Annals of DAAAM for 2010 & Proceedings of the 21st International DAAAM Symposium, Volume 21, No. 1, ISSN 1726-9679
ISBN 978-3-901509-73-5, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2010
Make Harmony Between Technology and Nature, and Your Mind will Fly Free as a Bird
Annals of DAAAM International

A METHOD FOR SPHERICAL ROLLING BEARINGS QUICK TESTS

STIRBU, C[ristel]; HANGANU, L[ucian] C[onstantin] & GRIGORAS, S[tefan]

Abstract: *The paper presents a direct method for spherical roller bearing quick analysis. The method is based on a practical observation of bearings functioning: the cage speed depends the inner speed and the bearing loading too. In on terms of friction losses diminishing, the cage speed can be a qualitative index of the spherical roller bearings construction. We present the experimental measurement possibilities and some experimental results. The conclusions refer to a small type spherical roller bearing, in terms of simplifying the conditions of experiments.*

Key words: *spherical roller bearings optimization*

1. INTRODUCTION

The modern constructions of spherical roller bearings have an important capacity for axial and combined load. Under axial loads, many kinematic parameters are modified. The unloaded row of rollers changes the position of rolling bodies, according to the clearance between the inner components of bearing. The evolution of kinematic parameters of spherical roller bearings is an imporant aspect of the bearing practice, for the internal optimization of bearing geometry.

The cage speed depends on the inner ring speed, the external loads, the lubrication and the bearing geometry. The efficiency of the bearing depends on the inner friction losses. We define the cage speed like an initial functional parameter of the spherical roller bearing.

2. GENERAL CONSIDERATIONS

The cage speed is defined by the friction losses in a spherical roller bearing and these losses are a function of inner bearing geometry. Different authors consider the geometry as the main factor of the spherical roller bearing quality.

The tests were performed for different bearing geometries. In this respect we selected many bearings with different inner and outer osculations:

$$\phi_i = \frac{R_W}{R_{CI}} \text{ and } \phi_o = \frac{R_W}{R_{CO}} \tag{1}$$

where R_W is the rolling body curvature radius and R_{CI}, respectively R_{CO} are the rolling way radii, for inner and outer rings, (Gafitanu & Stirbu, 1996), (Gupta, 1984), (Stirbu et al. 2009).

The tests were performed on a 22308 C-type roller bearing, because its relatively smaller dimension.

Figure 1 presents the aspect of testing rig: 1 – the test spherical roller bearing; 2 – the testing head; 3 – termoresistance lubricant temperature measurement sunk in the oil bath; 4 – electromagnetic transducer for cage speed determination that receives the pulses from the magnets 5; the elastic element 6 measures the thrust outer load on the axial ball bearing 7; 8 and 10 are two elastic bodies (low thickness); 9 and 11 are resistive transducers submitted to traction, bending respectively, by the rotation tendency of the loading head, due to the friction torque in the roller bearing; 12 and 13 represent the gravitational system for radial outer load.

An electromagnetic transducer (similar with 4) measures the inner ring speed and we can read the ratio:

$$\varphi_C = \frac{\omega_c}{\omega_i} \tag{2}$$

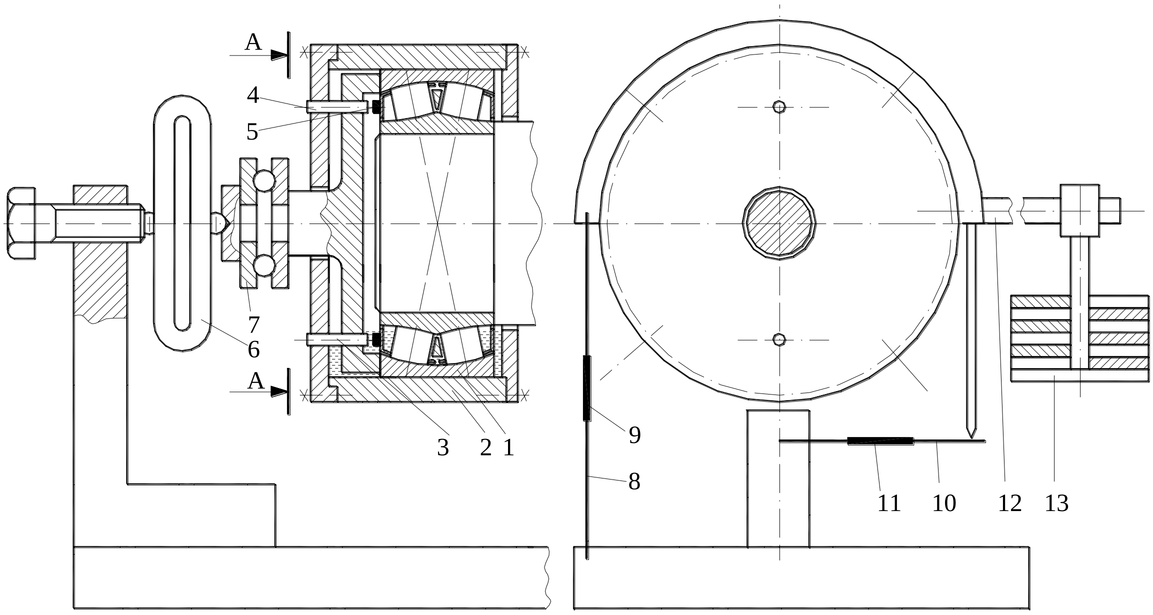


Fig. 1. The testing rig

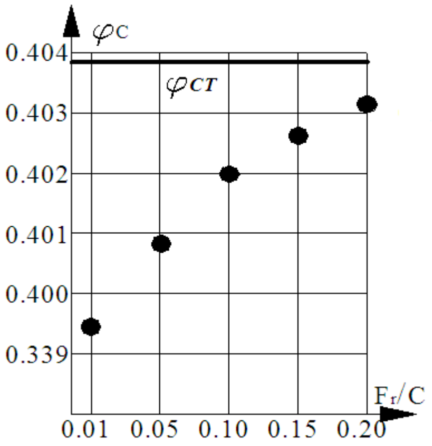
where: ω_c - measured cage angular speed and ω_i - measured inner angular ring speed.

The experiments were performed when the oil has constant temperature (the equilibrium temperature was measured by the thermoresistance 3).

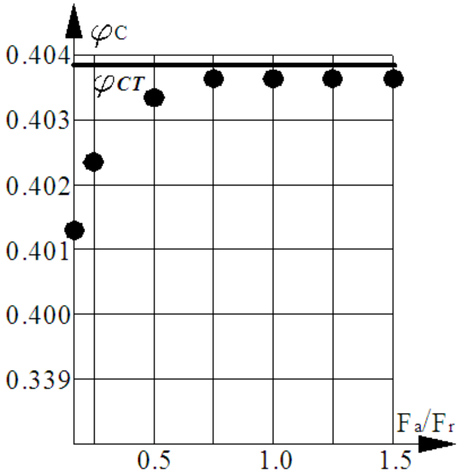
In term of comparing the standard spherical roller bearing functioning with other bearings, in a first stage, measurements were performed for the standard 22308 C-type spherical roller bearing and afterwards the tests were carried out on the same roller bearing with modified geometry, (Kleckner & Pirvics, 1982), (Noronha, 1990), (Shroeder, 1994). The osculations for the standard bearing are: $\phi_i = 0.973$ respectively $\phi_o = 0.979$. For the different modified bearings, the osculations are: $\phi_i = 0.961...0.980$ and $\phi_o = 0.970...0.986$ (minimum 4 bearing for each type).

The maximum diameter of the rolling bodies as well as the roller bearing inner clearance was kept to the nominal values of the standard 22308 C-type spherical roller bearing. The same roughness and working accuracy were used.

In the hypothesis of neglecting the sliding on the two rolling ways, one theoretically determines the kinematic parameter ϕ_{CT}, value that is specific to each roller bearing.



a) radial load



b) combined load

Fig. 2. Evolution of the ϕ_C ratio, according to the outer load

3. EXPERIMENTAL RESULTS

The cage speed measuring was necessary for every tested roller bearing in view of determining the other kinematic and dynamic parameters as well as the friction losses. The rig enables to perform the determination with an accuracy of 0.2% of the ratio ϕ_C.

The loading conditions were: pure radial loading and combined (radial and thrust) loading. Figure 2 presents the evolution of ϕ_C ratio, for the standard spherical roller bearing, under radial and combined load. The radial load increase (fig. 2 a) brings about the continuous growth of the cage speed, without the ϕ_C value reaching the theoretical value ϕ_{CT}. The aspect of ϕ_C variation curve is however kept for any working speed. The introduction of the axial load (fig. 2. b) significantly modifies the way ϕ_C increases with the growth of the F_a / F_r ratio exceeds which the value of 0.5, (Kleckner & Pirvics, 1982), (Shroeder, 1994), the ratio ϕ_C became stable, close to ϕ_{CT}.

The same tests were undergone by all the roller bearings tested under different circumstances, loads and lubrication conditions (various oils). For all versions, the ϕ_C ratio was measured after the temperature stabilization (after reaching the thermal equilibrium). The spherical roller bearings behavior was similar, but ϕ_{CT} differs for each spherical roller bearing: for bearings with small friction losses, ϕ_{CT} increases.

4. CONCLUSIONS

1) The proximity of the ratio between the cage speed and the inner ring speed to its theoretical value can be a simple criterion for the spherical roller bearing analysis, in terms to increase the functioning speed.

2) The ratio ϕ_C (cage speed/inner ring speed) is a qualitative factor of the spherical roller bearing friction losses. Its experimental determination is usefull to a quik bearins analysis on production line. For considerable axial loads, this ratio keeps constant, under normal lubrication conditions, regardless the roller bearing speed mode.

3) For large sizes bearings, similary original solutions, based on experimental researches are requested.

6. REFERENCES

Gafitanu, M. D. & Stirbu, Cr. I. (1996). Dynamic Analysis of the Interactions between Spherical Roller Bearings Elements, *Proceedings of the 26-th Israel Conference on Mechanical Engineering*, Haifa, Israel

Gupta, K. (1984). *Advanced Dynamics of Roller Element*, Springier, New York

Kleckner, R. J. & Pirvics J. (1982). Spherical Roller Bearing Analysis, *Trans. of ASME, Journal of Lubrication Technology*, vol. 104

Noronha, A. P. (1990). Calculated Simulation of the Operating of Spherical Roller Bearings, *Ball and Roller Bearing Engineering – Industrial Engineering (FAG)*, no. 104

Shroeder,W. D. (1994). *Spherical Roller Bearings Basics*, Power Transmission Design

Stirbu, Cr. I.; Grigoras, St. & Hanganu, L. C. (2009). Combined Spherical Roller Bearings Functioning Analysis, *Annals of DAAAM for 2009 & Proceedings of 20th DAAAM International Symposium*, pp. 215-216, ISBN 978-3-901509-70-4, ISSN 1726-9679, Viena, Austria, 25-28th November