POLYMER CONGESTION AND SHEAR THINNING IN EHD CONTACT

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ABSTRACT

In the mid-1950s, the blending of polymers into lubricants emerged as a common practice aimed at mitigating the temperature sensitivity of lubricant viscosity [1]. Traditionally, it was understood that polymer chains expand with increasing temperature, thereby influencing the overall viscosity of the lubricant and subsequently its film thickness [2] [3]. Yet, empirical investigations based on oil film thickness measurements of polymer solutions with varying polymer concentrations and viscosities across an elastohydrodynamic contact have uncovered a discrepancy between predicted and measured oil film thickness. Empirical observations have suggested a decrease in viscosity at the contact inlet, which is particularly notable in polymer solutions made of high molecular weight polymers [1]. This phenomenon, termed shear thinning, is attributed to high shear rate, resulting in a notable drop in viscosity. Note that theoretical predictions indicate that lower viscosity should correspond to reduced film thickness due to their proportional relationship. There is not conclusive evidence that shear thinning occurs at the inlet. If so, why? Is there another factor that may contribute to the film thickness anomalies described above? What is the role of polymers at the proximity of the contact region?

In-operando Raman spectroscopy experiments have shed light on the congestion of polymers at both the inlet and outlet of the contact in the elastohydrodynamic regime. **Figure 1** shows the observed local increase in polymer concentration across a ball-on-disc contact. This localized increase in polymer concentration at the contact inlets is surprising and may suggest a rise in inlet viscosity, even though the measured film thickness is thinning than expected in so cases.

This study presents an investigation aimed at unraveling the intricate interplay between polymer congestion, shear thinning, and their collective impact on viscosity and film thickness within the context of the elastohydrodynamic lubrication regime. The study investigates the influence of these factors under various operating conditions and polymer concentration. Experimental methodologies, including *in-operando* Raman spectroscopy for tracking polymer concentration in the contact, anisotropy experiments for determining local viscosity [4], and flow profile experiments, will be carried out to explore the complex dynamics at play. The findings from this research will advance the understanding of polymeric viscosity modifiers behavior under EHD lubrication regime and subsequently inform the development of more efficient lubrication strategies for industrial applications.

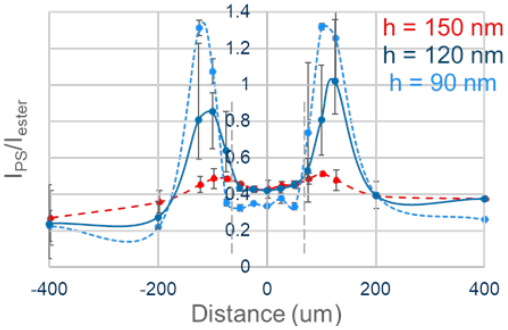

Figure 1 : Evolution of polymer concentration across the contact at different film thicknesses. Grey dash lines represent the contact diameter.

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