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Proposal for presentation at the 36th LEEDS-LYON SYMPOSIUM ON TRIBOLOGY
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A need for relevant multi-physics modelling of EHD problems: application to realistic film thickness and friction predictions*

W. Habchi[1], N. Fillot[2], O. Andersson[3], S. Bair[4], D. Eyheramendy[5], P. Vergne[2], G.E. Morales-Espejel[6,2]

[1] Lebanese American University, Department of Industrial and Mechanical Engineering, Byblos, Lebanon
[2] Université de Lyon, CNRS, INSA-Lyon, LaMCoS UMR5259, F-69621, France
[3] Department of Physics, Umea University, SE-901 87 Umea, Sweden
[4] G.W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, USA
[5] Ecole Centrale Marseille, CNRS, LMA UPR7051, F-13451 Marseille, France
[6] SKF Engineering and Research Center, Nieuwegein, The Netherlands

Recent years have seen a substantial development of new numerical methods in the field of modelling elastohydrodynamic lubrication (EHL) problems. For instance, film thickness prediction has been greatly improved, especially in terms of spatial resolution, dynamics, complex kinematics, calculation time, accuracy, etc. However, these studies have served to advance the understanding of the influence of surface features (roughness, bumps, ridges, dents, dimples, surface texture etc.) much more than issues related to the lubricant itself and its two major primary tribological functions; i.e. separation of moving surfaces and friction reduction.

Accurate prediction of both film thickness and friction is still an important challenge. It is directly related to engineering, industrial and society-concerned issues like lifespan optimization of machines and also energy saving. Moreover it is a multi scale problem because the macro behaviour of machine elements is strongly linked to complex mechanisms that occur at the micro or nano scales.

Tackling an EHD problem basically requires solving a system of three equations: Reynolds, film thickness and load balance equations. Nevertheless Reynolds established his famous equation within the frame of several hypotheses, among them the Newtonian behaviour of the lubricant. However real lubricants behave as non-Newtonian fluids and their response is not only governed by pressure and the applied shear stress (or rate) but it is strongly temperature dependent. The energy equation should be introduced because it is no longer possible to disregard the temperature influence since friction (i.e. shear dissipation) is considered. The thermo physical parameters like conductivity, density and specific heat are also influenced by pressure and temperature and this should be accounted in a friction simulation.

Frequent criticisms to the above statements came from the need to have available a huge number of parameters and in the difficulty to solve a large number of coupled non linear equations. Tribology being essentially a multi-disciplinary field, bringing together tribologists, physicists, rheologists and specialists of modelling and numerical methods appeared as an appropriate response. To this purpose, the multi physics EHD problem has been solved using a Finite Element full-system approach including appropriate stabilization and penalty methods. Different comparisons of both film thickness and friction are presented to highlight the importance of appropriate multi-physics modelling. These comparisons involve numerical solutions with physical models of different complexity as well as experimental results obtained under various operating conditions, including highly loaded high speed cases.

* Corresponding author : P. Vergne, philippe.vergne@insa-lyon.fr