DESCRIPTION FOR THE GENERAL PUBLIC

The research project is aimed at the basic and applied research upon a possibility for reducing the friction coefficient, the braking torque, and the wear of materials in friction junctions or system where two surfaces rub against each other. According to a kind of friction, both surfaces wear themselves quicker and more intensively or vice versa. In the case of this project, the boundary and mixed frictions will mainly occur. Both kinds of friction cause the weaker wear of material of which both surfaces rubbing against each other are made. At the same time the friction coefficients are relatively smaller than, e.g., in the case of the dry friction of two surfaces. In a friction junction made up of a rotating metal shaft, engine oil, and a rotary lip seal (the so-called *simmering*) the mixed friction exists between the surface of a metal shaft and a polymer lip of a lip seal, which results in the braking torque of the shaft to occur. As many years' experience reveals, due to the relative friction in the presence of engine oil (its thin film between both rubbing surfaces) in a space (a gap) between the shaft and the seal a relatively strong electric field is generated. It is an effect of tribocharging and the separation of positive and negative electric charges within a gap at both surfaces rubbing against each other – boundary layers. There exists a possibility for the reduction of the friction, and simultaneously the braking torque through the generation of an external electric field in a gap to compensate for an electric field that was generated there earlier. As a result of this process, as predicted, the braking torque of a rotating shaft, the wear of the lip seal's material, energy losses and operating costs will be reduced or even minimised.

An important part of the project will be working out a mathematical model and an analysis of different processes occurring in the friction junction. These processes are: mechanical (tribological), physicochemical (at the molecular level) and electrical – an electric field generated in the junction, electric double layers at both phase boundaries (a shaft–oil and oil–the lip of a lip seal) and an external electric field applied to the interfacial system – the friction junction. To this end an analysis of the processes and their description in the form of partial differential equations will be made, and a numerical model will be proposed.

Moreover, implementation and numerical calculations are intended which are based on the finite element and finite volume methods. Also the initial validation of a model along with experimental data obtained by the authors of this project will be done. The set proposed of the partial differential equations will be solved using the packages of the Ansys program based on the Workbench platform. Depending on an input model the integration of the three modules: CFD module, Mechanical and Electrostatics modules is planned during calculations.

Modelling of physicochemical phenomena that occur in synthetic lubricating oils will also be performed. The simulation of molecular dynamics under the action of an external electric field and without this field will be carried out. In this part of research here will be determined computationally the dipole momentum of each of the molecules. In this case the application of not only the method of force fields but also of the Density Functional (DFT) methods is intended. It will permit one to confirm a hypothesis proposed by the applicants that there exists the direct relationship between the molecule's dipole momentum and its behaviour under an external electric field. In addition the molecular simulations will be carried out to enable the examination of the lubricating oil molecules interaction with the surface that represents the surface of given material with which oil is in contact during its functioning in the friction junction.