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Debris entrapment in hybrid rolling element bearings

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1 Introduction

Lubricated contacts are widely used as interfaces within mechanical systems. Acting as an interface means separating the contacting surfaces. Even though the lubricant which fills this gap must only separate surfaces, it might sometimes interact with them. Indeed, all sorts of contaminants may be carried by a lubricating fluid. Particle entrapment can cause irreversible damages [1-2] to the contacting surfaces that is why the conditions and probabilities of such phenomena must be fully understood.

2 Numerical model

Assuming that particles are entrained by the lubricant flow and possibly caught between the contacting surfaces, the numerical model permitted to determine both the lubricant flow and the theoretical particle trajectories. Based on this model, critical entrapment cases and on the contrary favorable scenario avoiding any entrapment can be highlighted (figure 1).

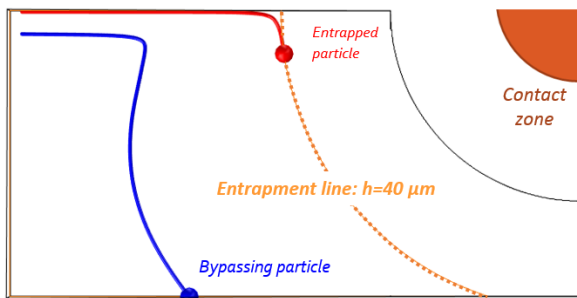


Figure 1: Numerical model

3 Experimental tools

The experimental work consisted in tests performed on two different devices, modelling different conditions of hybrid rolling contacts.

2.1 Twin-disc machine

The first one (figure 2) can reproduce highly-loaded lubricated contacts with high rolling speeds in a twin-disc configuration. After the tests run under realistic operating conditions, as those existing within REBs, the

contacting discs (steel or silicon nitride) surfaces were observed making possible qualitative and quantitative comparisons of entrapment ratios.

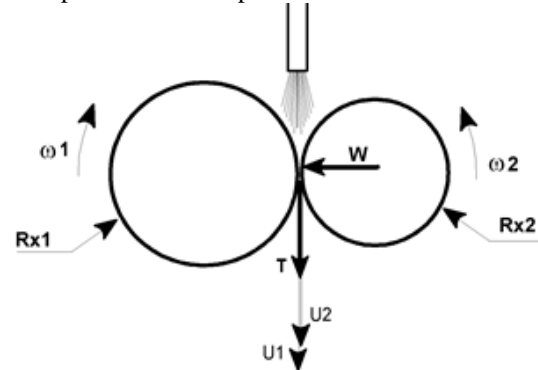


Figure 1: Twin-disc machine

2.2 Ball-on-plate test rig

The second device, a ball-on-plate EHD test-rig (figure 3) which includes a transparent disc (glass or sapphire), enables to visualize the lubricant flow penetrating into the convergent area and thus to analyze the particles entrapment from the direct observation of the fluorescent suspended particles.

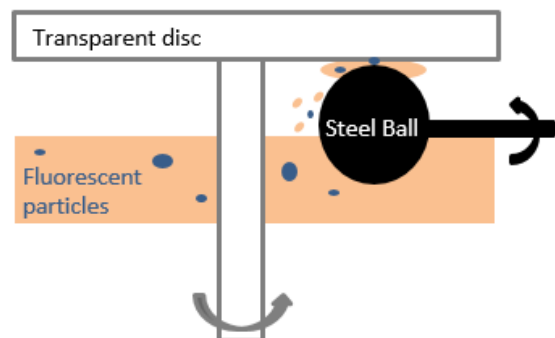


Figure 3: Tribometer with fluorescent particles

3. Results

The dual approach allows to validate numerical simulations. A relative strong influence of the ellipticity ratio was highlighted whereas adding sliding components or considering different couple of materials only slightly affect the entrapment phenomena. Despite different operating conditions in the different devices, similar tendencies were underlined.

4. References

[1] Dwyer-Joyce, R. S., and Heymer, J.: The entrainment of solid particles into rolling elastohydrodynamic contacts, *Tribology Series*, 31 (1996), 135–140.

[2] Ville, F., and Nelias, D.: An Experimental Study on the Concentration and Shape of Dents Caused by Spherical Metallic Particles in EHL Contacts, *Tribology Transactions*, 42 (1999), 231–240.