

EVALUATING SLIP EFFECTS IN ELASTOHYDRODYNAMIC LUBRICATION: INSIGHTS FROM NAVIER-STOKES EQUATIONS

R. Ajeeb, T. Požar, M. Kalin*

*mitjan.kalin@fs.uni-lj.si

^a University of Ljubljana, Faculty of Mechanical Engineering,
Laboratory for Tribology and Interface Nanotechnology,
SI-1000, Slovenia

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ABSTRACT

Elastohydrodynamics (EHL) has witnessed significant advancements by the incorporation of DLC coatings, designed to minimize friction and improve wear resistance. This innovation introduces other novel considerations, including the manifestation of slip at the solid-liquid interface.

The intentional integration of slip boundary conditions into the elastohydrodynamics of viscous fluids provides a nuanced framework for control, fostering exploration and optimization. This methodological approach enables comprehensive investigations into the influence of slip on the crucial parameters such as friction, pressure distribution, and film thickness.

In our computational inquiry into the dynamic interplay of elastohydrodynamic lubrication (EHL), we depart from the traditional use of the Reynolds equation, opting for the more complete mathematical description using Navier-Stokes equations [1]. The latter is chosen for its capacity to address partial or pure sliding scenarios, considering inertial terms and variations in fluid properties along the direction of normal to the flat surface, notably viscosity and shear. This departure is crucial as the Reynolds equation was found to be inadequate for analysing slip within the EHL line contact [2] especially at different slide-to-roll ratios [3].

Our investigation focuses on understanding the impact of slip on overall performance across varying slip lengths, assessing its influence on key EHL parameters. The precision of our fluid-structure interface model (FSI) is affirmed by meticulous calibration, ensuring reliability. The subsequent incorporation of slip as a boundary conditions marks a significant advancement in comprehending EHL dynamics for enhanced operational efficiency.

Following computational assessments of EHL with the proposed slip equation by Spikes et al. [4], the results reveal that an increase in slip length correlates with a decrease in the distance between opposing solids as seen in Fig. 1. Moreover, while there are changes in pressure distribution, they do not exhibit significant variability. Concurrently, as the slip length

increases, the coefficient of friction decreases, emphasizing the direct influence of slip length which relates to the applied coating on general EHL behavior. This study aims to deepen our understanding of the intricate relationship between the EHL characteristics, and the slip introduced by the coating, with a specific focus on achieving a lower coefficient of friction while mitigating asperity contact through careful consideration of film thickness.

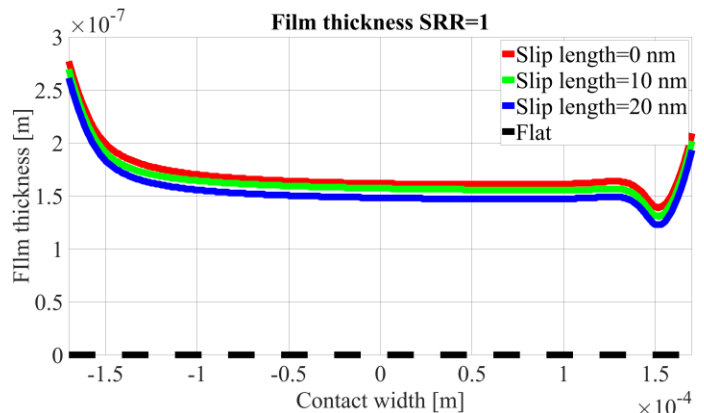


Fig.1 Film thickness variation

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