Success Story
COMET

FFG

AC²T research

XTribology
Excellence Centre of Tribology
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K2-Centres
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Multiscale Modelling of Porous Journal Bearings

The silent bearing – Our little "everyday helper"

The quest of AC²T and leading automobile parts suppliers for a porous journal bearing system for the automotive industry that is not only long-lived and reliable, but also extremely quiet even at the lowest operating temperatures, was crowned with success. The smart combination of modelling, laboratory experiments, measurement technology, and analysis led to the market launch of a novel lubricant that allows windshield wipers and power window lifts to operate without that dreadful cold squeaking noise, even well below freezing.

All that squeaks …

We all know squeaking from everyday life: the broken fan on your laptop computer, the electric mixer or the door whose hinges are in dire need of some oil. In cars, this affects mainly the bearings used in windshield wipers, power window lifts, fans, and air conditioners. In the automotive industry, reliability and comfort have the highest priorities, so we usually consider unpleasant noises during regular operation unacceptable.

A journal bearing is a simple and cheap mass-production element, which in principle does its job when being paired with a matching shaft (of a drive). So-called porous journal bearings are produced from metal powders and are soaked with a lubricant like a sponge. They have the advantage of "life-time lubrication", that is, they are maintenance-free and functional for their running life of typically 15 years.

The motivation for formulating a novel porous bearing oil was the customers' wish for a smoothly running bearing, in particular the prevention of so-called "cold squeaking" at temperatures below -20 °C. On the other hand, the full functionality and the running life of the bearing in the temperature range from -40 °C to +120 °C must be kept, since operation must remain possible in cold regions as well as in the hot engine compartment. Previous lubricants have frequently failed in terms of quiet running, especially at low temperatures. We could summarize that a soaked porous journal bearing has to be reliable, long-lived, maintenance-free, silent, and of course also cheap.

Simulation – Laboratory experiment – Validation – Prototype

The challenge was to design a developing environment from a combination of simulation and laboratory experiments, to assess the running life and the functionality, and to emulate these under realistic operating conditions. The experimental part focused on a targeted "creative" adaptation of a precision tribometer to make the occurring phenomena – cold squeaking and long term stability – observable and measureable. On one hand, this was achieved via heat-able and cool-able sample holders constructed at AC²T, and on the other hand via a special vibration sensor (see Fig 1),

the data of which was analysed using methods borrowed from speech recognition.

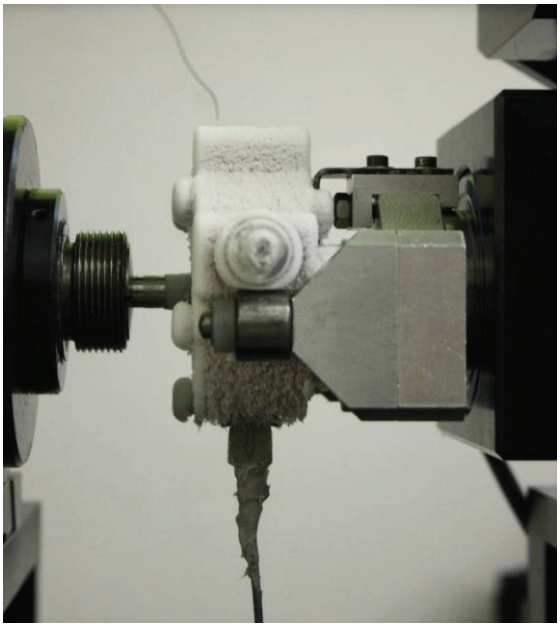

Fig. 1: Bearing experiments under realistic operating conditions down to -60 °C (at the bottom: vibration sensor for measuring the cold noises)

Additionally, simulations were carried out to study the influence of bearing geometry, the material and lubricant properties, temperature, and operational parameters (load, rotation speed) on the running properties of the bearing (friction losses, lubrication state, etc.). It was also necessary to model the angle-resolved oil permeability of the so-called "sinusoidal bearing" (see Fig. 2), patented by two project partners and featuring 10 alternating zones of stronger and weaker compression, and to validate the results on a test rig designed and constructed at AC²T. These measures were accompanied by rigorous chemical and physical lubricant and material analysis.

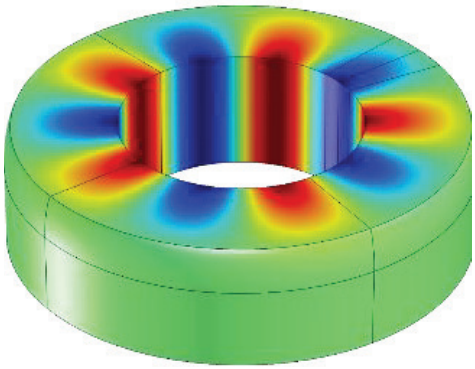

Fig. 2: Model for the permeability of the "sinusoidal bearing" with zones of stronger and weaker compression

Effects and Outcome

The joint research project of AC²T together with industrial partners led to the successful development and market launch of a novel porous bearing lubricant.

It was critical for the success that all players in the supply chain (lubricant producer Klüber, bearing producer GKN, automobile parts suppliers Bosch and ebm-papst) cooperated with the research partner AC²T in a long-term project to explore the fundamentals, which allowed the development of a new product.

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Robert Bosch GmbH	Germany
ebm-papst St. Georgen GmbH & Co. KG	Germany