THE ELECTRICAL RESISTANCE OF THE LUBRICANT FILM IN THE CASE OF THE HYDRODYNAMIC SLIDING BEARING SUBJECTED TO SHOCKS

Ioan Marius **ALEXANDRESCU**, Radu **COTETIU**, Adriana **COTETIU**,
Dinu **DARABA**, Ioana Laura **ALEXANDRESCU**
Technical University of Cluj-Napoca
Ioan.Alexandrescu@imtech.utcluj.ro

Keywords: minimal lubricating film, electrical resistance, radial sliding bearing.

Abstract: *This paper presents experimental research on electrical resistance of the lubricant film, shock absorption in the lubricating film, under different static and dynamic load conditions. We focus on determination of the minimal lubricating film which estimates the minimum lubricating thickness between spindle and bushing in the case of the hydrodynamic sliding bearing subjected to shocks*.

1. INTRODUCTION

The main objective of the experimental tests was to determine the minimum electrical resistance of the lubricant film, under different static and dynamic load conditions. The geometry of the lubricant film will be approximated with a surface of constant thickness, equal to the minimum thickness of the lubricant film under static loading conditions [3]. The minimum electrical resistance of the lubricant film estimates the minimum thickness of the oil film between the spindle and the bearing [1].

In the framework of the experimental research, an additive mineral oil for bearings was used, type LA 32, STR 5152-89, viscosity class ISO VG 32[2].

The electrical resistance of the lubricant film was determined by executing a resistive circuit between the spindle and the bearing, which includes a standard resistor R_{12} = 49 KΩ [4], [5]. The measuring chain used to determine the minimum electrical resistance of the lubricant film between the spindle and the bearing is shown in *figure 1*.

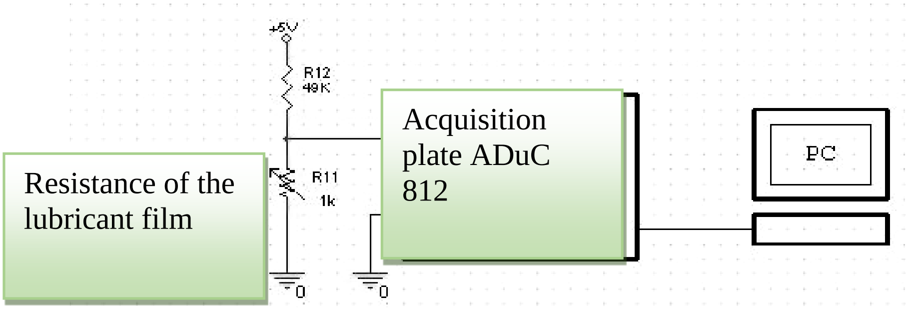

Fig. 1. Measuring chain

2. EXPERIMENTAL MEASUREMENT OF THE ELECTRICAL RESISTANCE OF THE LUBRICANT FILM

The experimental stand with the electrical circuit for measuring the minimum electrical resistance of the lubricant film is shown in *figure 2*, and a detail regarding the measuring chain in *figure 3*.

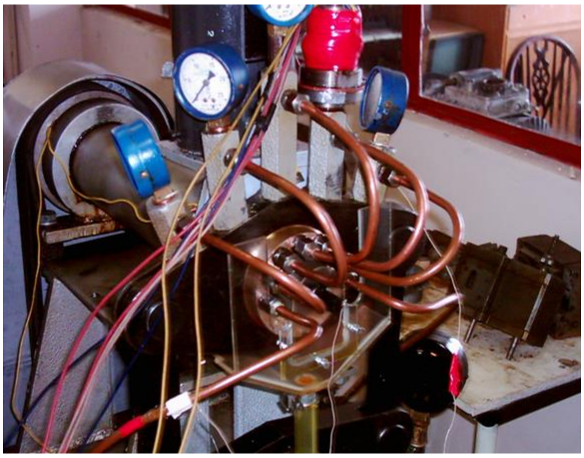

Fig. 2. The experimental stand

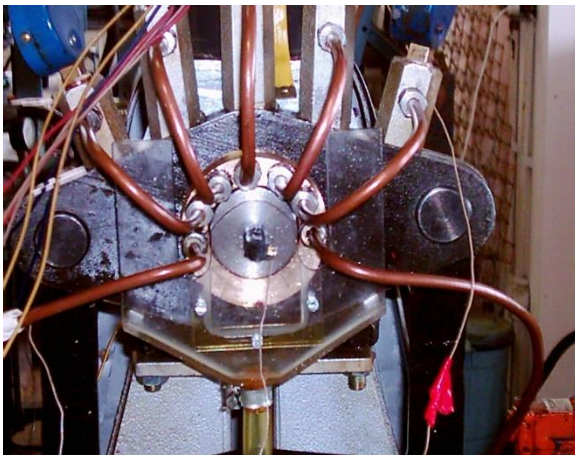

Fig. 3. Resistive circuit detail

The minimum resistance of the lubricant film, determined experimentally, as a function of supply pressure, dynamic load and static load for different spindle speeds is presented in *figure 4* for the case n =370 rpm, p_{in} =1.5 bar; *figure 5* for the case n = 600 rpm, p_{in} =3 bar, *figure 6* for the case n = 960 rpm, p_{in} = 8 bar.

The static regime is represented for the impact height H = 0 cm, respectively the dynamic regime is represented for the three heights, H =5 cm, H = 20 cm and H = 40 cm, corresponding to the forces F_1 = 1665 N, F_2 = 2356 N, F_3 = 3332.5 N.

The influence of speed and supply pressure respectively the influence of the static load at different speeds depending on the supply pressure on the minimum electrical resistance of the lubricant film depending on the dynamic load for the two cases of static load G_1 = 2250 N, respectively G_2 = 4500 N, is presented in *figure 4, figure 5* and *figure 6*.

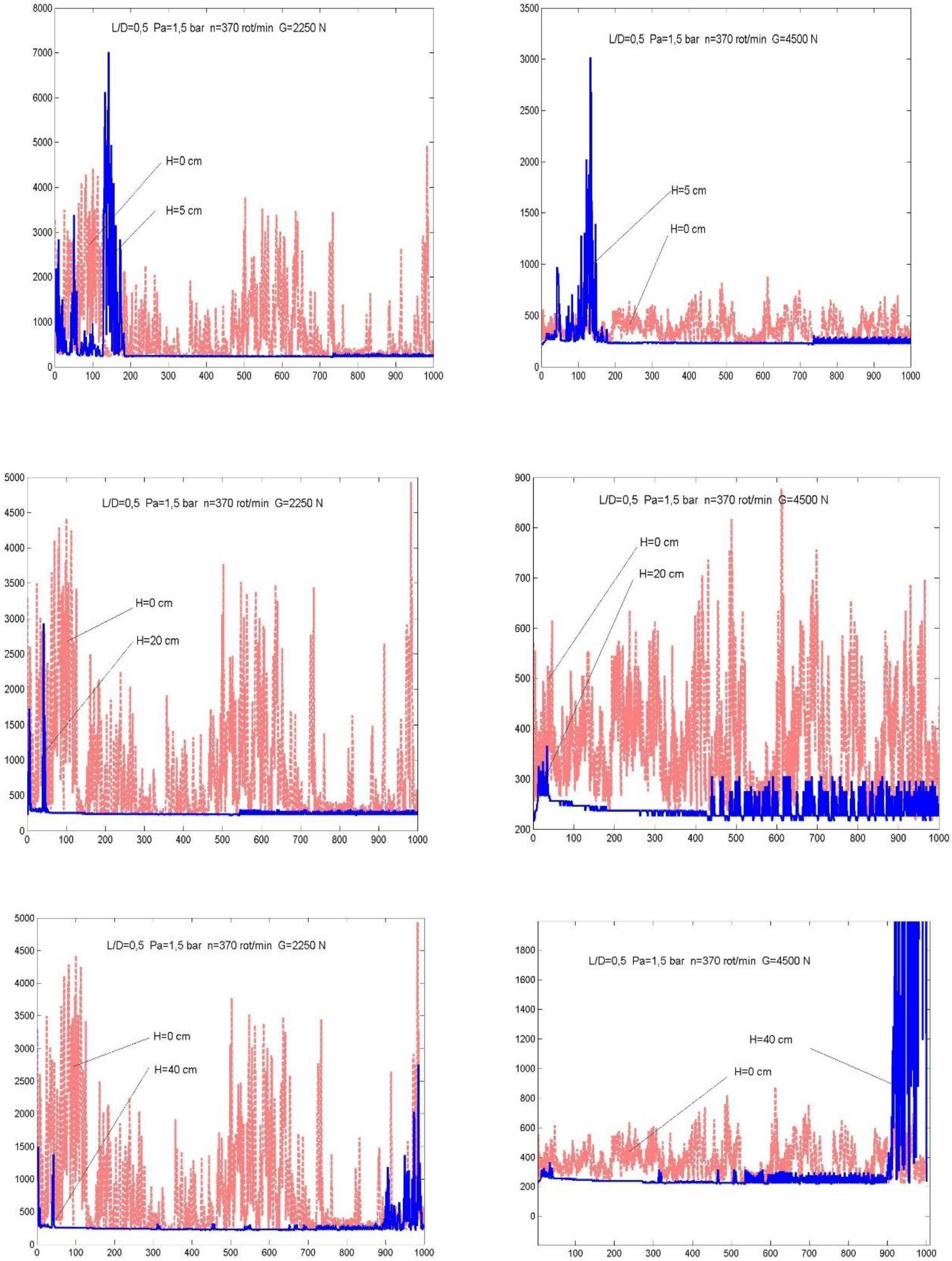

Fig. 4. Minimum electrical resistance of the lubricant film for the speed n = 370 rpm, p_{in} = 1.5 bar, depending on the static and dynamic loads

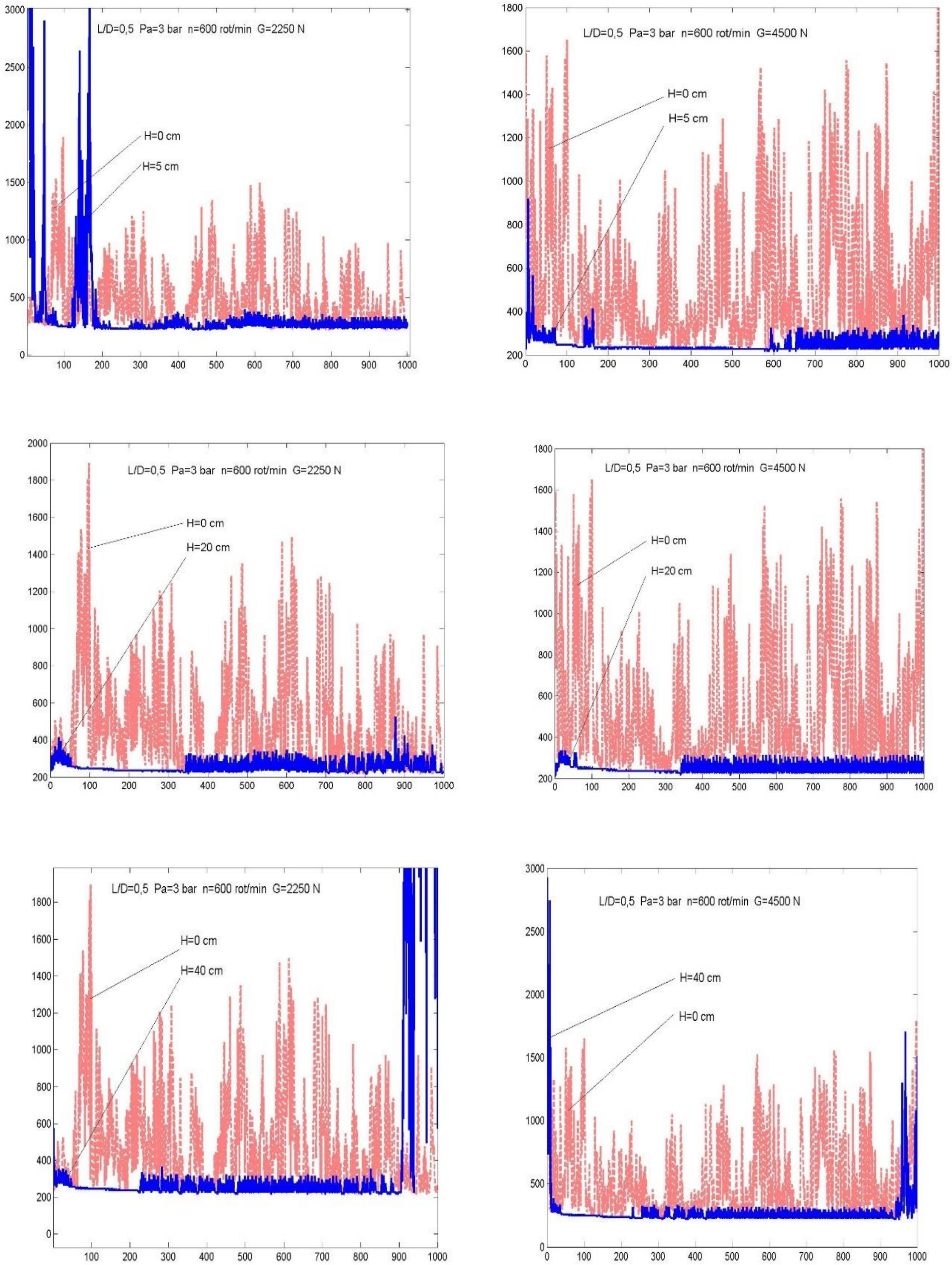

Fig. 5. Minimum electrical resistance of the lubricant film for speed n = 600 rpm, p_{in} = 3 bar, depending on static and dynamic loads

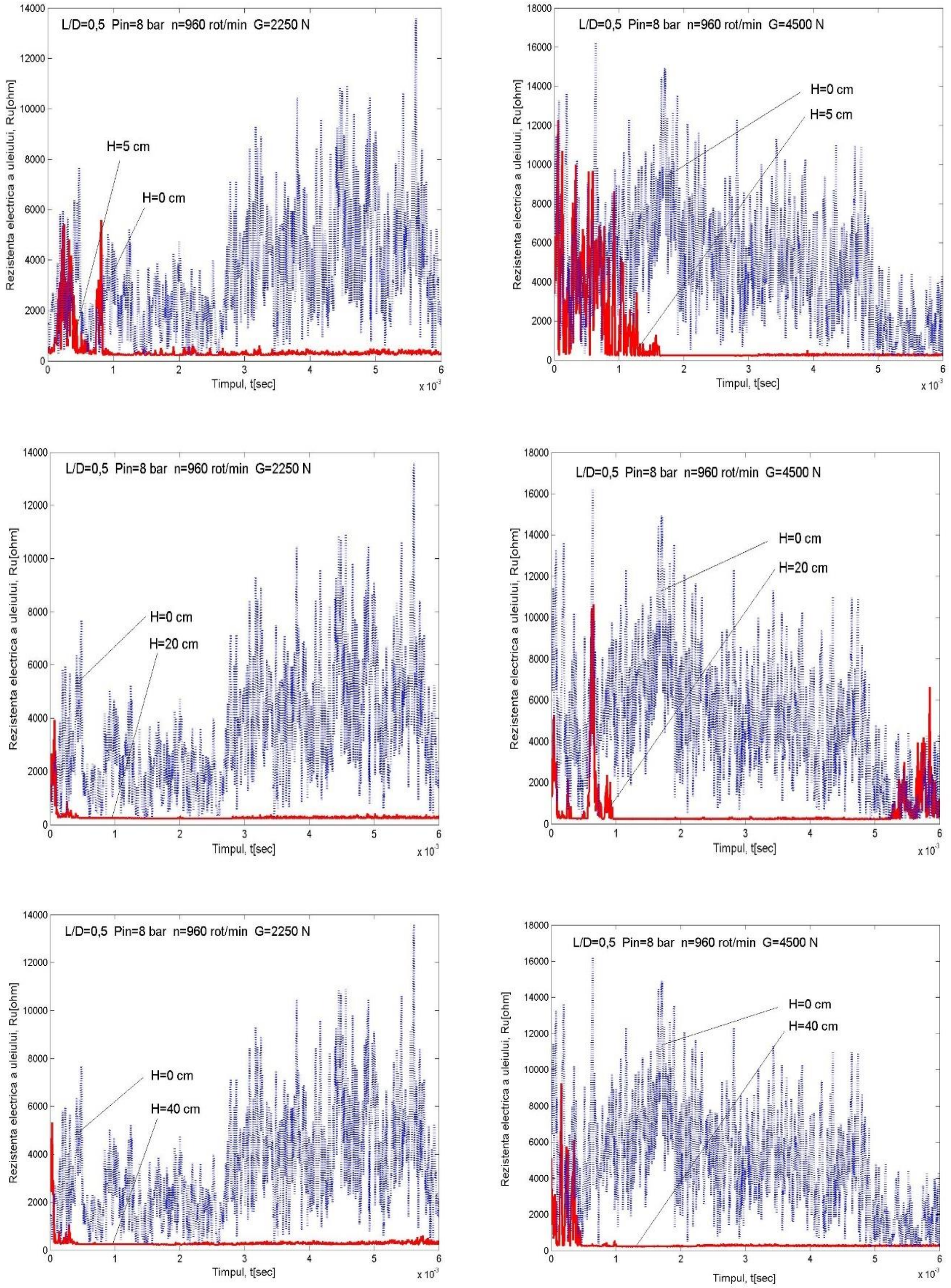

Fig. 6. Minimum electrical resistance of the lubricant film for the speed n = 960 rpm, p_{in} = 8 bar, depending on the static and dynamic loads

3. CONCLUSIONS

The following can be noted:

- the higher the dynamic shock load, the lower the electrical resistance of the film, the decrease occurring progressively with increasing load (retention time of the lubricant in the contact area decreasing with increasing load);
- the higher the static load, the lower the electrical resistance of the lubricant film;
- the higher the spindle speed, the higher the electrical resistance of the lubricant film under static operating conditions;
- for the studied radial bearing, with the application of the dynamic load for n = 370 rpm, a decrease in the average value of the lubricant film resistance is observed in relation to the value in the static regime between 2.13 – 2.97 times, for the static load G_1 = 2250 N, respectively between 1.13 – 2.39 times, for the static load G_2 = 4500 N; the drastic decrease in the thickness of the lubricant film in the area corresponding to the moment of the shock is noted, with the observation that retention of the lubricant film is observed in the contact area;
- by increasing the spindle speed to 600 rpm, the increase in the electrical resistance of the lubricant film is noticeable; the lower the static load, the higher the resistance of the lubricant film (1.19 times higher in the case of G_1 = 2250 N than in the case of G_2 = 4500 N);
- with the application of the dynamic load for n = 600 rpm, a decrease in the average value of the lubricant film resistance is observed in relation to the value in the static regime between 10.7 – 12.11 times, for the static load G_1 = 2250 N, respectively between 9.93 – 10.42 times, for the static load G_2 = 4500 N;
- at the spindle speed of 960 rpm, when the dynamic load is applied, there is a decrease in the average value of the lubricant film resistance in relation to the value in the static regime between 18.7 and 22.67 times, for the static load G_1 = 2250 N, respectively between 12.87 – 19.81 times, for the static load G_2 = 4500 N.

REFERENCES

[1] I. M. Alexandrescu, *Studiul comportării lagărelor radiale cu ungere hidrodinamică în condiţiile funcţionării cu şocuri şi vibraţii*. Teza de doctorat, Universitatea Tehnică Cluj-Napoca, 2005.

[2] I. M. Alexandrescu, R. I. Cotețiu, S. Haragâş, *Research on the load bearing force in narrow sliding radial bearings (L < 0,7 D) operating in shock conditions*. Acta Technica Napocensis,

Technical University of Cluj-Napoca, Series Applied Mathematics, Mechanics, and Engineering Vol. 62, Issue II, pp. 299-308, 2019.

[3] O. Chiver, N. Burnete, I. R. Şugar, L. Neamţ, E. Pop, *Study on Gear Ratio of Battery Electric Vehicles*, Ingineria Automobilului, Issue: 59, Bucureşti, pp. 11-16, 2021.

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

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