7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Heat dissipation in steel-steel and hybrid EHD contacts

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This work focuses on the measurement of temperature and the comparison of heat generation in all-steel and hybrid elastohydrodynamic (EHD) contacts. A recently developed spectroscopic technique exploiting the photoluminescence sensitivity of semiconductor-based nano-sensors to pressure and temperature is employed. The *in situ* measurements are conducted in EHD contacts using a ball-on-disc test rig. Pressure and temperature measurements are compared with predictions, using an in–house finite element thermal EHD model. The effects of sliding and normal loading on pressure, temperature and heat generation are detailed.

Keywords: in situ measurement, hybrid contacts, elastohydrodynamic, photoluminescence, heat generation

1. Introduction

The extreme operating conditions in the aerospace applications, combined with a growing demand for lightweight structures, made the choice of bearing's material crucial. In the last decades, hybrid ceramic–steel bearings have been proposed as an alternative to the classical all-steel ones [1]. Mostly commonly, hybrid bearings are composed of steel-based bearing rings and ceramic (silicon nitride (Si_3N_4) rolling elements.

This work is dedicated to study the effect of the nature of the contacting materials on temperature in EHD rolling-sliding contact. In particular, the effect of the sliding ratio and normal load on temperature rise, generated heat and power losses will be quantified and compared for all-steel and hybrid (Si3N4-steel) EHD contacts. Experimental measurements will be compared with numerical results.

2. Materials and methods

To measure the mean temperature within the EHD contact, a recently developed *in situ* technique is employed. This technique consists in dispersing fluorescent quantum dots (QDs) in the lubricant to exploit their sensitivity to pressure and temperature [2]. A ball-on-disc tribometer is used to simulate circular EHD contact at different slide-to-roll ratio (SRR) and to measure friction coefficient.

Balls made of bearing steel or Si_3N_4 are used together with steel or sapphire discs, for friction test or temperature measurements (fluorescence), respectively. Sapphire is a transparent material, with good mechanical properties to withstand high pressure contact and exhibits a thermal diffusivity similar to that of bearing steel.

A thermal EHD numerical model is also used as a complementary tool to compare and validate the experimental results, in particular the temperature prediction and heat generation.

3. Discussion

The effect of sliding (SRR=0-50%) and normal load on the temperature rise is evaluated with the different contact configurations. Experimental and numerical results are in good agreement and underline the significant effect of pressure combined with shear on the temperature rise whereas the effect of the thermal properties of the solids is limited. The previous results are confirmed by comparing the calculated heat generation and the experimental power loss.

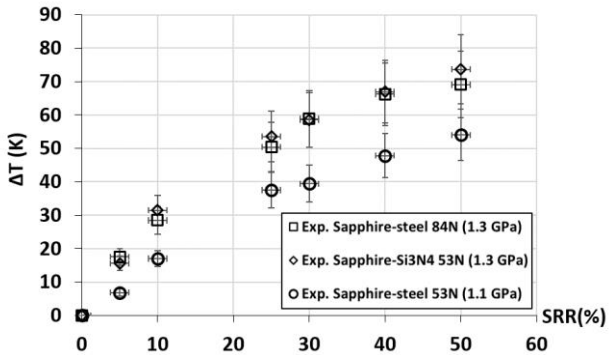

Figure 1: Measured average temperature rises as a function of the slide-to-roll ratio at the contact center.

4. Acknowledgments

This work was funded by the Lubricated Interfaces for the Future research chair established between INSA Lyon and the SKF Company.

5. References

[1] Zaretsky, E. V. et al., "Ceramic bearings for use in gas turbine engines", J. Mater. Eng., 11, 3, 1989, 237‑253.

[2] Seoudi,T. et al., "CdSe‑Based Quantum Dots as In Situ Pressure and Temperature Non‑intrusive Sensors in Elastohydrodynamic Contacts", Tribology Letters, 68, 73, 2020.