Lubricant base stock-surface interaction

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M Forder[1], J Umer[1], N Morris[1*], P King[1], S Howell-Smith[2], H Rahnejat[1]

Wolfson School of Mechanical, Electrical and Manufacturing Engineering, Loughborough University
Loughborough,UK.
Capricorn Automotive, Basingstoke, UK
*Coresponding author, N.J.Morris@lboro.ac.uk

1. Abstract

Superior performance is by far the most desirable aspect of any Spark Ignition (SI) engine that is designed for competition use. This is closely followed by a predictable life expectancy of the unit. A major aspect that can seriously affect both performance and longevity of the unit are the frictional losses and wear of the reciprocating components within the engine. One of the major areas where frictional losses and excessive wear that can reduce performance at an alarming rate is the first compression ring/cylinder liner interface. This investigation uses lateral force microscopy to determine the congruity of matching individual base stock components to liner material/substrate combinations.

2. Introduction

Many aspects of performance, efficiency and reliability of the internal combustion engine filter down from the developments found in the world of Motorsport. A significant number of the features that are found in modern mass-produced engines originate from high performance engines. One of these advancements has been the reduction of friction that is created at the interface of the moving components within the engine. Significant frictional losses occur between the cylinder liner and the piston first compression ring. This is highest in the areas of "bottom dead center" (BDC) and "top dead center" (TDC) where the piston and rings are momentarily stationary during reversal (Uras and Patterson, 1983). SI engines used in Motorsport operate for continued periods at high RPM. The lubricant/liner and lubricant must be capable of dealing with various regimes of lubrication ranging from boundary-mixed to hydrodynamic. By developing an advanced piston liner material, mated to a suitable lubricant, friction and wear can be significantly reduced with the potential for improved performance.

3. Experimental Research

Five different cylinder liner coatings supported by suitable substrate materials were chosen for evaluation. Two fluids that comprise common base stock lubricant formulation and a mixture of these were investigated. The first experimental phase of the project was to define the asperity level friction co-efficient of the combinations of both oil stock and liner material. An Atomic Force Microscope with a fluid cell was used in Lateral force mode to determine the liner material surface topography and frictional properties (Rosen et al, 1996).

4. Results

Figure 1 shows the Friction relative to Load for all five surface samples using one of the base oils. The gradients of the lines in figure 1 indicate the friction coefficient for each combination.

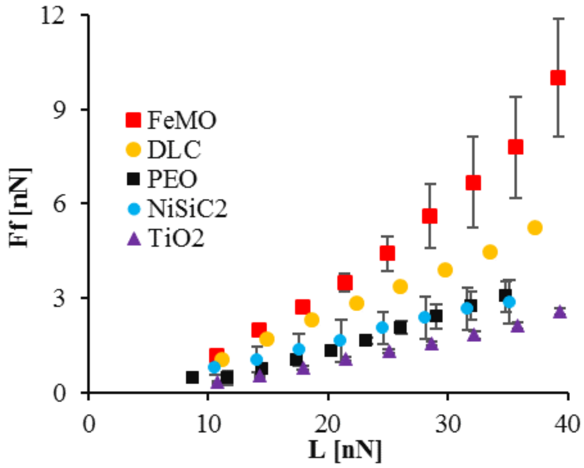

Figure 1: Friction force, F_f, vs Load, L

The results show that the relative frictional performance is dependent on the combination of surface and base stock formulation. The response of the fluid to shear during close confinement is clearly influenced by the surfaces it is bound by. The finding is important as during mixed and boundary regime lubrication in application thin film fluid layers confined between mating asperities could be expected to act in a similar way. Further work will investigate if the findings of the asperity level investigation reported in the current paper can be used in conjunction to contact mechanics theory of rough surfaces to explain component level frictional results from component level tribometers.

5. References

Uras, H.M. and Patterson, D.J., 1983. *Measurement of piston and ring assembly friction instantaneous IMEP method.* SAE Technical Paper. No. 830416.
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