Technology Trends in the Automotive Industry

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Abstract. Driven by legislature and the limited reserves of raw materials, the question arises as to how further reductions in friction can be achieved in internal combustion engines. Besides the development of electric and hybrid drive systems, the task involves exploiting potential savings which lie in the optimization of existing engine technology. The challenge is to explain physical relationships and to put the findings made by combining measurement and simulation into practice by choosing specific manufacturing methods. It is important to ensure that the selected techniques can be applied in global volume production.

Keywords: combustion engine, friction, emissions.

1 Introduction

Schaeffler is a leading global company in the industrial and automotive supplier industry and has around 84,000 employees in 170 locations in more than 50 countries. This also includes 74 manufacturing locations and 16 R&D centers. The company is characterized by above-average sales growth and profitability [1].

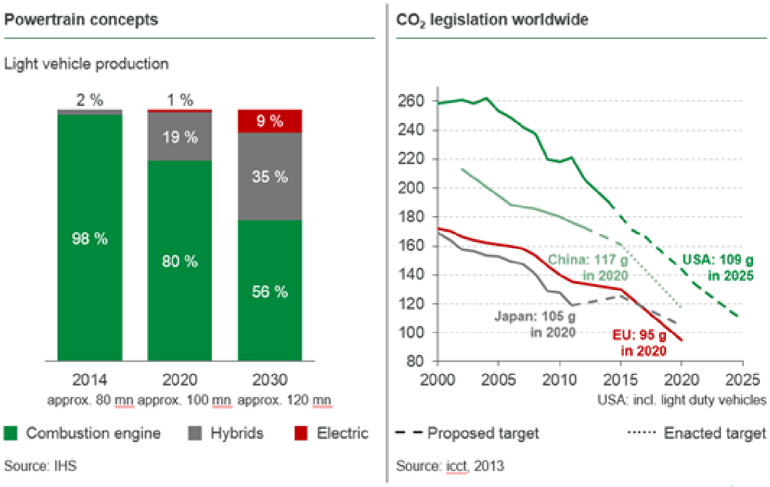

Fig. 1. Drive concepts and regulations concerning CO_2 emissions [1]

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Current legislation is putting pressure on the automobile industry to continuously reduce CO2 emissions (Fig. 1). Customers expect high efficiency and low specific fuel consumption as well as vehicles that are “fun to drive”. The focus of development activities is on optimizing existing systems, downsizing, hybridization and electric mobility.

The proportion of all-electric drives in vehicles will be around 9.2% by 2030 (Fig. 1). This means that the potential for reducing CO2 and improving fuel economy will have to have been fully unlocked by optimizing current systems. In addition to efficient energy use, the focus here will be on reducing friction in the internal combustion engine, among others.

2 Simulation, the basis for targeted reductions in friction

In order to make targeted reductions in friction using technological developments, it is necessary to understand the interactions between the friction partners. It is therefore all the more important to be able to explain physical relationships that result from measurements and simulations with the increasing level of detail of the system (Fig. 2).

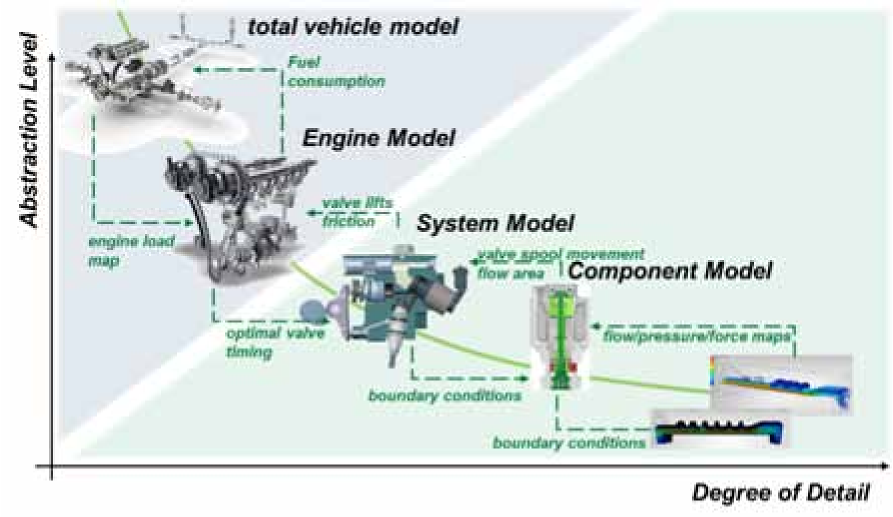

Fig. 2. Holistic approach to simulation [2]

Local effects such as the influence of friction can be simulated using elastic multi-body simulation. The results form the basis for understanding the physical processes between the bodies in contact and making targeted optimizations to the friction and the losses. The results of the elastic multi-body simulation show where the greatest losses caused by friction occur and what causes them. These findings form the basis for reducing frictional losses. One solution associated with this is the technical design of surfaces. Polishing, structuring, and coating play an important role here. The mostsuitable manufacturing method can only be selected when the bodies in contact are considered in conjunction with the lubricant and the tribological conditions.

3 Methods for reducing friction

Technology must seek to develop manufacturing methods that reproduce or anticipate the running-in process of the bodies in contact. Lapping is particularly important here, since smoother surfaces reproduce the running-in behavior of bodies in contact in ideal cases.

According to German standard DIN 8589, lapping is a metal cutting method that uses loose abrasives. The abrasive is found in a paste or a liquid. The workpiece is guided using a defined force over a contoured counterpiece. The unaligned cutting marks generate an isotropic (uniform) surface that is characterized by extremely low roughness (Fig. 3) [3].

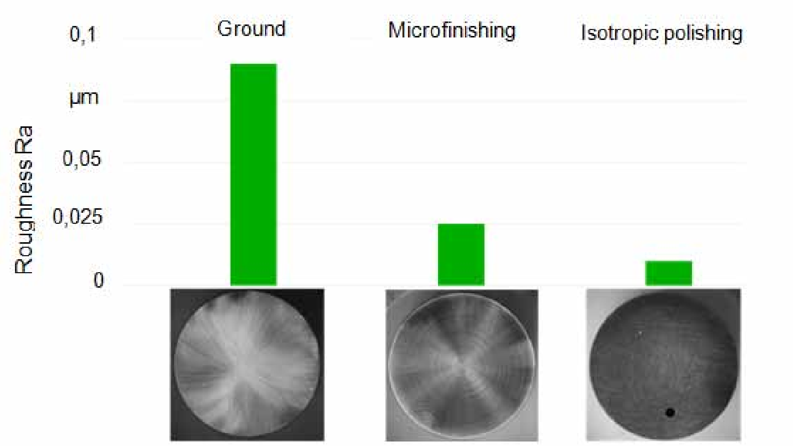

Fig. 3. Roughness values according to the methods used [4]

When developing manufacturing methods, it is important to always consider their implementation in a large-scale industrial setting, which can make further development of the subsequent processes necessary.

Another method that was developed to reduce friction is coating. It is based on changing the physical properties between the bodies in contact, in which layers of carbon (DLC or diamond-like carbon) are used in particular.

A significant main proportion of friction is adhesion. Local welding causes the rough peaks to be pulled out under load. The carbon contained in the layer is responsible for the reduction in adhesive forces among others.

The holistic approach to friction mentioned above means it is necessary to structure surfaces. Structures specifically serve to retain the lubricant between the bodies in contact. This creates a significant improvement to the tribological conditions. Major developments by IWS Fraunhofer in Dresden have been presented on this topic during the last few years (Fig. 4).

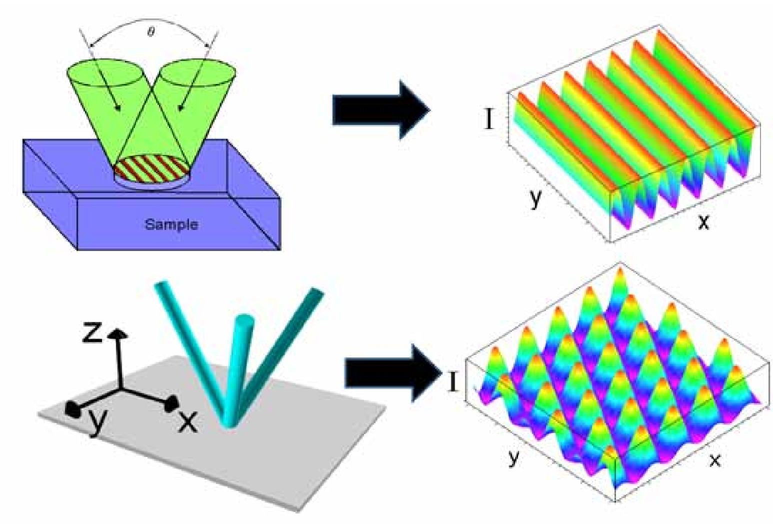

Fig. 4. Schematic of 2D laser and 3D laser interference structuring [5]

The advantage of such structures is that the optimum conditions generated within given tolerance limits during simulations can be manufactured with repeatable accuracy.

4 Summary

Targeted reductions in friction in combustion engines often depend on the quality of the results of the elastic multi-body simulation and on mastering modern manufacturing technologies. Progress can increasingly only be made by putting the findings that result from elastic multi-body simulation into practice on the component as well as choosing the correct lubricant and by taking the tribological condition into consideration. It is essential that upstream and downstream processes are considered here.

References

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