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Influence of a vibration load on the service life of rolling bearings in e-drives

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The increasing hybridization of drives places completely new demands on drive technology in vehicles. The combination of combustion engine and electric motor creates new challenges for the installed rolling bearings, as they are exposed to the vibrations of the ICE and the effects of driving dynamics when the electric drive is at a standstill. So far there have been almost no systematic studies of how these vibrations and the associated risk of standstill markings (false brinelling, fretting corrosion) affect the service life of the bearings. In this article /presentation a new test bench is presented, and the first results are discussed.

Keywords: E-drive, roller bearings, standstill marks, false brinelling, lifetime

1. Introduction

The electric drive is - regardless of whether in connection with a battery or a hydrogen fuel cell - the drive of the future. Compared to the internal combustion engine and its gear boxes, which have been continuously optimized for many decades, new solutions for these drive technologies now have to be developed relatively quickly and made suitable for series production. Because of the high demands placed on the drive components of a hybrid or electric car, this is an extremely demanding task [1].

2. Challenges and solutions

If a combustion engine and electric drive are combined, the rolling bearings are exposed to conditions that are absolutely not ideal. In particular, the vibration load caused by dynamic driving effects and the internal combustion engine is a major problem here. It was therefore very quickly recognized that early damage can result from standstill markings or false brinelling.
For a long time, no differentiation was made between conditions with small and large pivot angles (rolling path x / contact width 2b > 1) in the case of “false brinelling damage”. Thus, damage that differ significantly from one another and are triggered by different mechanisms were never differentiated. In order to be able to solve the problems successfully in practice, such a differentiation must be made depending on the swivel angle and contact width occurring in practice. However, if one not only wants to investigate the damage process due to vibration, but also to determine statements about the influence of the resulting damage on the service life of the bearing, one finds that numerous relevant influencing factors in practice cannot be simulated on the existing test stands. A big problem is, for example, that the rolling bearing “normal operation” cannot be simulated on it. For the life time prediction, however, it is precisely this interplay between vibration stress and high dynamics that is decisive, as local pre-damage can occur in the area of small swivel angles, which only leads to a failure under dynamic loads with a high rollover frequency (such as fatigue or pitting damage). For that purpose, a new test rig was designed.
On the test bench, angular contact ball bearings are predamaged under axial load by an oscillation movement and immediately afterwards subjected to an endurance load by rotation whereby high speeds are possible. What effects standstill markings have on the lifetime of the rolling bearings due to the oscillation pre-damage can be checked. Within the presentation and the full paper lifetime test results will be presented and discussed.

3. Conclusion and outlook

As part of a publicly funded project, it was possible to develop and set up a new roller bearing test bench with which it is now possible for the first time to specify combined load profiles consisting of the smallest pivoting loads and continuous rotation. The performance data of the test stand are specially designed for the requirements of rolling bearings in electric drives for vehicles. State-of-the-art measurement technology allows online monitoring of the most important tribological measured variables and thus an interpretation of the processes taking place in the contact points.
First results show that the test bench meets the expectations placed on it. The measurement results give hope that it will be possible to track the occurrence and progress of the damage online. The next steps are testing the maximum possible test bench parameters and then developing a standard test for industry. In a first larger series, the influence of defined standstill markings on the bearing life is to be determined. These results will be presented within the detailed manuscript and the presentation on the conference.

4. References

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