Friction analysis in laser textured surface lubricated contacts

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Abstract

The aim of this paper is to evaluate the friction reduction potential of alternative surface finish processes of the cylinder liner of engines in order to lower the friction losses between piston, rings and cylinder liner. This issue presents an analysis of laser surface textured lubricated contacts, including both the theoretical model and the experimental tests. A theoretical friction prediction model has been built up where friction can be predicted from the pattern of the surface topography of the cylinder liner. An experimental work has shown that this model is able to predict with a great accuracy the friction losses of various surface structures resulting from laser engraving.

Keywords: surface roughness, laser texturing, hydrodynamic lubrication, friction, numerical tribometer, testing.

Introduction

In the very recent months the oil price have reached a high level similar to the one of the two previous big oil crisis. Consequently, the efforts to increase energy savings have been again privileged by the state policy.

In the field of ground transports the main source of energy savings is to lower the mean fuel consumption of the vehicles. The efforts can be made by lowering the weight of the vehicles, by means of new driving strategies or by better combustion processes. But there is also a very promising way to reduce the fuel consumption of the vehicles; it is to increase the fuel efficiency of the internal combustion engines.

This increase of the fuel efficiency in an engine can be obtained through different ways but one of the most promising is to reduce the friction losses which are responsible of about 30 % of the energy losses of the engine.

According to Monteil et Lebeaud [4], it appears that the piston ring cylinder system represents about 50 % of the total mechanical loss in engines. Figure 1(a) represents the distribution of friction losses in a 4 cylinder gasoline engine at 1000 t/mn. Consequently, in order to obtain the highest amount of fuel economy, the efforts should be focused on the piston rings-cylinder liner contact.

As the fuel consumption normalised cycle for the evaluation of the fuel economy is well defined, it appears that this set of running conditions leads to a large duration under hydrodynamic lubrication conditions. Consequently, we have focused the present work on the reduction of friction force in the hydrodynamic conditions, e.g. typically the piston skirt-cylinder liner contact (Figure 1(b)).

As the hydrodynamically running conditions can be highly enhanced by the lubricant trapped into the contact, the aim of the present work was dedicated to the structuring of the cylinder liner surface