



A REVIEW OF LUBRICANT VISCOSITY ON ENGINE PERFORMANCE CHARACTERISTICS OF CI ENGINE

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ABSTRACT

Fuel economy is affected, both by fuel and engine lubricant quality. Engine lubricant quality plays a vital role in reduction of fuel consumption by effective reduction of friction between the contact surfaces of engine parts. The principal factors which influence engine friction power are speed, load, and surface topography of engine components, oil viscosity, oil temperature and type of friction modifiers used. This paper reviews the study about the engine operating conditions such as speed, load and engine lubricant viscosity, which affect engine friction power significantly. Three factors: speed, load and oil viscosity were chosen as variables with each factor having two levels. An empirical model was developed based on the selected parameters i.e. speed, load and engine lubricant viscosity for the predicting the distribution of possible outcomes (friction power).

KEYWORDS

fuel consumption, friction power, oil viscosity, friction modifiers.

I. INTRODUCTION:

Economy, Efficiency, Effectiveness and Ecology form the four significant pillars for sustainable growth of a nation. 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 the rings are operating predominantly in the hydrodynamic lubrication regime, whereas the valve train system is operating in the mixed/boundary lubrication regime. It is known fact that hydrodynamic friction is related to the viscosity of engine oil. The new energy conserving engine oils are designed to reduce friction losses from both types of lubrication by tailoring the viscosity characteristics of the base oil and the chemistry of the friction-modifying additives.

The principal factors which influence engine friction power are speed, load, and surface topography of engine components, oil viscosity, oil temperature and type of friction modifiers used. The best way forward for both new and old vehicles is to reduce existing friction losses inside an engine-improve the lubrication of the moving elements. Automotive engine lubricant quality plays a very important role in improving the fuel economy and reducing the vehicle exhaust emissions. Fuel efficient engine lubricant reduces the friction between the contact surfaces of critical engine parts, which leads to reduction of fuel energy utilized for overcoming the friction, hence conserving the fuel. The need for fuel efficient automotive lubricant for the next generation vehicle is felt due to rise in the crude prices. It is interesting to note that significant savings can be achieved by improving the vehicle mileage by reducing the engine friction through engine lubricant technology. Therefore engine lubricant becomes one of the important design parameters. The critical components resulting in the majority of engine friction are; piston ring (liner assembly), bearing system, valve train system, and engine powered auxiliaries.

II. LITERATURE REVIEW:

Effect of engine oil viscosity on engine friction and fuel consumption was studied by many researchers. Radimko Gligorijevic et al. [1] described the effect of lubricants of different viscosity grades on the fully warm end of engine friction power loss (W) - which includes piston ring assembly (P), Valve train (V) and bearing (B). Total friction power loss is a low for the less viscosity grade oil and the overloss through piston ring assembly reduces significantly when low

viscosity grade lubricants was used.

Taylor [2] has reported that the friction losses in the piston assembly vary as $\sqrt{\eta \omega}$, where η is the lubricant dynamic viscosity (mPa.s) (calculated at a temperature representative of the piston assembly) and ω is the angular speed (rad/s) of the engine.

For journal bearings, under light loaded conditions, petroff equation [3] suggested that the friction power loss would vary linearly with lubricant viscosity.

$$F = 2\pi\eta\omega^2 LR^3/C$$

Where F is the friction power loss (watts), η is the lubricant dynamic viscosity (mPa.s) appropriate to the bearing, ω is the engine's angular speed (rad/s), L is the bearing width (m), R is the bearing radius (m) and C is the bearing radial clearance (m). For a heavily loaded bearing, Taylor [4] has shown that the friction power loss would vary as $\eta^{0.75}$.

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 [5].

Piston rings act as sealing between the liner and the piston by making the oil film during their operation. Furuhama [6] incorporated, for the first time, the squeeze film effect in the Reynolds equation for analyzing hydrodynamic lubrication for piston ring/liner assembly under fully flooded inlet conditions. Wakuri et al. [7] also analyzed the piston ring assembly by considering the cavitation effect and a squeeze film in the Reynolds equation.

Muftiet al. [8] also investigated the influence of engine operating conditions and engine lubricant rheology on the distribution of power loss at the engine component level. The study was carried out under realistic fire conditions using a single cylinder gasoline engine.

Asimilar study for assessing the effect of engine lubricant rheology on piston skirt friction was undertaken by A. Kellac et al. [9] by developing a piston skirt lubrication model based on a modified Reynolds equation. The results of tribological characteristics such as the movement of the piston, the minimum film thickness, the frictional force and friction power loss were studied in relation to the oil viscosity. 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.

OIL STANDARDS:

Several oil standards are used to select an oil which is appropriate for a given application. The most basic is the SAE grade [10]. This classification is reported for oils as SAE XX for single grade oils or SAE XXWXX for multi-grade oils, where XX represents a number. Each number represents a range of viscosity at 0°F if the number is attached to the W, which stands for winter, and 210°F if not.

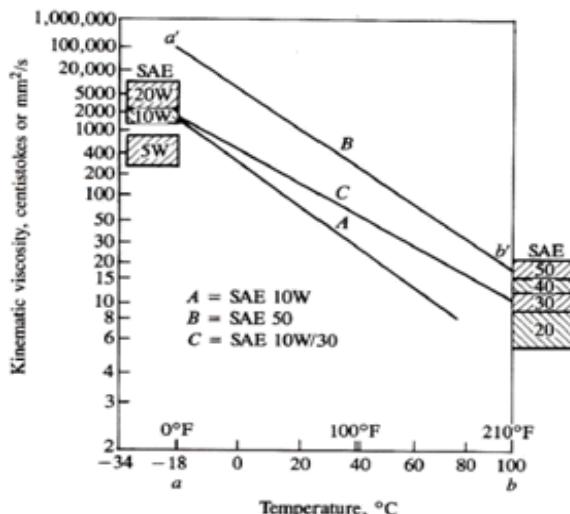


Figure 1: Example viscosity ranges of various SAE grades [10]

III. OBJECTIVES:

The focus of this research work is to study the effect of engine lubricant viscosity on engine friction characteristics and fuel consumption of a diesel engine. Another important objective is to study the factor among speed, load and lubricant viscosity, which affect engine friction power.

IV. EXPECTED EXPERIMENTAL SETUP:

INSTRUMENTS:

- AC dynamometer
- Fuel consumption unit
- Pressure sensor
- Angle encoder
- Speed sensor
- Temperature indicator
- Data acquisition system, etc.

TEST ENGINE:

Four stroke, four cylinder, off-highway, direct injection heavy duty diesel engine.

ENGINE LUBRICANTS:

2 Engine lubricants are selected as follows:

OIL A: SAE 20W-50

OIL B: SAE 10W-30

Both of these engine lubricants are commercially available. Viscosity index is a measure of the variation in kinematic viscosity due to changes in the temperature of a petroleum product. A higher viscosity index indicates a smaller decrease in kinematic viscosity with increasing temperature of the lubricant.

EXPECTED LIST OF PARAMETERS FOR STUDY:

OIL	TORQUE (Nm)	SPEED (RPM)	IMEP	FMEP	BSFC
A	50	1000			
		2000			
	100	1000			
		2000			
	200	1000			
		2000			

	300	1000	FOR STUDY
		2000	
B	50	1000	
		2000	
	100	1000	
		2000	
	200	1000	
		2000	
	300	1000	
		2000	

V.CONCLUSIONS:

We can say that total friction power losses are low for the less viscosity grade oil and the power loss through piston ring assembly reduces significantly when low viscosity grade lubricants was used. Friction power loss would vary linearly with lubricant viscosity. Low viscosity oil results in low fuel consumption. Oil viscosity directly affects friction in the hydrodynamic regime.

VI.FUTURE SCOPE:

Dominant factor among speed, load and lubricant viscosity, which affect engine friction power significantly can be investigated through a DOE approach from experimental data of diesel engine using different grade of oil.

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