

## LUBRICATION CONDITION MONITORING IN EHD LINE CONTACTS USING THE ELECTRICAL IMPEDANCE METHOD

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### KEYWORDS

*EHL; Experiments in tribology; Wear; Condition monitoring*

### ABSTRACT

In this study, we developed the electrical impedance method [1] which measures thickness and breakdown ratio of oil films in elastohydrodynamic (EHD) line contacts simultaneously within thrust needle roller bearings [2]. Initially, we theoretically demonstrated that the oil film thickness  $h$  and breakdown ratio  $\alpha$  can be simultaneously measured from the complex impedance produced when an AC voltage is applied to EHD line contacts. To verify the measurement accuracy of the developed method, we monitored the oil film thickness of a thrust needle roller bearing and compared with the theoretical value by Ertel–Grubin equation [3], as shown in Fig. 1. Additionally, we measured the lower race temperature  $T$  and bearing torque  $M$  to detect the lubrication condition in detail.

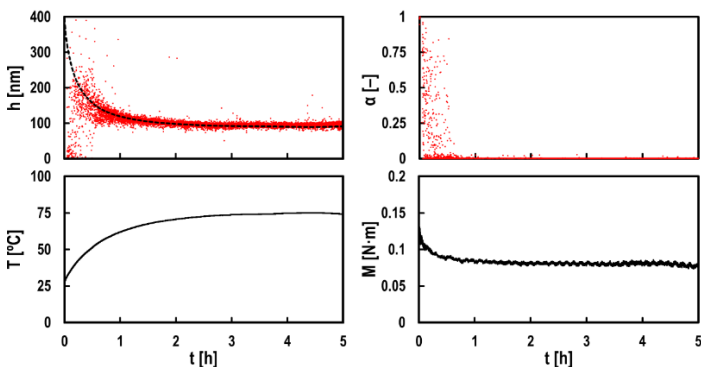


Fig.1 Time evolutions of measured oil film thickness  $h$  (top left), breakdown ratio  $\alpha$  (top right), lower race temperature  $T$  (bottom left), and bearing torque  $M$  (bottom right); bearing: FNTA2542, lubricant: mineral oil, rotational speed:  $N = 3000 \text{ min}^{-1}$  and axial load:  $F_a = 1.5 \text{ kN}$ ; red plots in graphs: measured values by the electrical impedance method; black broken line in top left graph: theoretical prediction at  $T$  by Ertel–Grubin equation.

These results revealed that the oil film thickness was thinner than the theoretical value immediately after starting the test, with the breakdown ratio greater than 0 (indicating mixed lubrication). However, the breakdown ratio decreased over time, and the oil film thickness nearly matched the theoretical value one hour after starting the test, when it is believed that running-in wear is complete (i.e.,  $\alpha \approx 0$ ). Furthermore, after examining the race surface following the test, we confirmed that running-in wear had indeed occurred, as shown in Fig 2. These results suggest that the developed method can monitor the lubrication conditions in EHD line contacts, such as those in practical bearings, in detail.

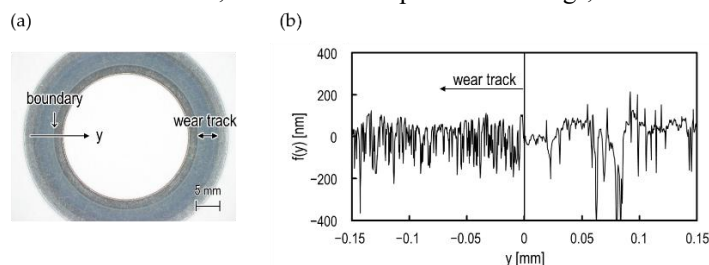


Fig.2 Observations of the lower race surface after the experiment; (a) photograph of the wear track and (b) surface roughness profile around the boundary of the wear track; black vertical line at  $y = 0$  in (b): boundary of the wear track.

### REFERENCES

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