EXPERIMENTAL STUDY OF THE INFLUENCE OF SCRATCHES ON TWO-LOBE JOURNAL BEARING PERFORMANCE

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INTRODUCTION
The aim of this experimental study is to present the effect of scratches on the film pressure and temperature, measured under various conditions at the film/lobe interface of a two-lobe journal bearing.

Pressure and temperature measurements have been performed simultaneously during steady state operating conditions in both axial and circumferential directions. As presented in Figure 1, 20 thermocouples and 19 pressure probes are distributed on the two-lobe journal bearing. For this study, scratches have been generated on the shaft at two locations (L/3 and 7L/12) and several depths varying from half to twice the radial clearance.

![Figure 1. Pressure and temperature measurements points](image1)

The test rig is also equipped with a tachymeter for measuring the speed and a flow-meter for the oil supply. A torquemeter gives precise measurements of the friction torque during operation. The test rig (Figure 2) is monitored by a computer which enables the operating conditions to be controlled and permits the measurements from the probes to be monitored at the same time. A series of hundred values of each probe

![Figure 2. Test rig](image2)
signal was acquired at 10 Hz frequency. The average yielded a single value per probe, for each operating condition. Each test was repeated at least three times to ensure a good repeatability.

**BEARING, MODUS OPERANDI AND TEST PARAMETERS**

The two-lobe journal bearing used in this experimental study is characterized by a 100 mm diameter and 68.4 mm length. The tested bearing (0.5 preload ratio) has been paired with a 100 mm steel shaft with 65 µm of vertical radial clearance (C) and 130 µm of horizontal radial clearance. The lubricant used for the tests is an ISO VG 46 oil, which has been supplied at controlled temperature (40 °C) and pressure (0.17 MPa).

Seven configurations were tested: the first one is the reference case without defect and the six others have one scratch. For each test, imposed load varied between 6,000 N and 10,000 N (with 1,000 N steps) and rotational speed between 500 rpm and 3,500 rpm (with 750 rpm steps). Furthermore, additional tests at 100 rpm have been performed in order to study the effect of scratches on bearing performance at low speed.

**RESULTS AND DISCUSSION**

Firstly, the results of the reference case (without scratch) are presented as a function of speed for a constant load of 10,000N. As can be seen on figure 3, when comparing graphs 3a and 3b, the shaft is carried by the lower lobe. The speed does not influence significantly the pressure (graph 3a), except for the case at low speed for which the pressure zone is less extended than the other cases. The temperature in the bearing mid-plane (graphs 3c & 3d) is obviously increasing with speed: the higher the speed, the higher the temperatures measured on the journal bearing. Note that these values are important for all comparisons done with scratches cases because they are reference cases.

![Figure 3](image-url)

**Figure 3.** Results for 10,000 N loaded cases with no defect on the rotating shaft, a) Mid-plane pressure for the lower lobe, b) Mid-plane pressure for the upper lobe, c) Mid-plane temperature for the lower lobe, d) Mid-plane temperature for the upper lobe.

Figure 4 presents the results obtained for the configurations with one scratch on the shaft located at 7L/12 and three different depths. In fact, this scratch divides the bearing in two regions, one being large and the
other one narrow. Figure 4 gives the mid-plane pressure of the lower lobe at 500 rpm and 10,000 N. It is clearly visible that the pressure in the bearing mid-plane decreases with the depth of the scratch and the pressure zone gets smaller. As expected, the maximum pressure moves axially from the bearing mid-plane towards the largest region of the bearing. Thus, the probe placed in this zone gives the maximum measured pressure and its evolution.

![Figure 4](image)

**Figure 4.** Mid-plane pressure of the lower lobe at 500 rpm and 10,000 N

The third part of this study is dedicated to the cases with a scratch located at L/3. For this configuration, two pressure probes were facing the scratch, thus allowing to measure the pressure drop caused by the scratch. Figure 5 shows the influence of the scratch depth on the axial pressure field measured at 185° angular coordinate (points with solid lines on the right hand side) and 195° angular coordinate for the others (on left hand side of the figure). As expected, the pressure in the scratch drops with the increase of the scratch depth. On the largest side of the bearing, the pressure increases to compensate this drop in order to carry the load.

![Figure 5](image)

**Figure 5.** Axial pressure at 185° and 195° of the lower lobe at 500 rpm and 10,000 N

**CONCLUSION**

With these three experimental cases, the influence of a scratch on the bearing behavior has been shown. The impact on the pressure field is linked to the depth and the location of scratch. The deeper the scratch, the lower the pressure inside it; moreover, the pressure in the larger part of the bearing increases. There is also an effect on the temperature fields and on running variables such as oil flow rate, torque or position.

**KEYWORDS**

Hydrodynamics: Journal Bearings, Thermal Effects in Hydrodynamics, Components: Steam Turbines