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A first approximation of the global energy consumption of ball bearings

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Rolling element bearings are found in every piece of machinery and are, therefore, a source of energy losses that can't be ignored. During the last years a series of energy efficient bearings have been developed aiming to reduce the losses of a bearing without sacrificing its load carrying capacity. A methodology to estimate the energy losses of the usage of a specific bearing type on a global scale is presented in this paper. The method that is based on current norms, provides a first approximation for the determination of the CO_2 emissions of bearings and it is tested for its plausibility.

Keywords (from 3 to 5 max): rolling bearings, energy efficiency, friction, ball bearings

1. Introduction

The contribution that widely used components have on global energy emissions has not been investigated up until now. Rolling element bearings are found in every piece of machinery and are, therefore, a source of energy losses that can't be ignored. The influence of friction optimized designs and the use of new material have on friction needs to be quantified, in order to assess the impact that the REBs have on the global CO_2 emissions. A methodology to estimate the energy losses of the usage of a specific bearing type on a global scale using existing norms is presented in this paper.

2. Methods

In order to calculate the friction losses of ball bearings, a set of operating conditions had to be chosen. ISO 15312 [1] (thermal speed rating calculation) is the only source for a commonly acceptable set of operating conditions found in the literature. The operating conditions used in the calculations are found in Table 1.

Table 1: Operating conditions

Ref. Temp. Bearing	70°C
Ref. Load for Radial Bearings	5% C0r
Lubricant viscosity @ 70°C	12 mm²/s
Method of lubrication	Oil bath
Internal clearance	N
Bearing rotation axis	Horizontal
Stationary ring	Outer ring

2.1. Method of calculation

Friction calculation were carried out for the 62 type of ball bearings. This type was chosen as being an average type of all ball bearings. The calculations were run using the bearing calculation software BearinX of Schaeffler and the SKF friction model. The results of the energy losses were then weighted according to sales volume of each specific bearing dimension. A yearly running time of 38% corresponding to 3287h/year was assumed [3].
The calculations were carried out for standard Schaeffler bearings (Schaeffler Standard) as well as for a mix of friction optimized and standard bearings (Schaeffler Product Mix).

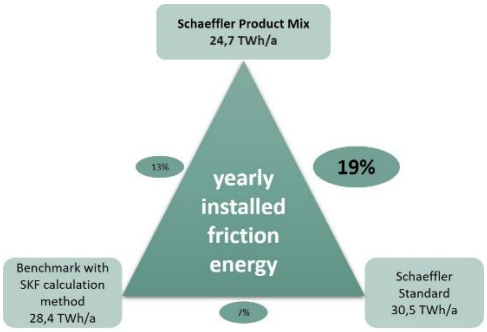

Figure 1: Total friction losses of ball bearings.

3. Discussion

The results make the effect of friction optimized designs more than evident. The Schaeffler Product Mix which includes the bearings with friction optimized designs are in total 19% less energy intensive are their standard counterparts. Given the amount of bearings installed in machinery worldwide, this amounts to 5.8 TWh/year. The plausibility of these results is made clear when the same calculations are carried out using the SKF friction model. Even though the model is semi empirical and specifically tailored to SKF bearings, it is still predicting friction losses in the same amount as the Schaeffler software BearinX. Given the differences in design between the bearings of the two companies the agreement of the results is seen as acceptable.

4. Conclusion

A method for calculating the energy losses of rolling element bearings has been presented. The results make clear what amount of energy savings can be made when adopting energy efficient designs. This method can be used for any type of bearings and if modified accordingly for other components.

5. References

[1] ISO 15312, "Rolling Bearings – Thermal Speed Rating - Calculation", 2008.
[2] F. Bauer, H. Groß, „Betriebszeiten in Europa – Wo stehen die deutschen Betriebe?, WSI Mitteilungen 6/2006, 314 - 320