



EFFECT OF LUBRICANT VISCOSITY ON PERFORMANCE OF CI ENGINE

Hardik Gevariya

P.G. Student (M.E.Thermal), Mechanical Engineering Department, LDRP-ITR, Gandhinagar, Gujarat.

Kaushal Bhavsar

Asst. Professor, Mechanical Engineering Department, LDRP-ITR, Gandhinagar, Gujarat.

ABSTRACT

Engine operating condition such as speed, torque and oil viscosity play a vital role in fuel economy for CI engine. Oil viscosity, oil temperature and type of friction modifiers used also play vital role in fuel economy. This research paper investigates the effect of speed, torque and lubricant viscosity on friction power. Three factors: speed, torque and lubricant viscosity were chosen as variables with each factor having two levels (low and high). Minitab 15 was used for investigating the most significant factors among these. The results show that at high speed, FP can be reduced as torque increase. At low speed, there is no significant change in FP with change of torque. At low torque, FP increases as speed increase. Low viscosity engine oil can improve a vehicle's fuel economy by decreasing the friction between the engine components.

KEYWORDS : Fuel economy, Oil viscosity, Friction power, Torque.

I. INTRODUCTION

Engine oil is necessary to decrease the friction and wear of the relative contact between moving parts in the engine. However, when high viscosity engine oil is used, frictional loss due to the high viscosity is inevitable. To decrease these frictional losses, much research has focused on using low viscosity engine oil to improve fuel economy.

Engine lubricant becomes one of the important design parameters. The critical engine components resulting in the majority of engine friction are; piston ring/liner assembly, bearing system, valve train system, and engine powered auxiliaries (such as the water pump, oil pump and fuel pump). It is generally accepted that both the piston assembly and bearings are operating predominantly in the hydrodynamic lubrication regime, whereas the valve train system is operating in the mixed/boundary lubrication regime.

II. LITERATURE REVIEW

H.G. Kim et.al. [1] Analyzed the influence engine oil viscosity has on oil seal friction and wear in order to improve fuel economy. Friction torque tests show engine oil seal friction torque increases with rotational shaft speed. The smallest friction torque value was observed with 5W-20 oil. The friction torque was half as large when the engine oil temperature was 90°C and the rotational shaft speed was 1000 rpm. Also, friction torque depended sensitively on the T.I.R. at high temperature and rotational speeds.

The influence of pressure and temperature on the oil viscosity has to be taken into consideration. This can be accomplished only within the TEHD algorithm. Rodermund formula proves to be applicable there. However, for different oils it is difficult to obtain reliable coefficients. Using only pressure-dependent viscosity (EHD calculation) is not always justified because it accounts only for the viscosity increase due to pressure rise without considering the viscosity decrease due to temperature rise. [2]

Effect of engine oil viscosity on engine friction and fuel consumption was studied by many researchers. Radimko Gligorijevic et.al. [3] Describes the effect of lubricants of different viscosity grades on the fully warmed up engine friction power loss (W) - which includes piston ring assembly (P), Valve train (V) and bearing (B). Total friction power losses are low for the less viscosity grade oil and the power loss through piston ring assembly reduces significantly when lower viscosity grade lubricants was used.

Taylor [4] has reported that the friction losses in the piston assembly vary as $\sqrt{\omega}$, where ω is the lubricant dynamic viscosity (mPa.s) and ω is the angular speed (rad/s) of the engine.

For journal bearings, under light loaded conditions, petroff equation [5] suggested that the friction power loss would vary linearly with lubricant viscosity.

For a heavily loaded bearing, Taylor [6] has shown that the friction power loss would vary as 0.75 .

Effects of engine oil viscosity on fuel consumption were studied by Taylor and it has been reported that low viscosity oil results in low fuel consumption [7].

A similar study for assessing the effect of engine lubricant rheology on piston skirt friction was undertaken by A. Kellaci et. al. [8] by developing a piston skirt lubrication model based on a modified Reynolds equation. It was concluded that oil viscosity directly affects friction in the hydrodynamic regime. The best design involves obtaining a system that operates principally in a hydrodynamic lubrication regime using low viscosity oil.

III. EXPERIMENTAL INVESTIGATION

Three factors were chosen each having two levels for investigation of CI engine. Two speed, 1000 rpm and 2000 rpm were selected for this investigation. Two torque values 50 Nm and 350 Nm were selected. Two different lubricant (engine oil) were selected -type A having low viscosity and type B having high viscosity.

TABLE - 1
DOE (RESPONSE-F.P.)

| Run No | Speed | Torque | Lubricant Type | F.P. (response) |
|--------|-------|--------|----------------|-----------------|
| | (Rpm) | Nm | A/B | (kW) |
| 1 | 1000 | 50 | A | 2.2 |
| 2 | 1000 | 350 | A | 2.65 |
| 3 | 2000 | 50 | A | 10.63 |
| 4 | 2000 | 350 | A | 2.97 |
| 5 | 1000 | 50 | B | 2.17 |
| 6 | 1000 | 350 | B | 2.24 |
| 7 | 2000 | 50 | B | 12.74 |
| 8 | 2000 | 350 | B | 48 |
| 9 | 1000 | 50 | A | 2.17 |
| 10 | 1000 | 350 | A | 2.27 |
| 11 | 2000 | 50 | A | 10.15 |
| 12 | 2000 | 350 | A | 2.61 |
| 13 | 1000 | 50 | B | 1.79 |
| 14 | 1000 | 350 | B | 2.87 |
| 15 | 2000 | 50 | B | 12.19 |
| 16 | 2000 | 350 | B | 2.74 |

IV. DESIGN OF EXPERIMENT

Software MINITAB 15 was used for investigating the most significant factors among three main factors namely speed, torque and engine oil (lubricant) viscosity.

Analysis details:

Confidence level :95%
 Number of replicates :2
 Number of experiments :16
 Alpha :0.05

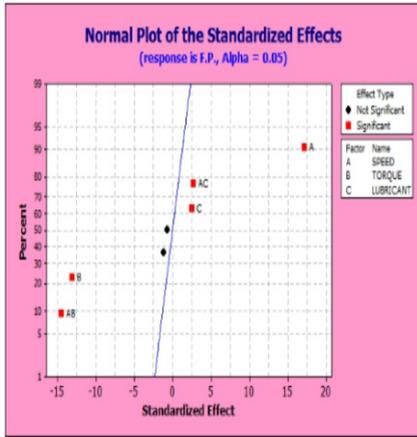


Figure 1: Normal plot (for all factors)

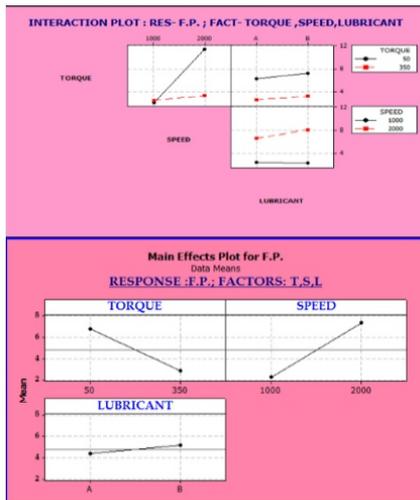


Figure 2: Interaction plot and main effects plot For FP

IV. RESULT AND DISCUSSION:

- At high speed 2000 rpm, when torque increases from 50 Nm to 350 Nm, there is reduction of FP is 3.69 times for lubricant A (check order 3-4 & 11-12) and 3.52 times for lubricant B (check order 7-8 & 15-16). So, average reduction of FP (average of both lubricants) is 3.6 times.
- At low speed 1000 rpm there is no significant change in FP when torque increases from 50 Nm to 350 Nm (for both lubricants).
- At low torque, when speed increases from 1000 rpm to 2000 rpm, FP increases 4.75 times for lubricant A (check order 3-1 & 15-13) and 6.34 for lubricant B (check order 5-7 & 15-13)
- From interaction plot, it is clear that line of torque and speed has different slope. FP is less for low speed and low torque is less than high speed and low torque.
- It is also clear that FP is less for low viscosity grade lubricant when engine is running at high speed (i.e. 2000 rpm). While at low speed for both torque, there is no significant change in FP with change in lubricant grade.
- From main effects plot, slope of is higher than slope of torque and lubricant.
- From normal plot, it is clear that A, B, C, AB and AC are significant

factors, while BC and ABC are not significant factors.

V.CONCLUSIONS

- There is reduction in friction when lower viscous lubricant was used instead of higher viscous lubricant at higher speed of engine.
- Engine friction power increases with the engine lubricant viscosity and speed.
- Engine friction power decreases with the increases in torque.
- Speed is more significant factor compared to torque and lubricant viscosity.
- At high speed, FP can be reduced up to approx. 3.6 times as torque increases from 50 Nm to 350 Nm.
- At low torque, FP increases approx. 5.5 times as speed increases from 1000 rpm to 2000 rpm.

REFERENCES:

- [1] H. G. Kim and S. I. Jean "Effect on friction of engine oil seal with engine oil viscosity" International Journal of Automotive Technology, Vol. 9, No. 5, pp. 601–606 (2008) DOI 10.1007/s12239-008-0071-0
- [2] Analysis of diverse simulation models for combustion engine journal bearings and the influence of oil conditionals Bukovnika, Nicole Dorra, Valdas Caikaa, Wilfried J. Bartz, Bernhard Loibnegger Tribology International 39 (2006) 820–826 www.elsevier.com/locate/triboint
- [3] Radimko Gligorijevic et. al., Contribution of Engine oil to Diesel Exhaust Emission and Friction Reduction, The Annals of University of Galati Fascicle VIII, Tribology 2003 Issn 1221-4590.
- [4] R.I. Taylor et.al, Lubricants & Energy Efficiency: Life-Cycle Analysis, Leeds-Lyon Symposium on Tribology, Sept 2004.
- [5] G.W. Stachowiak & A.W. Bachelor, Engineering Tribology, Elsevier Tribology Series, 24, 1993.
- [6] R.I. Taylor, "Lubrication Tribology & Motorsport", SAE 2002-01-3355.
- [7] R I Taylor, "Engine friction: the influence of lubricant, Rheology", Proc Instn Mech Engrs Vol 211 Part J, 1997.
- [8] A. Kellaci, R. Mazouzi, B. Khelidj, A. Bounif, "The effect of lubricant rheology on piston skirt/cylinder contact for an internal combustion engine", ISSN 1392 - 1207. MECHANIKA. 2010. Nr.1(81).