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EFFECT OF SELECTED ECOLOGICAL LUBRICANTS ON THE WEAR OF DEFINED SLIDING BEARING

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The presented contribution deals with the comparison of selected ecological oils of the same viscosity class in terms of wear of the sliding bearing B 60 M4 as part of the matched sliding pair lubricated by ecological lubricant. The wear of the sliding bearing is monitored using the parameters; the change of geometric tolerance cylindricity having the most indicative capability about the size and location of wear. The second parameter is weight loss, and the third parameter is the change of surface roughness at the contact point of friction elements. Results are statistically processed and presented in the form of graphs and tables.

Keywords: tribology, Tribotestor M'06, MUK – F 300 PC

Currently, the possibility of compensation of an increasing number of lubricants by ecological equivalent comes to the fore. In the field of agriculture, the use of environmentally friendly lubricants is one of the ways to eliminate the pollution of soils, water and groundwater with operation fillings of agricultural mechanisms. The expanding market with ecological lubricants provides a choice of various products from various manufacturers. In our contribution, we have focused on the comparison of ecological oils in terms of sliding bearing wear as part of a tribological element.

Material and methods

Tribological experiments were performed using Tribotestor M'06. This universal test device enables performing various types of tests such as limit load tests (seizing test), limit velocity tests (velocity seizing test), capacity tests for determining the pv diagram and life (durability) tests.

The test device consists of three main parts. The test part itself is made of the drive units of samples rotational motion, vertical loading force and measuring head. Another part contains the elements of a pneumatic circuit and all electronic devices. The last part is a control-evaluating unit in the form of a connected desktop computer. Starting, check, control, data collection and test evaluation itself are performed on the connected computer.

Our experiment was performed using the seizing test.

In Fig. 1, there are depicted the measuring head and test samples. The sliding node is made of the couple of bodies creating a planar contact by a rotating test shaft against the test sliding bearing.

The sliding bearing is fixed in the measuring head. The sliding bearings by the KaJo Metal company were full-bronze, centrifugally moulded, marked as B 60 M 4, and with the dimensions: φ 30 mm for external diameter, φ 25 mm for internal diameter, and 20 mm for the length of the sliding bearing. The bearing shell of the test shaft with φ 25 mm for external diameter and with length 25 mm was made from steel 14 220 and fixed to the cylindrical part of the supporting shaft. The supporting shaft was attached to the drive unit by a shrink conic connection through tightening force over the internal thread in the cone. The sliding node was lubricated using the test ecological oil, which was gravitationally dropping through the upper part of the measuring head.

The ecological oils Mogul HEES 46, Hydros 46, Fuchs Plantohyd 46 S and Shell Naturelle 46 HF-E were the tested lubricating mediums.

Mogul HEES 46 is an ecological oil produced on the base of synthetic esters. It is designated for extremely stressed hydrostatic systems of machines and equipment working at temperatures between -20 °C and 80 °C throughout a year. There is expected a lifetime similar to the lifetime of petroleum oils.

Hydros 46 is a biologically decomposable oil on the base of saturated synthetic esters. It is characterised by excellent properties under high pressure and temperature and multiple extension of exchange intervals. It is neutral to seals, preserves its properties under high frosts, and

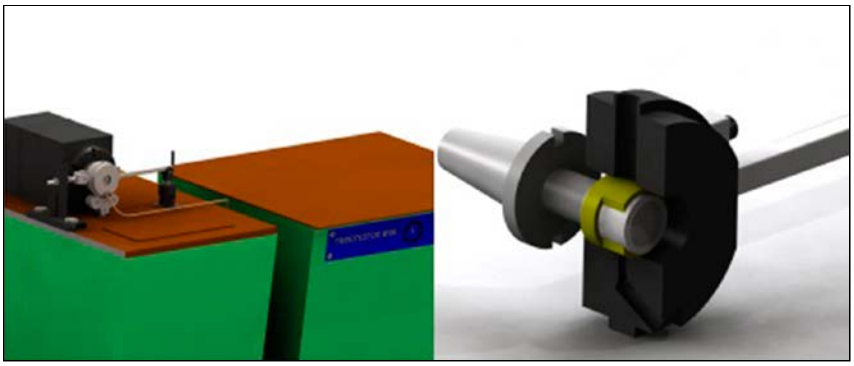

Figure 1 Measuring device Tribotestor M'06 and a detailed view of the measuring head and test samples

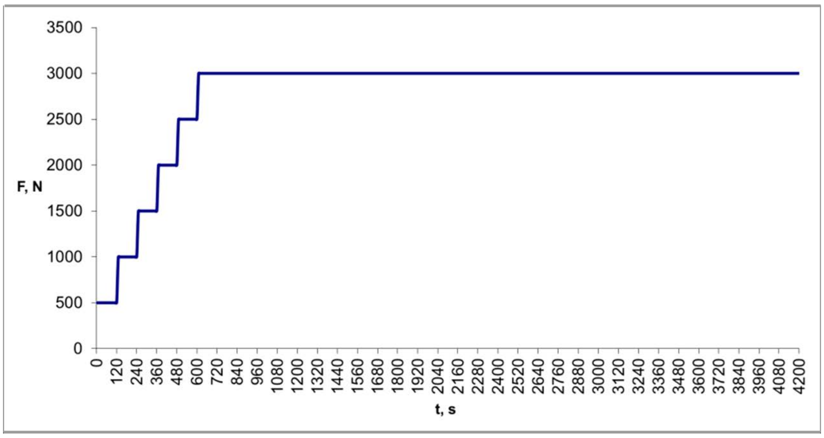

Figure 2 Continuance of loading force depending on time

Figure 3 Devices used: MUK – F 300 PC, Mitutoyo SJ-201 and Voyager Pro VP 613 CN

Experimental tests were performed under the following operating conditions:

- revolutions 180 min^{-1}, constant throughout the test duration in clockwise direction;
- test duration 70 min, of which 10 min. represented running-up;
- loading ranging from 500 N to 3,000 N according to Fig. 2.

Cylindricity measurement was done using the MUK – F 300 PC device. This device is designated for measuring the variations of shape: roundness, cylindricity, conicity, and straightness of external and internal rotation surfaces with and without interruptions. Measured parameters were evaluated numerically in the form of figures and were simultaneously displayed on the monitor. The diagram of observed deviations was displayed automatically. Information from the screen was also archived and printed on A4 paper. Sliding bearings were weighed before and after the experiment on the accurate Voyager Pro VP 613CN scales, and surface roughness was measured with Mitutoyo SJ-201. The monitored parameter was R_a. The value of R_a represents the mean arithmetic value of absolute deviations of the profile in *n* chosen points of the profile on the basic length.

has good lubricating properties and a minimum foamability.

Fuchs Plantohyd 46 S is an environmentally friendly, rapidly biologically decomposable oil on the base of synthetic esters of HEES type, following the standard VDMA 24 568. It is usable in all the hydraulic and circulation systems that require using the oil of the ISO VG 46 class. It is suitable for mobile and stationary hydraulic systems.

Shell Naturelle 46 HF-E is a fully synthetic, environmentally friendly hydraulic oil for usage in hydraulic and liquid gear systems. Shell Naturelle 46 HF-E is an easily biologically decomposable hydraulic oil with low ecotoxicity, particularly suitable for use in ecologically sensitive fields.

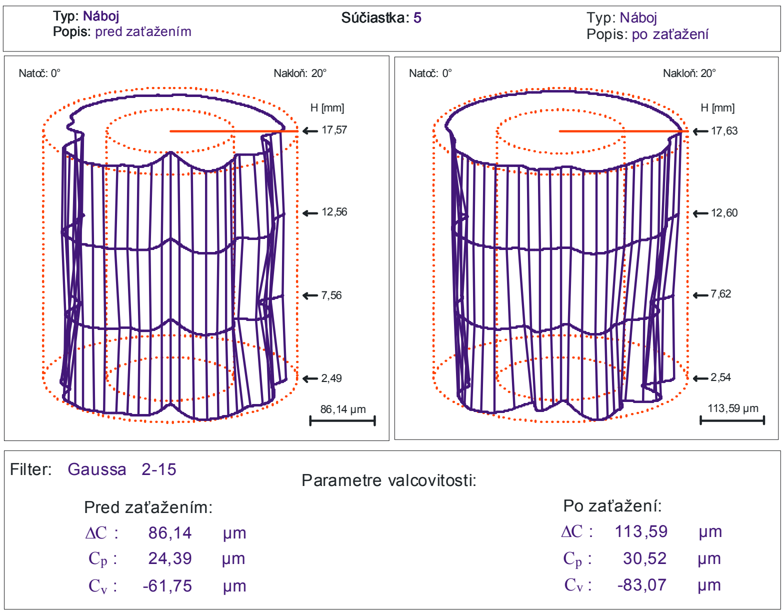

Figure 4 Sample output from MUK F-300 PC

Results and discussion

By using the device MUK-F 300 PC we conducted the laboratory measurements of sliding bearing cylindricity, which defined the value of absolute deviation of cylindricity Δ*C*. Figure 4 shows the outputs of MUK-F 300 PC before and after the experimental tests. Measurements were carried out on all the test samples both before and after the experimental test. On this basis, we determined the resulting value of absolute deviation of cylindricity for individual ecological oils, and they were subsequently processed in graphic form (Fig. 5).

The weight loss of sliding bearings was determined using the accurate Voyager Pro VP 613CN scales, by measuring the weight of samples before and after the experimental test. Figure 6 compares the weight losses of sliding bearings depending on the ecological oil used. Mogul HEES 46 had the lowest value of weight loss, followed by Hydros 46, the third one was Plantohyd 46 S, and the highest value of weight loss was observed in Naturelle HF-E 46.

The evaluation of roughness changes considerably illustrates the ongoing processes of wear during the experimental tests in the sliding node. The roughness of sliding bearings was measured using the Mitutoyo SJ-201 laboratory device before and after completion of experimental tests; the monitored parameter was R_a.

The change of roughness R_a for sliding bearings depending on the oil used is shown in Fig. 7. In all cases, there was a decline in roughness R_a. The highest decline was recorded in Naturelle HF-E 46 and the lowest decline in Hydros 46.

Conclusion

Table 1 gives a summary of the monitored parameters determining the sliding bearing wear. The obtained records also indicate that the highest value of the change of cylindricity deviation Δ*C* of the sliding bearing was recorded in Shell Naturelle HF-E 46, the ecological oil Hydros 46 reached the second highest value of change, followed by Fuchs Plantohyd 46 S,

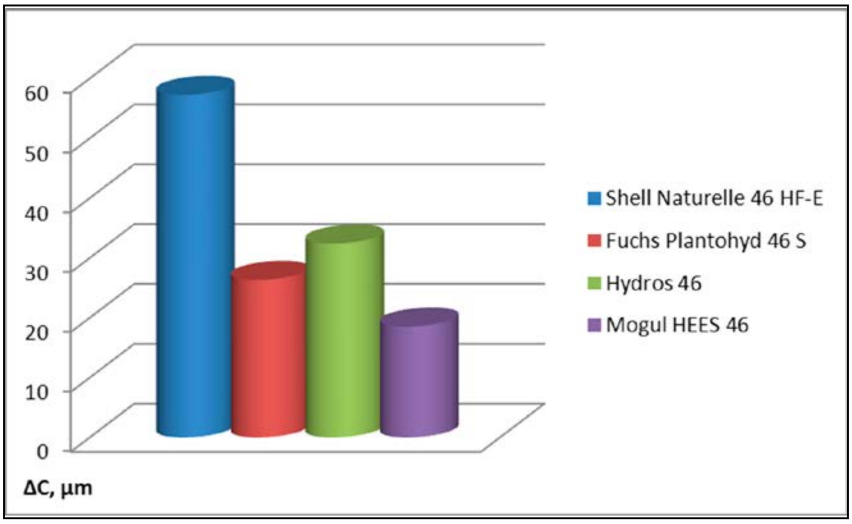

Figure 5 Comparison of changes in the deviation of sliding bearings cylindricity Δ*C*

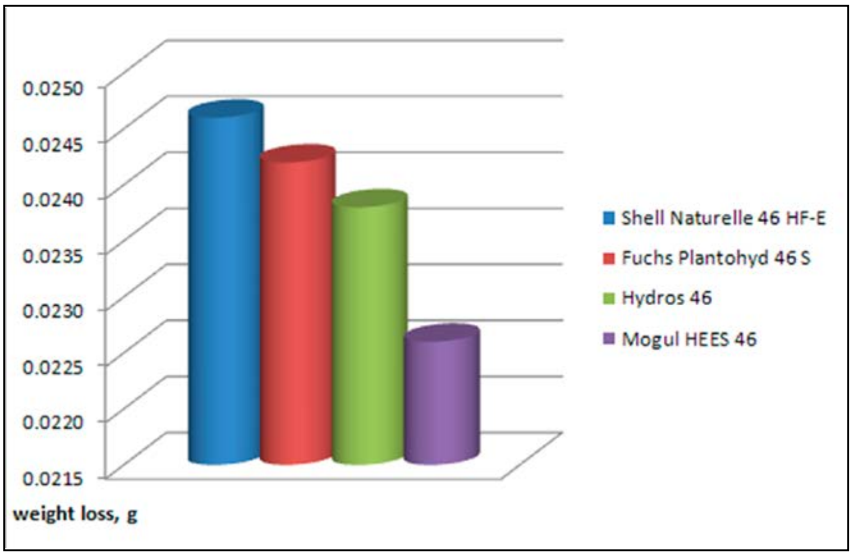

Figure 6 Comparison of weight losses depending on the oil used

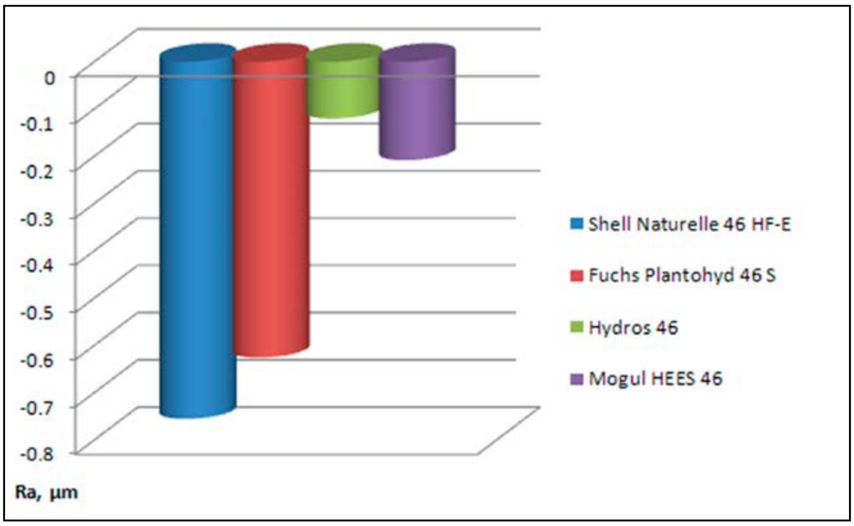

Figure 7 Relationship between the change of roughness Ra and the ecological oil used

Table 1 Summary of results of wear parameters of the defined sliding bearing depending on the selected ecological lubricants

	Cylindrical deviation ΔC in μm	Weight loss in g	Change of roughness R_a in μm
Shel Naturelle 46 HF-E	57.256	0.0246	-0.755
Fuchs Plantohyd 46 S	26.3345	0.0242	-0.6255
Hydros 46	32.399	0.0238	-0.12
Mogul HEES 46	18.5414	0.0226	-0.208

and Mogul HEES 46 reached the lowest value of change in cylindricity deviation ΔC.

The second parameter was sliding bearing weight loss. The highest value of weight loss was recorded in Shell Naturelle HF-E 46; on the contrary, Mogul HEES 46 reached the lowest value. Change of roughness Ra confirms the greatest changes of sliding bearing when using the ecological oil Shell Naturelle HF-E 46. On the contrary, the lowest changes of roughness Ra were recorded in Mogul HEES 46 and Hydros 46.

The final summary of measured values shows that Mogul HEES 46 is the most suitable oil from the selected ecological oils for the given sliding pair and defined operating conditions.

The obtained results are comparable with the values obtained by Kročko (2012). Subsequent life tests will give a definitive answer to the usability of examined oils in the field of slide assembly.

References

KROČKO, M. 2012. Štúdium degradability tribologického systému vplyvom pôsobenia ekologických mazív. Dizertačná práca. Nitra : SPU.

KUČERA, M. 2004. Analýza poznatkov zo skúšania tribologických vlastností vybraných materiálov. Nitra : SPU, 2004, s. 75–80. ISBN 80-8069-362-5.

KUČERA, M. 2008. Predikcia vlastností dvojíc materiálov v podmienkach medzného trenia. In Acta Technologica Agriculturae, roč. 11, 2008, č. 1, s. 11–15.

MAJDAN, R. – KOSIBA, J. – TULÍK, J. – KROČKOVÁ, D. – ŠINSKÝ, V. 2011. The comparison of biodegradable hydraulic fluid with mineral oil on the basis of selected parameters. In Research in Agricultural Engineering, vol. 57, 2011, special iss., pp. 43–49.

RÉDL, J. – VÁLIKOVÁ, V. – KROČKO, M. 2012. Mathematical model of a sliding couple lubricated with biolubricants. In Acta Technologica Agriculturae, vol. 15, 2012, no. 2, pp. 46–52.

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