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# Editorial: Special Issue "Automotive Tribology"

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The automotive industry faces new challenges and fast technological changes. The continuous increase in the severity of government regulations outlines new targets about fuel consumption, pollution, and mechanical efficiency; hence, hybrid vehicles (HEVs) and plug-in hybrid vehicles (PHEVs) are likely to become mainstream in the future. Nevertheless, according to recent report the annual sales of non-electrified vehicles, HEVs/PHEVs, and battery electric vehicle/fuel cell vehicles will be 4.5 million, 4.5 million ("only" 1.4 million units in 2016), and 1.0 million units, respectively, by 2030 [1]. In other words, although the automobile market is shifting to electrification, in 2030, vehicles equipped with internal combustion engines will still account for approximately 90% of the annual sales volume of passenger vehicles, and further fuel saving of internal combustion engines will be required. On the other side, despite the incessant increase in investments related to the electric vehicles sector, most of the scientific research has been focused on the energy efficiency and performance of batteries and electric powertrains, whereas topics related to new and unconventional architectures for brakes, bearings, transmissions, tailored lubrication systems in hybrid or full electric vehicles have been researched so far from tribological point of view in few papers [2–7].

This Special Issue of Lubricants observes the latest developments concerning frictional and wear behavior of complex mechanical systems, by pointing out the remarkable effort from academic and industrial researchers linked to tribological innovations in vehicular field. According to the substantial changes in operating conditions of near future automotive technology, this issue would provide useful support to engineers responsible for developing the most efficient and dependable systems with focus on reduced viscosity lubricant, valvetrain friction and lubrication, vegetable oil–diesel fuel mixtures, friction losses in gasoline and diesel engines of passenger car.

In Reference [8], the effect of reducing $CO_2$ emissions and cost analysis of ultra-low viscosity (ULV) engine oils for passenger vehicles are considered. More specifically, the authors analyzed the effect of reducing life cycle $CO_2$ emissions by reducing engine oil viscosity and extending the oil drain interval estimated by taking into account both mineral engine oil and synthetic engine oil. In the research, $CO_2$ emissions during vehicle operation were based on small gasoline engines in NEDC or New European Driving Cycle mode.

In the framework of complex coupling between engine dynamics and the lubrication regime of bearings, piston assembly, and valvetrain—an experimental apparatus for film thickness and shape estimation in a cam-follower line contact using optical interferometry—is presented with the paper [9]. The basic principles of the interferometric techniques and the color spaces used to describe the color components of the fringes of the interference images are reported by the authors. The encouraging results evidence the clear capabilities of the proposed technique as well as some practical problems intrinsically related to the cam-follower contacts, such as: the quick motion of the contact point, the geometrical errors, the surface defects, and the non-perfect parallelism of the contacting bodies. However, the developed methodology seems to be able to perform the analysis of different images by catching the values of the film thickness during the camshaft rotation. In the same area of investigation, the article [10] fundamentally observes the synthesis of modelling and numerical studies on the cam-follower elastohydrodynamic lubrication (EHL) mechanism, taking into account the effect of the axial modification of the cam depth. Among the main findings, the paper emphasizes the necessity of studying the effect of adding chamfer to the cam edges, as well as deepening the influence of different curvatures for the whole cam profile.

The use of fuel mixtures of diesel and vegetable oils in diesel engines is a relevant field of research due to the necessity of reducing pollution [11]. Besides the properties required for the normal operation of diesel engines, other aspects needing investigation are linked to the influence of these mixtures on piston ring–cylinder tribosystem behavior. In this framework, in Reference [12], an investigation on the tribological behaviors of mixtures of rapeseed and sunflower oils with regular diesel is proposed. Since the final goal is the friction coefficient prediction when the vegetable oil content in fuel is known, the authors applied artificial neural network (ANN)-based methods, which have already shown to be a valid tool for predicting tribological properties due to their great capabilities to generalize, cluster or organize data, and deal with uncertainties, such as noisy data and nonlinear relationships [13–15]. They trained the network with original experimental data obtained from a tribometer device with pin-on-disk setup by performing an accurate analysis of biodiesel–diesel mixtures from a tribological point of view, finding strong prediction capabilities of ANN.

In Reference [16], the application of the combined approach, investigating the friction losses in a modern four-cylinder passenger-car diesel engine, is presented. The approach brought together the experimental data resulting from engine friction measurements and predictive journal bearing friction loss simulations. The experimental tests were performed using a motored engine test bed with external charging and an air recirculation system to improve the thermal boundary conditions of the piston group. In summary, the methodology can be applied to analyze the friction losses of reciprocating engines in detail, and its subassemblies crankshaft journal bearings, valve train, and piston assembly. This analysis can be conducted over the entire engine speed and load range for different thermal boundary conditions with a high accuracy and enables the analysis of the influence of friction reduction measures, like low viscosity oils, design parameter variants of the crank train components, or comparisons between different engine concepts.

A meaningful measurement program covering a wide range of engine-operating conditions is introduced in [17]. The investigations are carried out at different engine mean supply temperatures ranging from 70 °C to 110 °C for a comprehensive consideration of the friction losses achieved with lubricants with low viscosity. For reasons of comparability, all investigations conducted in the work were carried out using the same passenger car type SAE 5W30 lubricant. This is done to exclude influences from different lubricant properties which may have substantial effects on the tribological behaviour of the engine sub-assemblies. The piston assembly friction losses are calculated by subsequent subtraction of individual friction losses from the results of the base engine friction measurements due to the applied procedure [16].

The paper [18] is a very effective concluding remark of the previous papers belonging to this Special Issue. In the paper, a novel method, used to investigate friction in internal combustion engines, was presented and applied to three engines featuring different architectures. The friction losses were investigated by combining experimental testing with accurate simulation techniques. However, by merely determining the quantity of present mechanical friction losses, no insight can be gained about the dominant form of friction or how close the engine is to minimum frictional operating conditions. Furthermore, potential harmful boundary friction and increased risk of failure for lubricated contacts cannot be located without investigation at engine sub-systems level. Potential risks that arise from reduced oil viscosity, and consequently, by promoted direct metal to metal contact are, for example, increased wear, component degradation, surface damage, or bearing seizures. Therefore, the article aims at extending the basis provided by the previous works by analyzing the lubrication regime of these three investigated engines.

All the mentioned results are proof of a ceaseless investigation effort towards tribological progress in the fascinating automotive world.

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