Advanced Electro-Tribological and Electro-Rheological Testing of Grease Lubricated Ball Bearings – from Impedance to Break Down Voltage

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1. INTRODUCTION

Lubricants used in electric mobility applications have to cater to an additional set of criteria, beyond the existing traditional requirements. If the stray currents produced by frequency converters used to control the motor speed are discharged through the associated ball bearings, over long term, it can damage the bearings [1]. To counter it, development of lubricants for electric vehicles must also consider electrical parameters such as permittivity, conductivity, and breakdown voltage. The primary aim of this study is to present a novel test methodology to investigate different greases at lab-scale to simultaneously characterize their frictional, and electro-tribological response. Additionally, the rheo-tribometer made it possible to measure rheological and electro-rheological properties of the greases. The sum of all these investigations can help us develop a model to understand the behavior of grease-lubricated ball-bearing systems under dynamic conditions.

2. SETUP AND METHODS

This study used type 7200 angular contact ball bearings filled with conductive and non-conductive grease. Additional tests were performed in a 25 mm diameter plate-plate setup at 100 µm gap.

Figure 1 MCR Tribometer test setup with DC voltage source.

The rheological and tribological measurements were carried out on a modular compact rheometer (MCR) equipped with different accessories. With the help of an electrical setup (Figure 1) using a DC voltage source, the occurrence of voltage break down was recorded during rotational speed ramps at 20V DC (Figure 3) and, at constant rotational speed, during a voltage sweep from 0 to 200 V DC.

3. RESULTS AND DISCUSSION

The speed ramps in Figure 2~~Figure 2~~ show the typical shape of Stribeck curves including the boundary, mixed, and the hydrodynamic regime. As expected, voltage breakdown is related to rotational speed which correlates with film thickness.

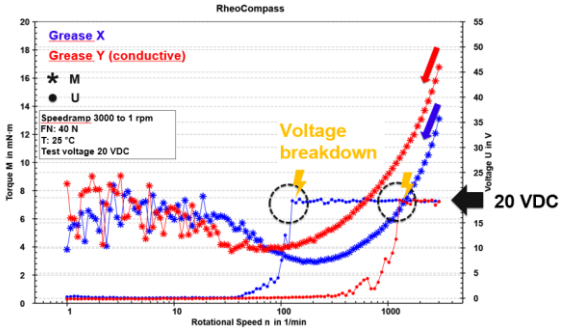

Figure 2. Graph showing the frictional torque and voltage breakdown as a function of rotational speed with two different greases in a 7200 ball bearing.

As demonstrated in Figure 2, if a ball bearing is operated from standstill up to higher rotational speeds, there is always an operating state at which flashovers may occur even at low voltages and even with conductive greases. But the lower the voltage at the flashover and the lower the capacitance of the ball bearing, the lower will be the energy of the flashover and thus the damage of the bearing raceways.

4. REFERENCES

[1] Gonda, A.; Capan, R.; Bechev, D.; Sauer, B. The Influence of Lubricant Conductivity on Bearing Currents in the Case of Rolling Bearing Greases. Lubricants 2019, 7, 108. https://doi.org/10.3390/lubricants7120108