GENERATION OF ACOUSTIC EMISSION FROM THE RUNNING-IN AND SUBSEQUENT WEAR OF A MIXED-ELASTOHYDRODYNAMIC CONTACT

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KEYWORDS
Acoustic Emission; Running-In; Wear; Mixed Lubrication

ABSTRACT
There is currently considerable interest in using Acoustic Emission (AE) to measure the contact conditions in the critical components of rotating machinery. Researchers [1] have shown that asperity interaction between their contacting surfaces is a source of AE. However there have been few attempts to describe the change in AE response as the surface changes.

The paper presents the AE response from the running-in and subsequent micro-pitting fatigue test of an elastohydrodynamic contact operating in the mixed lubrication regime, between two axially ground disks. The contact pressure, slide to roll ratio, rotational speed and oil supply temperature were kept constant throughout the experiment. The experiment was paused at various intervals so the surface roughness profiles could be measured. Figure 1 shows the AE results from the initial run-in of 3000 cycles (~3 min) and a subsequent 3000 cycles. At the start of the test the AE drops and then stabilises extremely rapidly. This is attributed to a decrease in surface roughness as a result of load induced plastic deformation of asperities. The AE results confirm the hypothesis that this type of surface modification occurs almost instantaneously upon first loading. After the first 3000 cycles the test was paused for a surface roughness measurement then restarted. The re-starting response, noticeably different from the first, is due to the reduced initial disk temperatures at restart and consequent increased viscosity and film thickness.

Figure 2 shows the AE results from the micro-pitting fatigue test which ran for 2.5 million cycles (~ 42 hrs). There is a significant, comparatively slow, decrease in AE over the duration of the test indicating continual but decreasing surface wear. Micro-pitting was observed after the first 100,000 cycles however there was no significant change in the surface roughness (R_q) over the test. It is hypothesised that the AE response is due to a self-limiting wear regime. In this, only a small proportion of prominent asperities interact and these generate the bulk of the AE signal. As they are worn by micro-wear mechanisms the contact pressure is redistributed more evenly and the AE reduces. The R_q value is unaffected as only a tiny proportion of the surface is being modified.

The results presented in this paper show that AE is extremely sensitive to modification of surface asperities and has great potential for use in monitoring running-in and wear regimes.

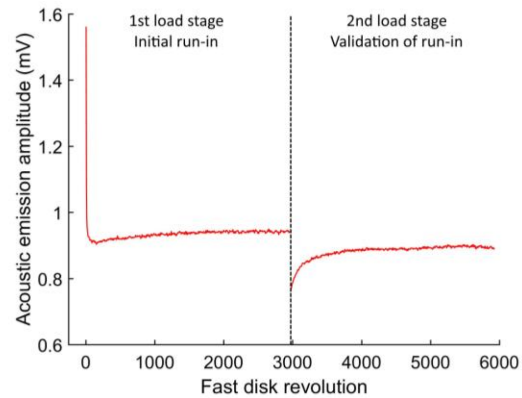

Figure 1. Initial running-in of disk set. Showing the mean Acoustic Emission band-passed between 150 - 300 kHz.

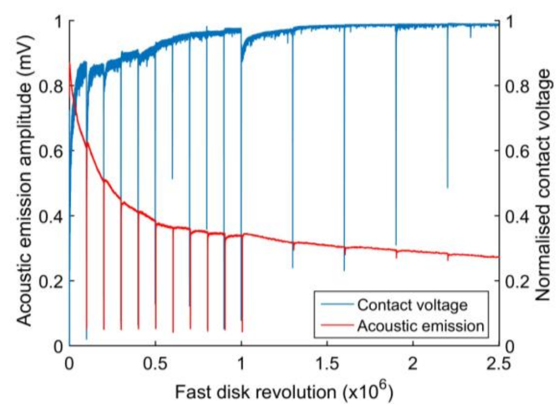

Figure 2. Micro-pitting fatigue test. Showing the mean Acoustic Emission band-passed between 150 - 300 kHz and the contact voltage for comparison. The spikes are transients due to pauses for surface measurement.

ACKNOWLEDGMENTS
EPSRC Grant references EP/L021757/1, and EP/K031635/1 supported this work in part.

REFERENCES
[1] Hamel M., Addali A., and Mba D. "Monitoring oil film regimes with acoustic emission." Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology, 228, 2, 2014, 223-231