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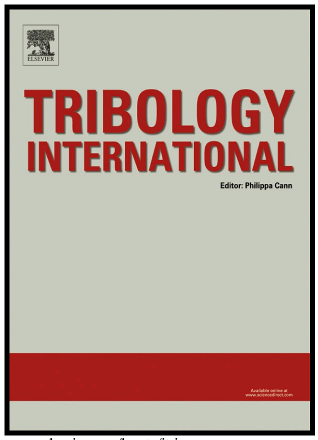

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Friction and wear of a piston ring/cylinder liner at the top dead centre: experimental study and modelling

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ABSTRACT

Wear assessment of critical components subjected to relative sliding is a key factor for the development of advanced materials and surface treatments in automotive industry. Simulation of wear process of the engine components is considered as a good alternative for experimental testing which is costly and time-consuming, but it requires a reliable experimental data for model fine-tuning. Therefore, friction and wear of cylinder liner against a piston ring were experimentally studied in simulated laboratory tests. The parameters which were controlled in these tests included oil type, lubrication starvation, surface finishing and surface coatings. The obtained experimental data were fed into a specific simulation model (AVL Excite-Power Unit). Comparison of experimental and simulated results yielded the error below 5 %.

Keywords: c*ylinder liner; piston ring; boundary friction; modelling; surface coatings*

1. INTRODUCTION

Important advancements in performance of reciprocating combustion engines are linked with tribological topics including improvements in lubrication, optimization of surface geometry of individual contacts, application of advanced materials and coatings, etc. Among various engine components, the piston group, i.e. pistons, rings and cylinder liners, is of special concern in passenger car engines since up to 50% of the total energy is lost due to friction of these components. Optimization of friction and wear characteristics of the piston–liner contact is always a trade-off with many other requirements: efficient heat transfer from the piston to the engine structure, sealing against oil flow into and gas leak from the combustion chamber and other [1-3]. In literature, enhancement of tribological performance of a piston group is usually sought through optimization of the surface topography of the honed surfaces [4-8], lubricant composition and lubrication regime [9, 10] as well as surface modification [11-14].

The most critical zone prominent for intensive wear is located at the top dead centre (TDC) because of the combination of various factors: alternating acceleration from and deceleration to complete stop, the highest temperature and lubrication starvation under mixed or boundary regime [15]. However, there are only few studies aimed at wear mitigation at the TDC [11, 16], while the main dependencies under these conditions remain poorly understood. In the extensive work [11] 19 fully-formulated alternative engine oils with different base stocks were tested pursuing improvement of their lubricating capability under hydrodynamic and mixed regimes, although boundary regime that is typical for TDC has not been sufficiently addressed. On the other hand, various types of surface modification such as hard chrome plating [17], thermal and plasma spray [18, 19], nano-HVOF [20], and nitriding [21] have been proposed to enhance wear resistance of piston rings and cylinder liners. Among these methods physical vapour deposition (PVD) of well-adhered surface coatings has great potential for wear reduction at TDC [17, 22]. Low thickness of the coating around 8 µm that is deposited at the last step of a manufacturing process allows keeping the piston ring geometry unaffected while offering a possibility for tailoring surface mechanical and chemical properties.