The Behavior of the Lubricant Film to Dynamic Stress at a Radial Bearing with HD Lubrication

Ioan Marius Alexandrescu[1,*], Radu-Iacob Cotetiu[2] Adriana-Gabriela Cotetiu[3]

Abstract: *The researches regarding the behavior of HD radial bearings in the conditions of operation with shocks and vibrations, are performed considering known the functional characteristics of the bearing in static regime. In the presented experimental research, the functional characteristics of the bearing in static regime are considered known, the measurements focusing on determining the minimum electrical resistance of the lubricant film, which estimates the minimum thickness of lubricant in the bearing.*

Keywords: *film resistivity, lubricant thickness, bearing.*

1 INTRODUCTION

It is found that depending on the loading, speed and dynamic viscosity of the lubricant, the minimum thickness of the lubricant film and the value of the friction coefficient can be changed [4], [5]. In the experimental research was used, an additive mineral oil for bearings, type LA 32, STR 5152-89, viscosity class ISO VG 32.

Due to the short time in which the dynamic loading takes place, it can be stated that the predominant phenomenon of achieving the bearing capacity of these bearings is the effect of expelling the lubricant from the gap.

2 EXPERIMENTAL DEVICES AND ACQUISITION CHAINS

The lubricant film resistivity, it determined through the achievement of a circuit between spindle and bushing which include a standard resistance R_{12} =49 KΩ (figure 1) [2], [3], [7]. The radial bearing spindle has a nominal diameter D = 60 mm, made of 18MoCr10 material, the bronze bearing in the composition, 88% Sn, 8% Sb, 4% Cu, has a width L = 30 mm, is presented in figure 2. The variation of the input speed is made with the help of the gearbox, which ensures the speeds of 960, 600 and 370 rpm. The static bearing loading system allows loading with forces G_1 = 2250 N, respectively G_2 = 4500 N. The dynamic bearing loading system allows loading with forces F_1 = 1665 N (H=5 cm), F_2 = 2356 N (H=20 cm), F_3 = 3332.5 N (H=40 cm).

All the tests were made at a 40 °C of the lubricant, being constant, pressure distribution p_{in} having the following values, from 0,5 bar to 10 bar [1], [6].

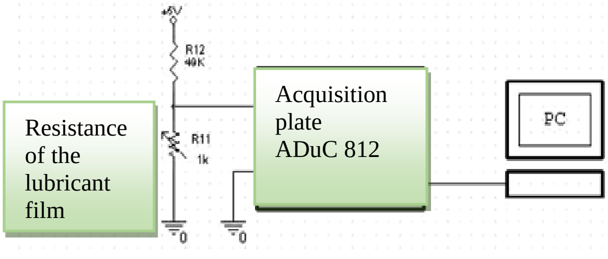


Fig. 1. Measuring the resistance of the lubricant film

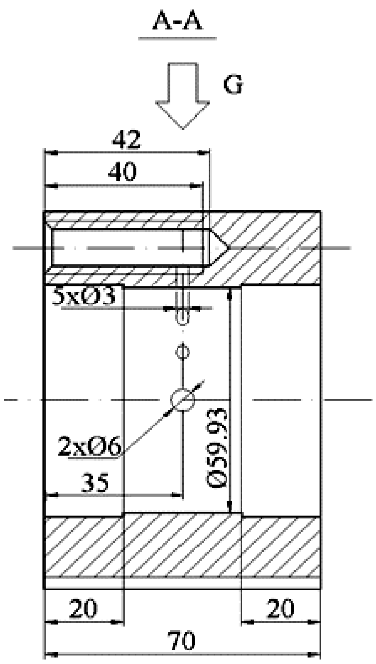
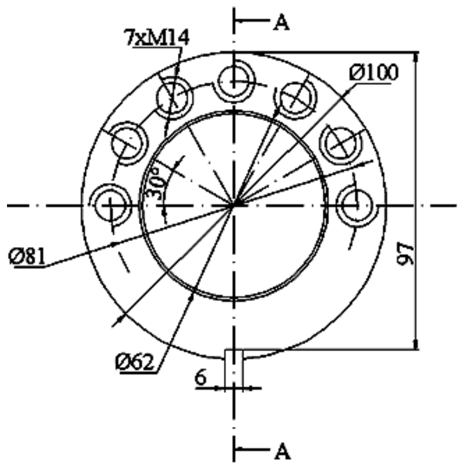


Fig. 2. The HD radial bearing



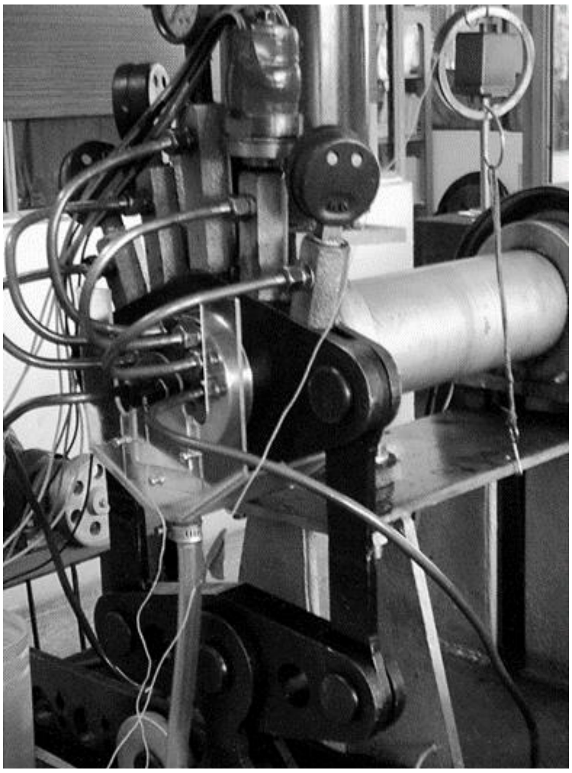


Fig. 3. The testing experimental devices

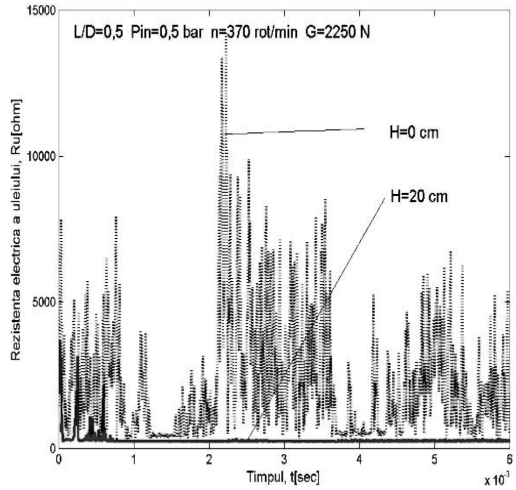
3. EXPERIMENTAL RESULTS

For the study it was used the experimental testing device of the radial bearings belonging to Technical University of Cluj-Napoca, North University Center of Baia Mare, Faculty of Engineering, Industrial Systems and Technology Management Department, (figure 3).

Influence of speed and supply pressure on electrical resistance minimum lubricant film, the dynamic and static charging conditions at different spindle's rotations are presented in figure 4 for n= 370 rot/min, p_{in} =0,5 bar, figure 5 for n= 600 rot/min, p_{in} =1,5 bar and figure 6 for n= 960 rot/min, p_{in} = 8 bar [1].

Notations used:

L- length of bearing (m); G- static loading (N); p- pressure (Pa); F- dynamically loading (N); h- fluid film thickness (m); D- bearing shaft diameter (m); H - weight launching height (m); n – the rotational speed.



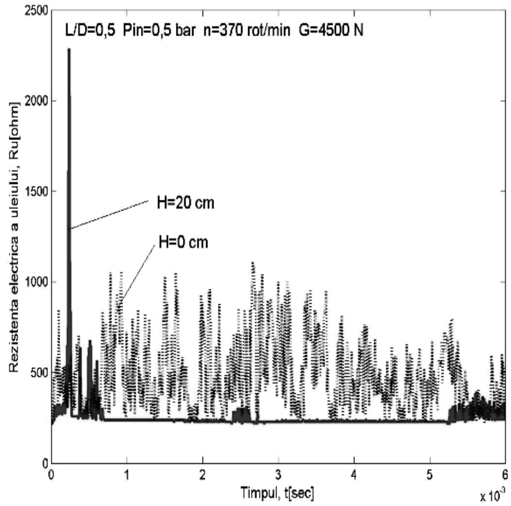
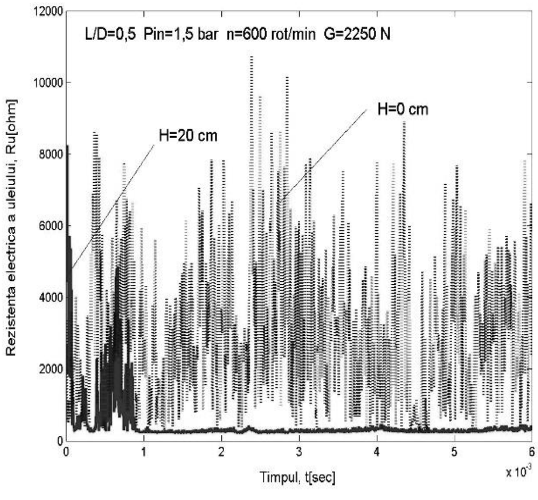


Fig. 4. The electrical resistance of the lubricant film for p_{in} =0,5 bar, n=370 rot/min, in relation to the dynamic and static charging of the bearing



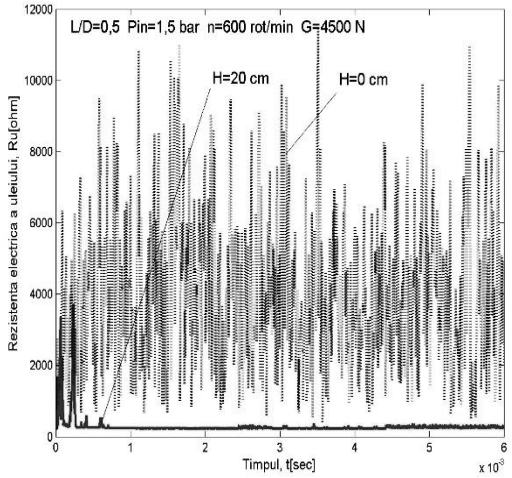


Fig. 5. The electrical resistance of the lubricant film for p_{in} =1,5 bar, n=600 rot/min, in relation to the dynamic and static charging of the bearing

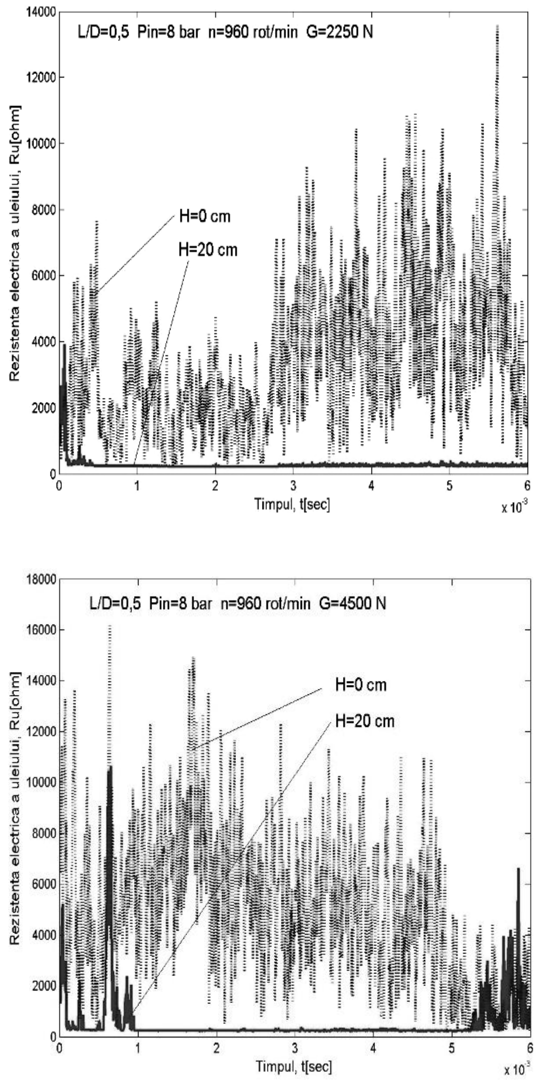


Fig. 6. The electrical resistance of the lubricant film for p_{in} =8 bar, n=960 rot/min, in relation to the dynamic and static charging of the bearing

4. CONCLUSIONS

The following observations can be stated:

- the higher the dynamic shock load, the lower the electrical resistance of the film, the decrease being made progressively with the increase of the load;
- drastic reduction of the thickness of the lubricant film in the area corresponding to the moment of shock;
- for n = 600 rot / min, the decrease of the average value of the resistance of the lubricant film in relation to the value from the static regime is between 9.93 - 12.11 times, depending on the static load;
- at the spindle speed of 960 rot / min, the decrease of the average value of the resistance of the lubricant film in relation to the value in the static regime is between 12.87 - 22.67 times, depending on the applied static load;
- in all situations studied, from a theoretical point of view, at high dynamic loads, over 2000 N, the minimum thickness of the lubricant film falls below the minimum allowable value of 5 μm, the results being in full accordance with experimental research, where the value of electrical resistance of the lubricant film suddenly decreases to a minimum value (275 Ω, penetration value of the lubricant film and implicitly metallic contact);
- both from a theoretical and experimental point of view, the decrease of the minimum thickness of the lubricant film is noticed with the increase of the static and dynamic load of the radial bearing;
- the supply pressure does not significantly influence the minimum thickness of the lubricant film determined both theoretically and experimentally;
- the increase of the spindle speed leads to the increase of the minimum lubricant thickness, with favorable implications on the radial bearing capacity.

REFERENCES

[1] Alexandrescu, I. M., (2005), Studiul comportării lagărelor radiale cu ungere hidrodinamică în condiţiile funcţionării cu şocuri şi vibraţii. Teza de doctorat, Universitatea Tehnică Cluj-Napoca, 2005, Conducător ştiinţific: prof. dr. ing. Eugen PAY Dr. H.C.

[2] Alexandrescu, I. M., Pay, E., Tiron M., Farcaş F. (2006), Aspect Regarding the Lubricant Film Thickness to the Radial HD Working Bearing under Hard Shocks. Scientific Bulletin, Serie C, Vol. XX. Fascicle: Mechanics, Tribology, Machine Manufacturing Technology. 6th Edition The International Conference of the Carpathian Euro-Region Specialists in Industrial System. North University of Baia Mare, 2006, ISSN-1224-3264, ISBN- 973-87237-4-4, 978-973-87327-4-0, pp. 9-14.

[3] Alexandrescu M., Cotetiu A., Daraba D. (2017), Experimental results regarding the lubricant film thickness to the radial HD working bearing under hard shocks. Scientific Bulletin Series C : Fascicle Mechanics, Tribology, Machine Manufacturing Technology; Baia Mare Vol. 31, pag: 7-12

[4] Şugar, I.R., Banica, M. (2014), Experimental Study Regarding the Computation of the Effective Power of a Spark-Ignition Engine. Engineering Solution and Technologies in Manufacturing. Applied Mechanics and Materials. Vol. 657, pp. 704-707, Switzerland, 2014, doi: 10.4028/www.scientific.net/AMM.657.704. ISSN 1662-7482.

[5] Şugar, I.R., Banica, M., Chiver, O., Giurgiulescu, L., 2019, Experimental Study Regarding the Classification of Seeds and the Determination of the Floating Speed for the Design of the Vacuum Cleaner and the Pneumatic Transport Installations, Analele Universitatii din Craiova Biologie Horticultura Tehnologia Prelucrarii Produselor Agricole Ingineria Mediului, vol. XXIV (LX), Editura Universitaria, ISSN 1453-1275, pp.250-253.

[6] ***, National Instruments. Data Acquisition Product Guide, 2001

[7] ***, ADuC 812 MicroConverter. Analog Devices Inc., 2003

Authors addresses

[1]Alexandrescu, Ioan Marius, Assoc. Prof. Ph. D. Eng. Technical University of Cluj-Napoca, North University Center of Baia Mare, Faculty of Engineering, Department of Engineering and Technology Management, 62A Victor Babes St., RO-430083, Baia Mare, ROMANIA, Tel. 0264-202975. E-mail: ioan.marius.alexandrescu@gmail.com,

[2]Cotetiu, Radu Iacob, Professor Ph. D. Eng., Technical University of Cluj-Napoca, North University Center of Baia Mare, Faculty of Engineering, Department of Engineering and and Technology Management, 62A Victor Babes St., RO-430083, Baia Mare, ROMANIA, E-mail: radu.cotetiu@gmail.com

[3]Cotetiu, Adriana Gabriela, Professor Ph. D. Eng., Technical University of Cluj-Napoca, North University Center of Baia Mare, Faculty of Engineering, Department of Engineering and and Technology Management, 62A Victor Babes St., RO-430083, Baia Mare, ROMANIA, E-mail: acotetiu@gmail.com

Contact person

[*]Alexandrescu, Ioan Marius, Assoc. Prof. Ph. D. Eng. Technical University of Cluj-Napoca, North University Center of Baia Mare, Faculty of Engineering, Department of Engineering and Technology Management, 62A Victor Babes St., RO-430083, Baia Mare, ROMANIA, Tel. 0264-202975. E-mail: ioan.marius.alexandrescu@gmail.com