Greases for e-drives: Thickener effect in high-speed bearings

Gabriel Calderon Salmeron[1) *], Fabian Schwack[1)], Johan Leckner[2)] and Sergei Glavatskih[1,3,4)]

[1)]System and Component Design Division, KTH Royal Institute of Technology, Sweden
[2)]Axel Christiernsson International, Sweden
[3)] Department of Electromechanical, Systems and Metal Engineering, Ghent University, Belgium
[4)] School of Chemistry, Faculty of Science, University of New South Wales, Sydney, Australia

*Corresponding author: gbcs@kth.se

The electrification of vehicles generates new challenges in driveline designs. Electric motors in e-drivelines are equipped with grease-lubricated bearings that need to fulfill challenging conditions such as high-speeds. This work focuses on how greases with different thickener systems, such as polypropylene and lithium-complex, perform under high speed and low load conditions in terms of friction and self-induced temperature. The experiments were executed with deep groove ball bearings at speeds relative to the bearing size of up to 600.000 nDm. The results suggest that not only base oil properties are important, but that the thickener also plays an important role in the energy consumption in the high-speed region.

Keywords (from 3 to 5 max): Grease, polypropylene thickener, lithium-complex thickener, rolling element bearings, high speed bearing test rig

1. Introduction

The electrification of vehicles generates new challenges in driveline designs. One of these challenges is related to the grease-bearing interaction in the electric motors since these bearings generally operate at high-speed rates. Based on the importance of reducing the friction in grease-lubricated bearings [1, 2], novel grease formulations are needed. To tune these formulations for such conditions, new testing methodologies for studying grease-bearing systems are needed [3].

2. Method

A new test rig that emulates the conditions of electric vehicles (Figure 1) is designed to perform experiments with mechanical conditions as close as possible to the ones present in an electric motor. The tribological response and the energy-saving potential of different grease-bearing combinations can be quantified in the new rig. The test rig allows variable load and speed tests. Friction torque is measured directly to achieve the highest accuracy and fastest response and determine energy-saving potential. 6208 deep groove ball bearings are used for the investigations.

Figure 1. High-speed bearing test machine

Lithium complex and Polypropylene greases based on the same oil and with the same NLGI grade are tested. Both greases are free from additives to isolate the effect of the thickener on temperature and friction torque. Several tests are carried out with speeds up to 600.000 nDm. The representative test duration is approximately 385 hours, consisting of a running-in period (48 hours), two ramp sweeps from 100.000 to 400.000 nDm, and one ramp sweep from 100.000 to 600.000 nDm.

3. Results and Discussion

The impact of speed on bearing operating parameters is presented. Strong thermal transients in the grease lubrication are observed during the running-in period when the shaft speed is increased in ramps from 100.000 to 400.000 nDm. The transient and steady-state data unveil the complexity of grease responses to changes in operating conditions. Polypropylene grease shows a more favorable response in terms of friction (Figure 2) and can be proposed as an alternative grease for electric vehicles. The polypropylene thickener technology could become the preferred one in the upcoming years and replace the traditional lithium-based greases that are also under pressure due to the possible shortage of lithium caused by its use in Li-ion batteries.

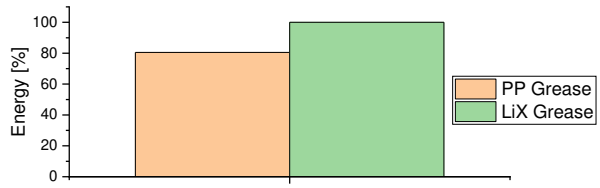

Figure 2. Mean consumed energy during the experiments. Normalized with the LiX grease.

4. References

[1] B. Vengudusamy et al., "On the film forming and friction behaviour of greases in rolling/sliding contacts," Tribol. Int., vol. 129, no. August 2018, pp. 323–337, 2019.

[2] L. I. Farfan-Cabrera, "Tribology of electric vehicles: A review of critical components, current state and future improvement trends," Tribology International, vol. 138. pp. 473–486, 2019.

[3] J. Van Rensselar, "The tribology of electric vehicles," TLT Tribology and Lubrication Technology, pp. 34-43, 2019.