Piston Ring Performance Optimisation in IC Engines

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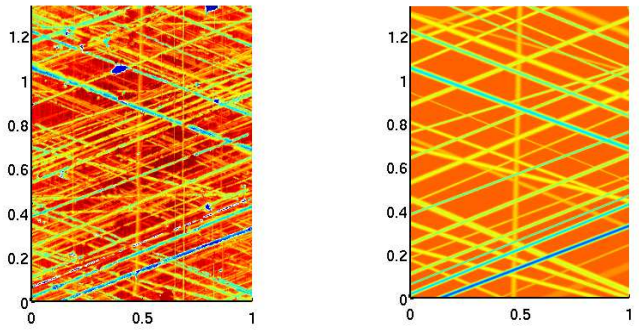
Introduction

Fuel efficiency and low polluting emissions are strategic points in current development of internal combustion engines. Engine efficiency optimization involves minimization of the engine frictional losses. The Piston Ring Cylinder Liner contact accounts for the engine's most important loss. Furthermore, the film thickness and friction in this contact depend (for a great deal) on the liner micro-geometry.

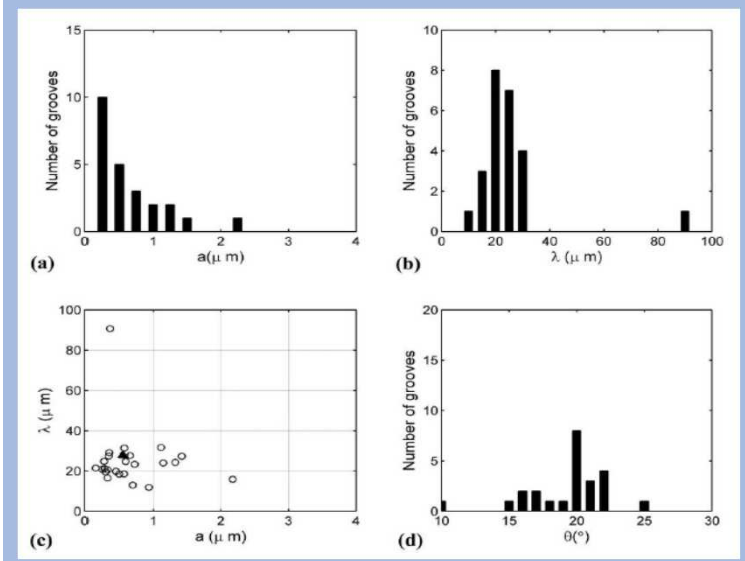
Micro-geometry measurement and Analysis

- Using a Sensofar the liner micro-geometry is measured very precisely (10^7 points).
- Using a MATLAB code the measured microgeometry (left) is analysed and the groove depth/width/angle is extracted (right).



Identified groove characteristics

- The identified groove parameters such as groove depth, groove width and groove angle are stored.
- Distributions are drawn showing how often a groove of certain properties is measured.



Research in cooperation with:

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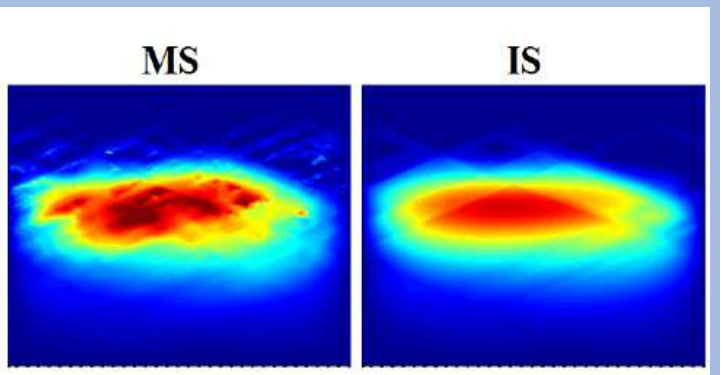
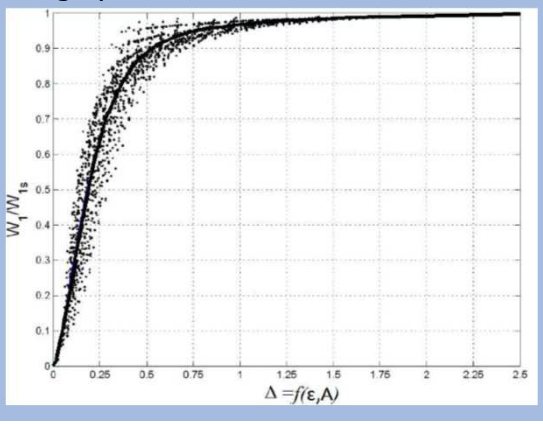
Pressure generation calculation

- Using a transient MultiGrid code the pressure distribution for the measured (MS) and identified (IS) surface are computed.
- The time averages of these pressure ditributions are used to obtain the load carrying capacity.
- Even though MultiGrid acceleration techniques are used, the transient calculation takes several days.



Pressure generation prediction

- Complementing the numerical calculation with a simplified analytical approach, it is possible to predict the load carrying capacity as a function of the operating conditions and groove geometrical parameters.
- The next graph shows the result for the first ring.



Conclusion

Using the derived analytical equations, the load carrying capacity and friction of the parabolic first ring and the flat third ring can be predicted as a function of the operating conditions and the groove geometrical parameters. For all 720 degree positions, the prediction calculation takes only seconds on a PC.

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