduced.

The results after modification work to the top ring and oil ring through engine testing are:

- The leakage of combustion gas (blow-by) is reduced from 27 to 17.67 lpm.
- The oil consumption is reduced from 21.33 to 7.27 gm.

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