A NOVEL METHOD FOR THE SIMULTANEOUS MEASUREMENT OF GREASE FILM THICKNESS AND CAGE ROTATIONAL SPEED IN ROLLING ELEMENT BEARINGS.

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KEYWORDS
Rheology, Fluid lubrication, Experiments in tribology, Ultrasonic film thickness

ABSTRACT
The precise and in-situ measurement of film thickness and the rotational speed of rolling elements within bearings is critical for understanding their tribological characteristics. Instances such as lubricating film breakdown or excessive slip can induce wear and eventual failure of the bearings. [1] This paper introduces a novel approach for concurrently assessing lubricant film thickness and rolling element rotational speed in rolling element bearings using ultrasonic reflectance. [2]

The methodology outlined demonstrates the feasibility of reconstructing grease film thickness profiles in small-sized rolling element bearings operating at high rotational speeds. This is achieved by synchronizing the pulsation of piezoelectric transducers with the rotational speed of the bearing cage, facilitated by an innovative synchronization algorithm exemplified in detail and validated through experimentation on a standard grease shearing machine.

Within this experimental setup, the film thickness of three commercially available Lithium-based greases is measured under various loads and rotational speeds. Comparative analyses are conducted between the ultrasonically measured thickness, the Hamrock-Dawson equation, literature findings, and torque measurements. [3] Furthermore, alongside film thickness measurements, non-invasive and in-situ assessments of rolling element rotational speed are performed with an accuracy of ±2 rpm. This enables the identification of critical transitions to slip conditions, dependent on journal rotational speed and applied load.

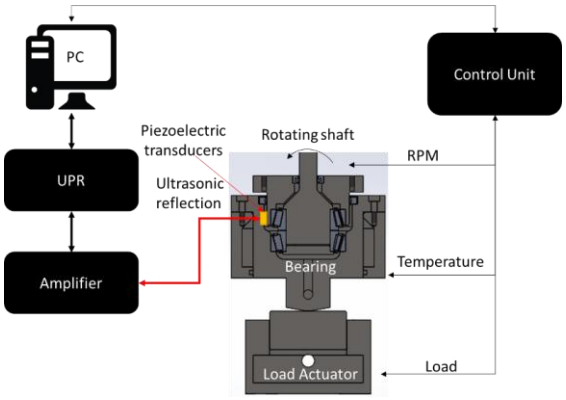

Fig. 1 illustrates the measurement setup of a rolling element test rig, equipped with various sensors and actuators including an ultrasonic reflectance sensor, temperature sensor, torque sensor, load actuator, and load sensor.

ACKNOWLEDGMENTS

This work was funded by the "Austrian COMET-Program" (project InTribology, no. 872176) via the Austrian Research Promotion Agency (FFG) and the Provinces of Niederösterreich and Vorarlberg and was carried out within the "Excellence Centre of Tribology" (AC2T research GmbH).

REFERENCES

[1] Lugt, Piet M. "A review on grease lubrication in rolling bearings." Tribology Transactions 52.4 (2009): 470-480.
[2] Dwyer-Joyce, R. S., B. W. Drinkwater, and C. J. Donohoe. "The measurement of lubricant–film thickness using ultrasound." Proceedings of the Royal Society of London. Series A: Mathematical, Physical and Engineering Sciences 459.2032 (2003): 957-976.
[3] Zhou, Yuxin, Rob Bosman, and Piet M. Lugt. "An experimental study on film thickness in a rolling bearing

for fresh and mechanically aged lubricating greases." Tribology transactions (2019)