The challenge of studying the impact of lubrication on ball bearing performance

and why we use an alternate approach

The lubrification is fundamental in ball bearings. As a matter of fact, many researches are still ongoing in order to improve the understanding of the behavior of lubricants within bearing. This useful research is performed at both academic and industrial levels.

In particular, many challenges are associated with the numerical modeling of lubricated contacts:

- The complexity of EHL (elastohydrodynamic lubrication) is very big;
- The multiplicity of the parameters is significant;
- The time required for the simulations can be very high;
- The availability of the relevant lubricant data can be tricky or may requires a huge amount of resources (money, time, equipment,...) to extract the useful parameters (viscosity, pressure coefficient, temperature coefficient,...).
- ...

Picture designed by vectorpouch

Also, when modeling the impact of lubrication, managing uncertainties and multiple hypotheses remains arduous:

- Are the contacts correctly fed by the lubricant?
- Are the experimental data really reliable?
- Is the mathematic treatment reliable (numerical stability ,numerical convergence,...)?
- Are the classic film thickness formula enough to correctly estimate the actual film thickness (formula historically established for academic cases, as cylinder on cylinder)?
- ...

At APO-GEE, our goal is not to replace the work performed by all the lubricant researchers all over the world. If it would be so, how could we do that? However, the question that we asked ourselves is this one: is an EHL model necessary to achieve what we want to achieve?

Our goal is to understand how we can improve the working behavior of ball bearings. We do that by understanding the physics behind the deleterious phenomena, from one side, and by proposing innovative solutions based on these physical aspects, on the other.

Coming back to the lubrication, let us first consider the cage instability problem. Our goal is not to precisely determine how the cage could behave with one lubricant or another. Our goal is to understand the effects of friction on the behavior of the cage. What is the impact of low friction (optimal lubrication)? What is the impact of high friction (bad or no lubrication)? Once we have a deep understanding of this, how can we act to solve the cage instability problem? If we attempt to bring a new solution based on the design, this approach does not necessarily require a dedicated EHL model. We have proved it.

The same observation can be made for high-speed bearings. Our goal is to find a way to understand how to significantly improve the behavior of high-speed ball bearings. If we can identify generic improvements, which are independent of the friction level, a dedicated EHL model is not necessarily required either. We have also proved it.

Research on lubrication remains a relevant and important topic to continue to explore. As well as associated modeling. But solving complex issues can also come from a deep understanding of ball bearing physics (and more particularly the kinematics of the balls), associated with an original methodology. We spent 10+ years of intensive and continuous research to reach this. With significant proven and demonstrated results.

In this context, what would be your next bearing engineering challenge?

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