ABSTRACT

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This doctoral dissertation is devoted to the analysis of the influence of an a-C:H:W amorphous carbon coating and the degree of degradation of synthetic engine oils on the tribological properties of lubricated friction pairs operating under conformal and non-conformal contact conditions with limited lubrication. The literature review covers issues related to friction and wear processes, the characteristics and classification of engine oils, methods of surface layer engineering, and the tribological properties of amorphous carbon-based coatings, with particular emphasis on a-C:H:W coatings. The experimental programme included an evaluation of the influence of the a-C:H:W coating and synthetic engine oils SAE 5W30 (new and used) and SAE 5W40 (new) on tribological processes occurring in friction pairs operating under conformal and non-conformal contact conditions. The coefficient of friction, starting torque, contact temperature, wear of the mating elements, and changes in the geometric properties of surface layers were analysed. The investigations were supplemented by an assessment of the anti-seizure properties and degradation of the tested engine oils, as well as an analysis of the roughness, stereometric parameters, and surface topography using profilometry together with optical and three-dimensional digital microscopy.

The experimental investigations demonstrated that the influence of the a-C:H:W coating on tribological performance depends on the contact geometry, applied load, temperature, and the type and service condition of the lubricant. Under non-conformal contact conditions, the coating promoted the stabilisation of the coefficient of friction and reduced the wear intensity of the mating elements. Under conformal contact conditions, no unambiguous tendency towards friction reduction was observed; however, the coating affected the wear processes and the development of the surface layer. Furthermore, the use of degraded SAE 5W30 engine oil resulted in increased friction, higher operating temperature, and greater wear intensity compared with new oil. The anti-seizure tests and the analysis of the surface layers confirmed the influence of operating conditions and material pairing on the tribological processes and wear behaviour. Based on the obtained results, scientific and practical conclusions were formulated, and directions for further research were proposed. The obtained results provide a basis for the design and improvement of lubricated friction pairs employing a-C:H:W coatings and synthetic engine oils.

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