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# ASPECTS REGARDING THE LUBRICANT FILM THICKNESS TO THE RADIAL HD WORKING BEARING UNDER HARD SHOCKS

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***Abstract***: *Due to the very short time of loading radial bearings exposed to shocks and vibrations, of about 0.5-1 ms, this paper presents a few experimental assessment concerning the function of radial bearings with HD lubrication in the case of huge challenging working. It was focussed on the determination of the lubrifiant film resistivity and minimal resistance on the lubricant film, which estimates the minimum lubricant thickness between spindle and bushing*
***Key words*** *: bearing, , radial hydrodynamic bearing, lubrifiant film resistivity.*

## 1 INTRODUCTION

Taking into consideration the Stribeck curves, that can be applicable to sliding bearings it has been found that the minimum thickness of the lubrifiant film and the rubbing value can be modified depending on the challenging working, speed and oil dynamic viscosity [7].

În the case of sliding bearings the lubrifiant working conditions corresponding to $h_{min}$ is imposed by rugosity; the medium height of the roughness can be reckoned for the spindle $R_{1\ max} \cong 5$ μm; as for the bronze bushing $R_{2\ max} \cong 5$ μm is to be considered [3]. So, in the case of fluid rubbing functioning conditions, the minimum lubrifiant thickness has to be bigger than an allowable value, $h_{min,a} \geq 10$ μm.

We consider the closing motion between spindle and bushing on the direction of the center line, without the rotation of the spindle (the case of the non-rotating bearing), so that the lubricant expulsion effect be prevalent in the achieving of the squeeze film [8].

Analytically expressed, the Reynolds equation corresponding to this study, within an isothermal approach is [1]

$$\frac{\partial}{\partial x}\left(h^3\frac{\partial p}{\partial x}\right)+\frac{\partial}{\partial z}\left(h^3\frac{\partial p}{\partial z}\right)=12\eta\frac{\partial h}{\partial t}. \tag{1}$$

where η- viscosity of lubricant ($Ns/m^2$); p-pressure (Pa); h- fluid film thickness (m).

## 2. EXPERIMENTAL DEVICES AND ACQUISITION CHAINS

The research was made using a HD radial bearing with L/D=0,5 and the spindle's diameter $d_e$ =59,86 mm, and the bushing diameter $D_e$ =59,93 mm, spindle's asperity 58-62 HRC, made of 18MoCr10, bronze bushing made of 88% Sn, 8%Sb, 4%Cu.

The dynamic loading of the bearing is made through the louncing of a weight which hits the bearing at different heights. They were made assessments for heights between 5 and 40 cm, using a weight with m=5 kg, so as for H=5 cm we have $F_1$=1665 N, for H=20 cm we have$F_2$=2356 N, and for H=40 cm we have $F_3$=3332 N. The static working conditions is presented for the following value H=0 cm.

Using a lubrifiant oil for bearings of LA 32 STR 5152-89 type, with the viscosity of 31,3 cSt at 40 °C, all the tests were made at a 40 °C of the lubrifiant, being constant, pressure distribution $p_{in}$ having the following values, from 0,5 bar to 10 bar[2].

The lubricant film resistivity, which estimates the minimum lubricant thickness between spindle and bushing, it determined through the achievement of a circuit between spindle and bushing which include a standard resistance $R_{12}$ =49 KΩ [4], [6].

Figure 1 presents the lubricant film resistivity measuring chain.

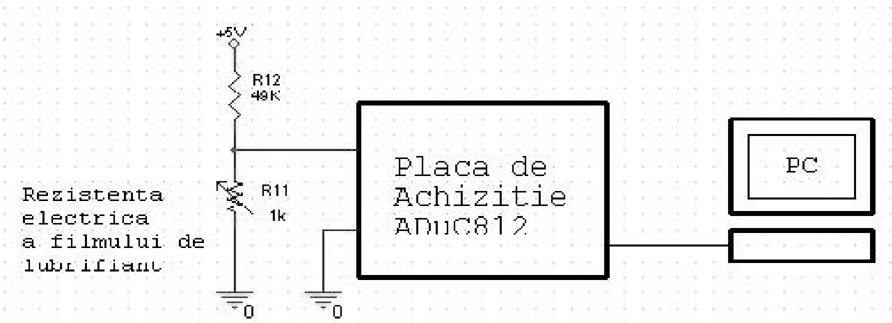


**Fig.1**. The lubricant film resistivity measuring chain between spindle and bushing

For the study of these bearings it was used the experimental testing device of the radial bearings belonging to The North University of Baia Mare, Department of Manufacturing

Engineering, using the modern techniq concerning acquisition and manufacture experimental results (Fig. 2).

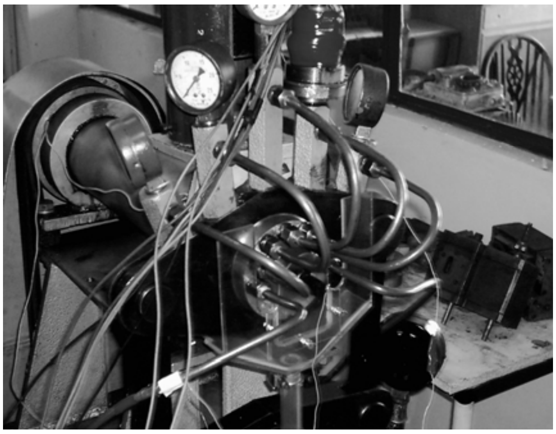

**Fig. 2.** The testing experimental devices

ADuC 812 (figure 3), produce by Analog Device, has an 8051-compatible microcontroler core supported by 8Kb Flash/EE program memory, 640 bytes Flash/EE data memory and 256 bytes data SRAM on-chip[5]. The digital data can be sent to a PC via a standard UART Serial Port. The analog signal sources can be connected to the on-chip 8 channel 12-bit ADC [9], [10].

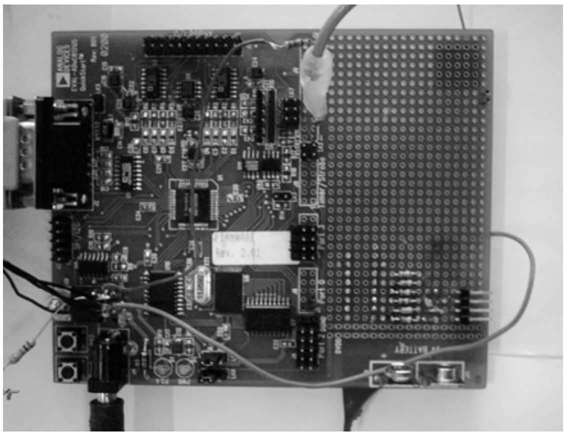

**Fig.3.** Placa de achiziție ADuC 812 [9]

## 3. EXPERIMENTAL RESULTS

The signal taken by the data acquisition system ADuC 812 have been analised by PC with the help of MATLAB 6.5.0.18091 3a program.

Minimal resistance on the lubricant film, which estimates the minimum lubricant thickness between spindle and bushing depending on the available supply pressure, the static and dynamic charging conditions at different spindle's rotations are presented in figure 4 for n=370 rot/min, $p_{in}$ =0,5 bar and figure 5 for n=600 rot/min, $p_{in}$ =1,5 bar.

The dynamic loading of the bearing is made through the launcing of a weight which hits the bearing at different heights. They were made assessments for heights between 5 and 40 cm, using a weight with m=5 kg, so as for H=5 cm we have $F_1$=1665 N, for H=20 cm we have$F_2$=2356 N, and for H=40 cm we have $F_3$=3332 N. The static working conditions is presented for the following value H=0 cm.

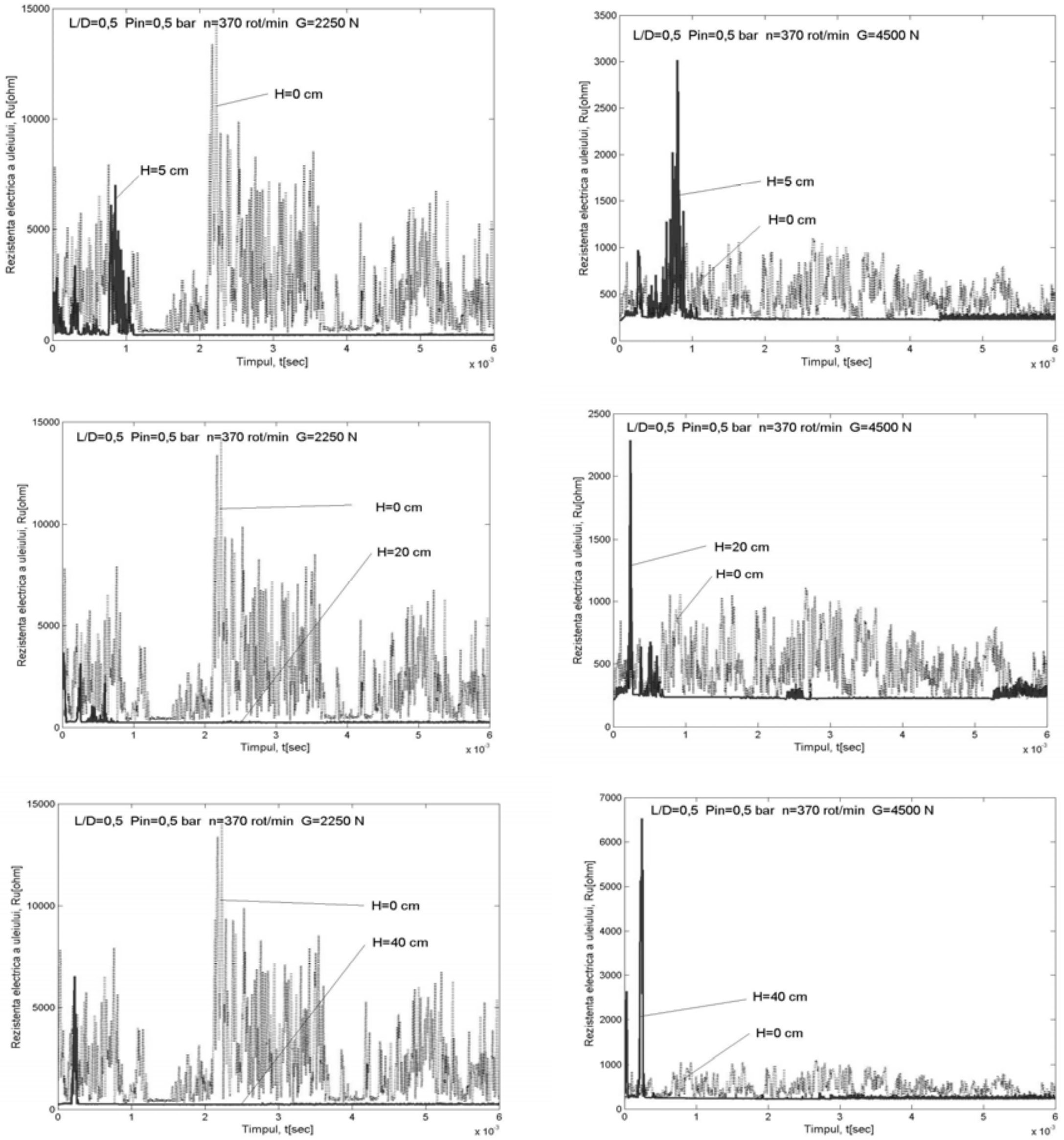


**Fig. 4.** The lubricant film resistivity for n=370 rot/min, $p_{in}$ =0,5 bar, depending on the static and dynamic charging conditions

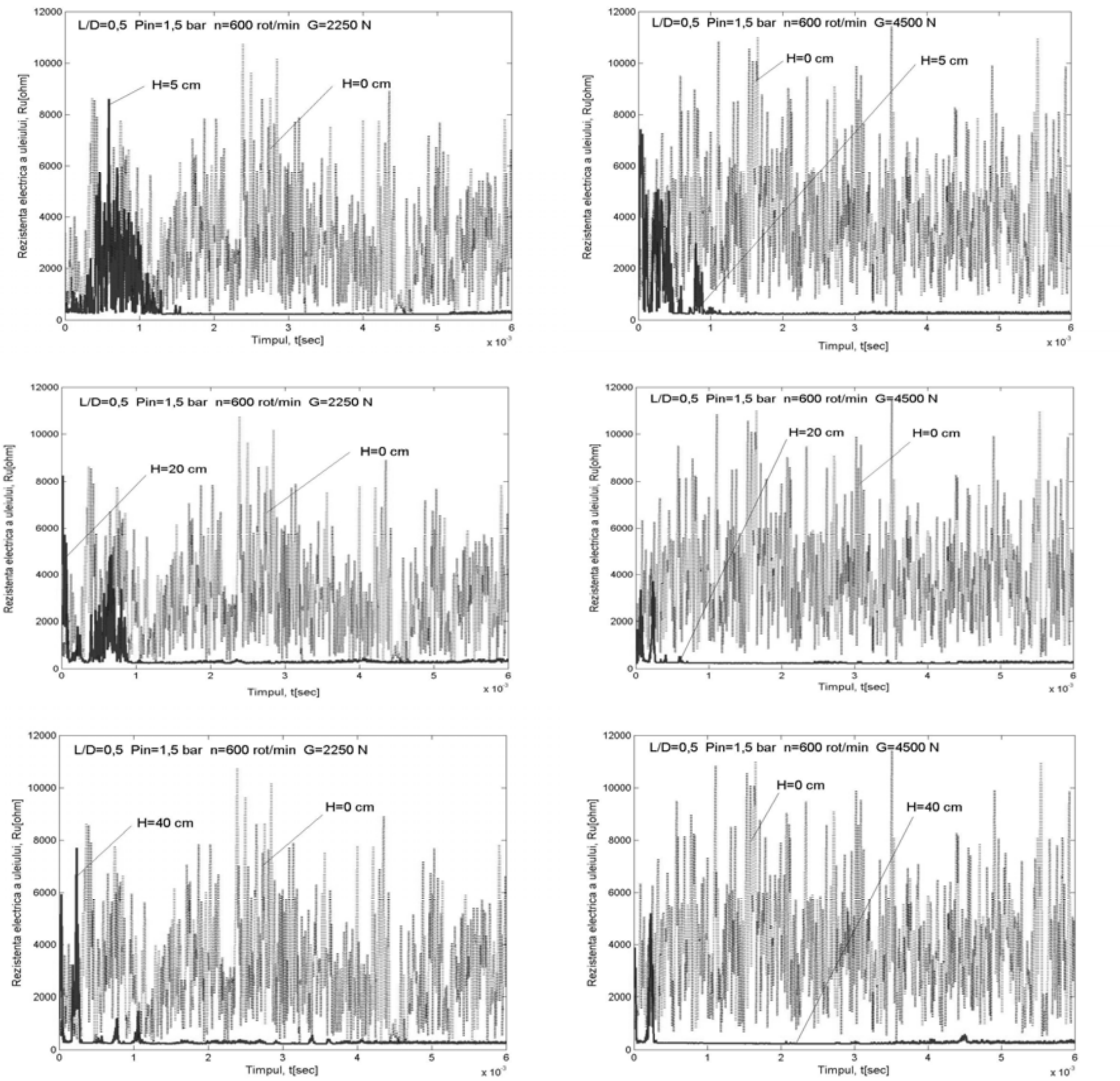


**Fig. 5.** The lubricant film resistivity for n=600 rot/min, $p_{in}$ =1,5 bar, depending on the static and dynamic charging conditions

## 4. CONCLUSIONS

The following conclusions may be taken into consideration:

- For the radial HD bearing with L/D=0,5 the mean value of the lubricant film resistivity, which estimate the lubricant film's minimum thickness, at revolutions n=370 rot/min, it's approximate three times bigger in the static case, than in dynamic case, for the static change $G_1$ =2250 N, respective two times bigger in the static case, than in dynamic case, for the static change $G_2$ =4500 N; to be noticed the sudden decrease of lubricant film's thickness in area wich corresponds to the shock's time.

- Through spindle revolution's rise at 600 rot/min, for the radial HD bearings with L/D=0,5 it is noticed the rise of minimum film's thickness as much as the static charge is lower, the film's resistivity is bigger.
- Once, with the dynamic charge's application $F_1$=2355 N, at n=600 rot/min, it notices a decrease of mean value of the lubricant film resistivity in relation with value of static regime about seven times approximatelly.
- At the hard shocks, the elastic deformation doesn't cover the lubricant squeeze being possible a metalic contact, meaning the film's thickness to be decrease at zero.

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