Study of the lubricant-surface system for in-cylinder applications [Abstract]

Study of the lubricant-surface system for in-cylinder applications

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1. Introduction

There is an increasing emphasis put on energy efficiency for road transport, accounting for around the 30% of all the greenhouse emissions [1]. Friction represents a fifth to a quarter of the energy losses in an IC engine, therefore reducing it, is one of the keys objectives, which points to the use of better materials and their optimised combination, such as surfaces, their topography and their interactions with formulated lubricants [2,3].

There is a large volume of reported research on friction reduction using new lubricants, their additives and surfaces. However, a few of these directly address the behaviour of the surface active species with coated surfaces and the approach which can be undertaken to optimise their combination as a system for given applications.

2. Methodology

An analytical approach is presented regarding the study of oil-surface to study the role of friction modifiers bonding to different surfaces and obtain the most suitable combinations, particularly for in-cylinder applications of high performance engines.

The method proposed includes the use of an in-house sliding tribometer, replicating top dead centre reversal conditions for piston compression ring-cylinder liner conjunction (Figure 1). The tribometer is capable of measuring friction in situ. Specimen of measured surface topography and surface morphology are used as counter faces used in high performance engine applications. Various formulated lubricants are used in these tests. The run-in surfaces are examined for friction using atomic force microscopy to ascertain any improvements as the result of use of particular friction modifiers. Furthermore, XPS and an orbitrap Mass Spectrometry and used to ascertain the extent of adsorption of these additives to the investigated surfaces [3].

In order to study which surface active additives in a lubricant results in optimal performance, a quantitative analysis is made, using Orbitrap Mass Spectra [4]. Comparing the acquired results versus the standard will result in the knowledge of the bonding affinity of known additives to the used surfaces.

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Figure 1 Slider rig used in the tests

3. References

[1] M. Nakada, Trends in engine technology and tribology, Tribol. Int. 27 (1) (1994) 3–8

[2] Morris N, Leighton M, et al "Combined numerical and experimental investigation of the micro- hydrodynamics of chevron- based textured patterns influencing conjunctional friction of sliding contacts", Proc IMechE, Part J 2015;229:316-35.

[3] W W F Chong and H Rahnejat 2015 *Surf. Topogr.: Metrol. Prop.* **3** 044002

[4] Da Costa, C.; Reynolds, J. C.; Whitmarsh, S.; Lynch, T.; Creaser, C. S. *Rapid Commun. Mass Spectrom.* **2013**, *27*, 2420–2424.