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INFLUENCE OF LUBRICANT TYPE ON THE FRICTION PROCESS PARAMETERS OF TAPERED BEARINGS

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Abstract. In order to extend the service life of rotating units of various equipment, it is necessary to ensure proper lubrication of the bearings. Bearing durability depends on various operational parameters such as load applied to the bearing, rotational speed, lubrication method and grease used. This paper presents the results of the research on tapered bearings. During the study, the aim was to determine the influence of the type of grease used on the indicators of the bearing friction process and how these indicators change for bearings of different manufacturers.
Keywords: tapered bearings, friction, wear, surface roughness

INTRODUCTION

Many different experiments are carried out in the field of studying the wear process of rolling bearings. For example, the Porto Mechanics Institute [1] tried to determine the effect of biolubricants on the wear of tapered bearings. The Japanese Society of Tribologists conducted tests to determine the effect of wear loss on tapered roller bearings [2].

This article presents the results of experimental research on tapered bearings. Tapered bearings are used in cars, various machine tools, reducers and other devices. This type of bearing has good resistance to radial and axial loads and shocks. Tapered bearings of three different manufacturers were chosen for the research: TIMKEN JL 69349-310, KOYO JL 69349-10, SKF JL 69349-310/Q. This type of bearing is used in cars such as Mazda, Kia and others. There were chosen such conditions for the experiments, that correspond to the operating conditions of tapered bearings installed in car wheels. The main dimensions of the investigated bearings: diameter of the outer ring 63 mm, diameter of the inner ring 38 mm, bearing height 17 mm.

Tapered roller bearings from three different manufacturers were tested experimentally. During the experiments, different types of oils were used in order to evaluate the influence they have on the indicators of the friction process of the bearings, and at the same time on the longevity of the bearings.

PROCESS OF THE RESEARCH

During the experiments, the bearing was loaded with an axial force (Fig. 1) F_a, which, depending on the design of the tapered bearing, transfers the load to the rollers, which in turn transfer the load to the outer ring of the bearing. Due to the design of the tapered bearing, the outer ring of the bearing is subjected to an axial load F_{Ra} and a radial load F_{Rr}.

A tribological test stand (Figure 2) was used for the tests. The main characteristics of the stand:

- Engine power – 1.5 kW;
- Engine speed – 1500 rpm;
- Belt drive ratio – 1:1;
- Minimum load – 400 kg;
- Maximum load – 5000 kg.

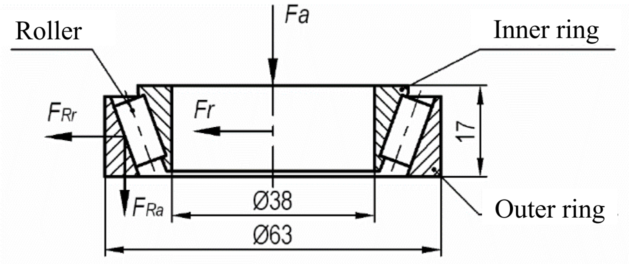

Figure 1. **Load diagram of a tapered roller bearing**

Figure 2. **Tribological bearing test stand (**1 **–** load; 2 – the location of the load on the bearing; 3 – engine; 4 – the seat of the bearing under study; 5 – switch with fuses**)**

The tests were carried out using several types of oils:

- Engine oil Pemco 10w40
- Transmission oil Pemco 80w90
- Universal consistency grease Litol-24.

Each bearing was tested for at least 3 million cycles. After every 300,000 cycles, the bearings were disassembled, all parts of the bearing were cleaned without disassembling the separator with rollers, measurements and visual inspection were performed, during which defects on the working surfaces of the bearings were identified (Fig. 3). The bearings were then re-installed in the test stand with the remaining oil (oil was topped up if necessary) and the bearing was allowed to continue rotating for another 300 thousand cycles.

During the research, the bearing wear and roughness parameters *Ra*, *Rz*, *Rmax*, *H* were measured. The height of the bearing was measured at four points inside the outer ring of the bearing with two Holex indicators, division value of which was 0.01 mm (Fig. 4). Surface roughness was measured with a profilometer Garant ST1.

Figure 3. **Various fixed defects of the investigated bearing surfaces were recorded with a metallographic microscope (**10 times magnification**)**

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New bearings were chosen for the tests, unlike previous experiments that looked at both new bearings and bearings that have been already in service. Used bearings were tested in the previous experiments, since not only the influence of various lubricants on the bearing characteristics was studied, but also RVS lubricant additives, which aim to restore the serviceability of used bearings. This article will not discuss the use of RVS lubricant additives and their effect on the restoration of bearing friction surfaces.

During the experiments, the bearings were subjected by a load of constant magnitude and it was equal to 1250 kg. During preliminary studies [3], bearings were tested at different rotation frequencies and with different lubricating oils. The following values of rotation frequency were chosen: 250 rpm (corresponds to a car speed of 30 km/h), 500 rpm (corresponds to a car speed of 60 km/h), 750 rpm (corresponds to a car speed of 90 km/h) and 1000 rpm (corresponds to a car speed of 120 km/h h car speed). This paper presents the results of research where the rotational frequency of the bearings was constant and equal to 1000 rpm, so that the time for testing each bearing would be as short as possible, and the progress of wear would be observed more quickly, but not exceeding the limit conditions of the bearing operation defined by the bearing manufacturer.

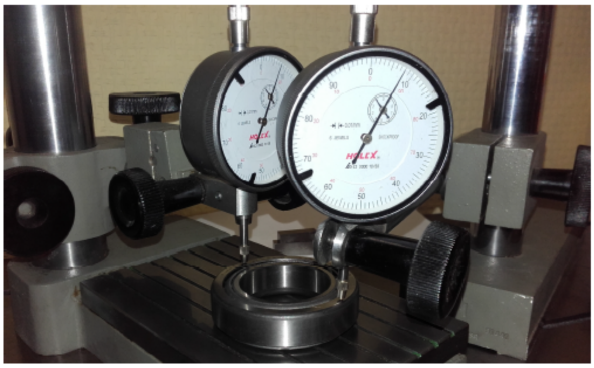

Figure 4. **Bearing height change measurements**

ANALYSIS OF RESEARCH RESULTS

The results of measurements of the height change of the bearings examined during the study are presented in Figure 5. More than 8,000 measurements were taken during the study. The obtained data were processed statistically and the mean values were used in the graphs presented in Figure 5. Graphs of bearing height variation are obtained using approximating curves.

The smallest bearing height change was recorded for a Timken bearing that was lubricated with Litol 24 grease, and the height change was 10 m. An analogous height change was obtained for an SKF bearing using the same grease. The largest change in bearing height was found for the Koyo bearing, lubricated with Pemco 80w90 oil. The height change is equal to 26 m (from 91 m to 65 m). When using Litol 24 grease, the height change reached 20 m.

The largest change in surface roughness (0.131 m) was determined for the Timken bearing, which was lubricated with Pemco 10w40 oil. The smallest changes in surface roughness for all tested bearings were obtained for lubrication using Litol 24 grease. The change in roughness was 0.032-0.035 m. As can be seen from the curves (Fig. 6), at the beginning, the wear of the contact surfaces of the bearing takes place, so the roughness decreases. After reaching 1 million cycles, the contact surfaces become fatigued and begin to break down - the curves begin to rise, i.e. roughness increases. Detached small surface particles scratch and destroy the working surface and after 2-2.5 million cycles it increases the roughness of the contact surfaces. As the process continues, for Timken (Litol-24) and Koyo (Litol-24) bearings, the roughness begins to decrease again, because the thick grease prevents heat from dissipating, and the particles in the grease are beaten to the surface and the surface resets, while the roughness of the other bearings (Figure 6) continues to increase, because more and more particles appear in the grease, they move freely in the grease, sometimes they are pressed, then they are rubbed off the contact surfaces again, the liquid grease easily gives off heat, so the resulting medium and conditions worsen the rolling of the contact surfaces of the bearing against each other (ring-roller).

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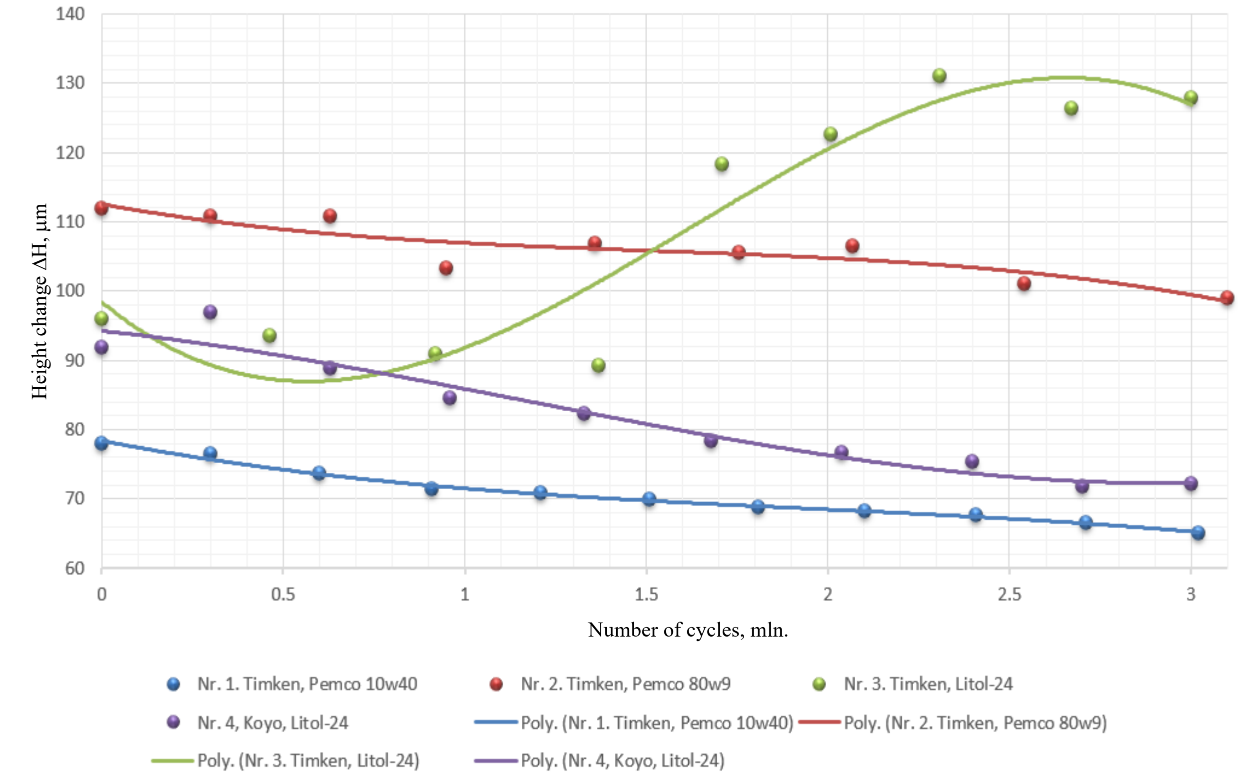

Figure 5. **Bearing height variation**

Figure 6 presents the results of measurements of the roughness *Ra* of the working surface of the outer ring of the tested bearings.

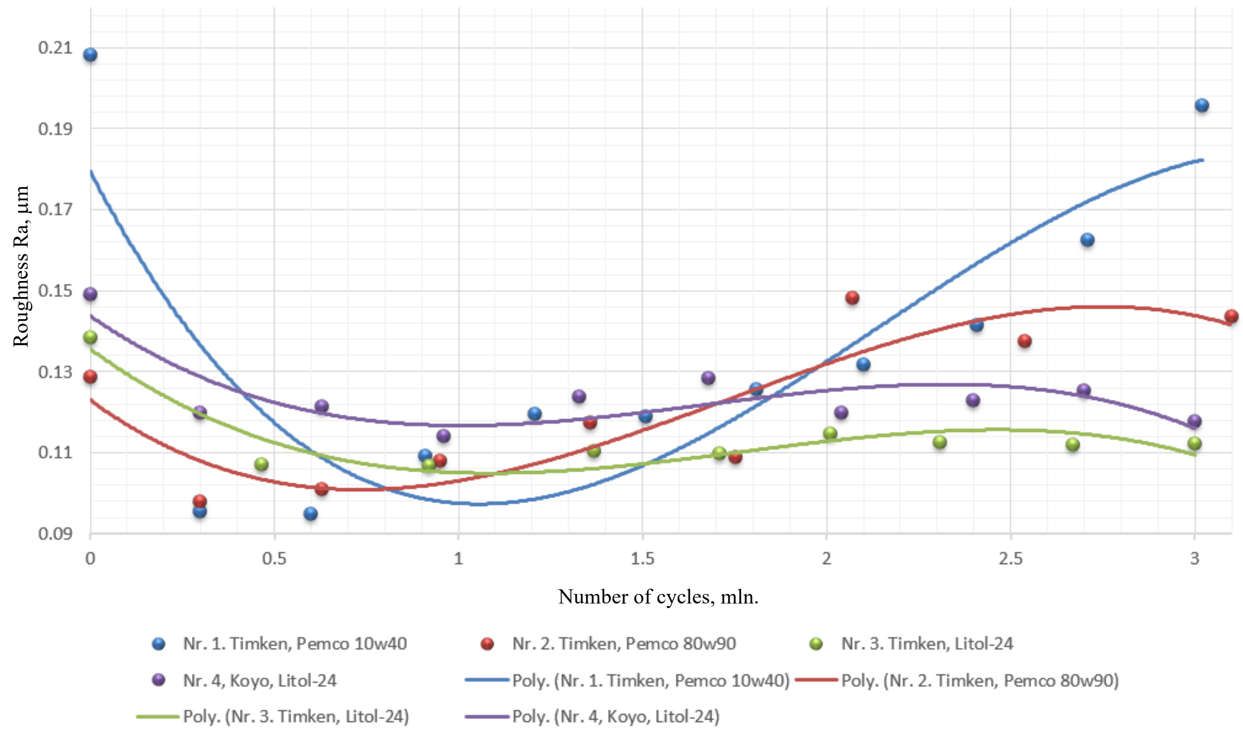

Figure 6. **Variation of the roughness *Ra* of the working surface of the outer ring of the bearing**

CONCLUSIONS

1. The analysis of the obtained results shows that the type of lubricant has a rather large influence on the wear of the bearings. The largest changes in bearing height and working surface roughness were obtained for bearings that were lubricated with Pemco 10w40 oil. Meanwhile, the smallest changes in the

parameters of these bearings were obtained using universal consistency grease Litol 24, the viscosity of which was the highest among the used bearing lubrication fluids.

2. Comparing Timken and Koyo bearings, it was found that the Koyo bearings had a small change in the roughness of the working surface and bearing height. Taking into account the fact that the price of Koyo bearings is approximately 20% lower than Timken bearings, and the obtained wear parameters results are more than 40% worse, it can be recommended to choose Koyo bearings.

3. SKF bearings are 30 percent. more expensive than Timken, and wear parameters are similar to those of Timken bearings, so Timken can be a suitable alternative to SKF bearings.

4. When using oils of lower viscosity (engine and transmission oil), it is necessary to take measures to collect bearing wear products from the oil, because the particles of the worn and broken surface begin to damage the contact surfaces of the bearing and increase the intensity of their wear. Therefore, the tools that are used both in car gearboxes and in the crankcases of internal combustion engines are proven - magnets that attract particles and filters that trap and clean the oil.

REFERENCES

1. B. M. Graca, A. J. V. Campos, J. H. O. Seabra. Taper Roller Bearings Lubricated With Bio Greases. Mecanica Experimental. 2009, Vol 17, 117-128.
2. Tomoya Hotta, Shoji Noguchi, Tohru Kanada. Fundamental Study on Preload Loss in Tapered Roller Bearings. Tribology Online. 2016, Vol 11, No 2, 326-332.
3. Prunskas J., Sukimosi greičio ir tepalo rūšies įtakos kūginių guolių trinties proceso rodikliams tyrimas, magistro baigiamasis projektas. KTU, PTVF, Technologijų katedra. Panevėžys: KTU PTVF, 2016. – 67 p.