

Effects of oil groove location on viscosity profile in hydrodynamic lubrication journal bearing

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ABSTRACT – This paper presents an experimental work to determine the effect of oil groove location on viscosity profiles in hydrodynamic lubrication around a journal bearing. The journal bearing test rig was used in this study to characterize the profiles. A journal of 100mm diameter with a length-to-diameter ratio of 0.5 was used. Measurement of the film viscosity profiles around a journal bearing is based on the ultrasonic reflection technique. The single oil supply groove was set at -30° , -15° , 0° , 15° , 30° and 45° positions.

1. INTRODUCTION

Film thickness and viscosity are important physical properties in machine element lubrication. In the case of journal bearing, varying the speed and loads tends to change these two properties to some extents. A single groove for plain journal bearing is common in industrial applications. The groove is used to distribute oil over the length of journal and improve the temperature field. Oil enters the groove through an oil supply hole and flows either by gravity or under pressure. The oil supply conditions (pressure, temperature, groove dimensions and location) influence the flow rate (ref). Theoretically, changing operating conditions will affect the oil temperature inside the bearing. When the temperature changes, viscosity tends to follow and subsequently the film thickness gets affected.

Previous study by authors on the effects of oil inlet pressure and groove location were reported somewhere else [1-3]. In the present study, extended experimental work has been conducted to determine the effect of oil groove location on viscosity profile in hydrodynamic lubrication around a journal bearing. Measurement of the viscosity profiles around a journal bearing is based on the ultrasonic reflection technique as described in earlier studies [4-7].

2. METHODOLOGY

The journal bearing test rig used in this study to characterize the profile is shown in Figure 1. A journal of 100mm diameter with a length-to-diameter ratio of half was used. The journal was modified by preparing holes on the journal. The purpose built longitudinal and shear transducer assemblies [4,7] were then fixed by pressing them into the holes (Figure 2). The protruding

part of the Perspex plug (for shear waves) were machined in order to follow the contour of the journal.

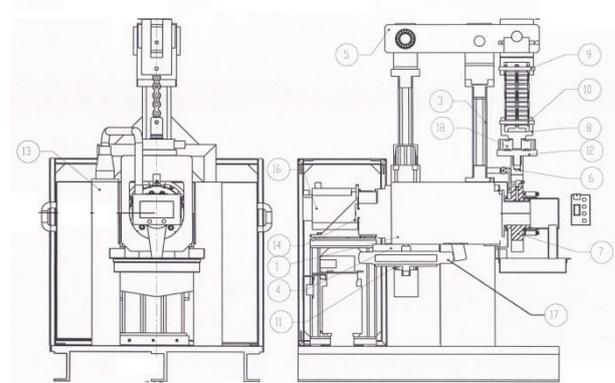


Figure 1 Journal bearing test rig.

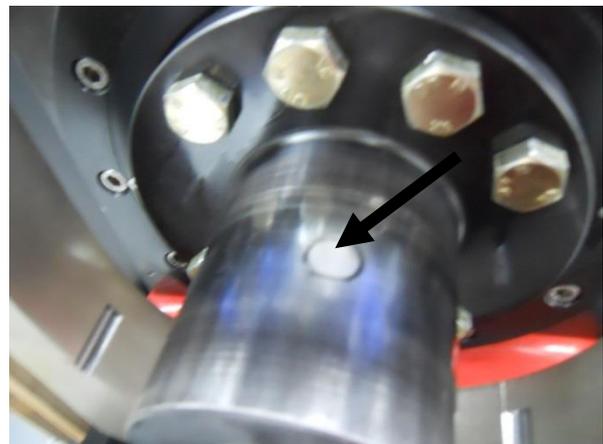


Figure 2 A purpose built longitudinal transducer placed into the shaft.

The journal was then mounted horizontally into the bearing. A pneumatic bellows was used to apply the required load. The maximum speed of the journal test rig is 1000 rpm. The speed used for testing was 300, 500 and 800 rpm.

A Single groove of 40mm in length, 10mm in width and 5mm in depth were used in this study. During tests, the journal bearing was run at different loads (10 and 20 kN). In this study, the single oil supply groove was set at -30° , -15° , 0° , 15° , 30° and 45° in positions.

Details of test bearing dimensions, lubricant properties and operating parameters are given in Table 1.

Table 1 Dimensions of test bearing, lubricant properties, operating parameters and sensor specification.

| Parameter | Values |
|---------------------|--|
| Journal Diameter, D | 100 mm |
| Bearing Length, L | 50 mm |
| Radial Clearance, c | 52 μ m |
| Load Applied, W | 10 and 20kN |
| Journal Speed, | 300 – 800 rpm |
| Lubricant Type | Shell Tellus S2 M |
| Lubricant viscosity | 68 cSt @ 40 $^{\circ}$ C 8.8 cSt @ 100 $^{\circ}$ C |
| Pressure Sensor | |
| Model | MEAS (M5156) |
| Range | 10 Mpa |
| Accuracy | 0.001 \pm 1% Mpa |
| Temperature Sensor | |
| Model | PT 100 |
| Range | 0 – 100 $^{\circ}$ C |
| Accuracy | \pm 1% measured temperature |

3. RESULTS AND DISCUSSION

The corresponding reflection coefficient data for different speeds were obtained and plotted in Figure 3. Figure 3 represent reflection coefficient at speed of 300 rpm. A repeating pattern was very clear. A single pattern represents a profile from one revolution of the journal. For the case of 300 rpm, 1000 segments with 502 points per waveform were obtained for reflection coefficient data points in single pattern.

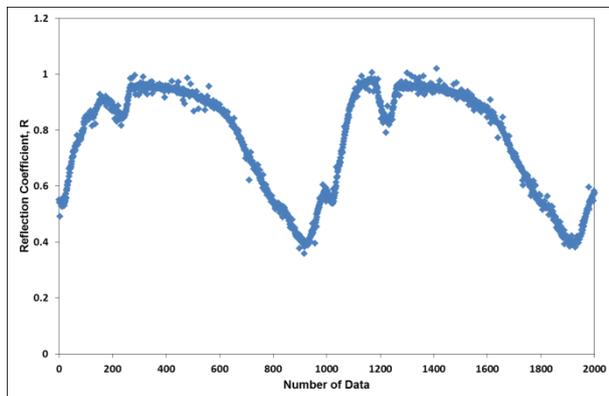


Figure 3 The reflection coefficient of the 2000 signal segments at 300 rpm.

A block of 2000 signal segments in the time domain was recorded with the journal running at 300 rpm for 10kN load in the cases of different groove locations. After the measurement was completed, the 2000 segments data were transferred to a computer for post processing. Each segment was extracted and reflection coefficient determined. The corresponding reflection coefficient data after FFT were obtained and plotted as shown in Figure 4.

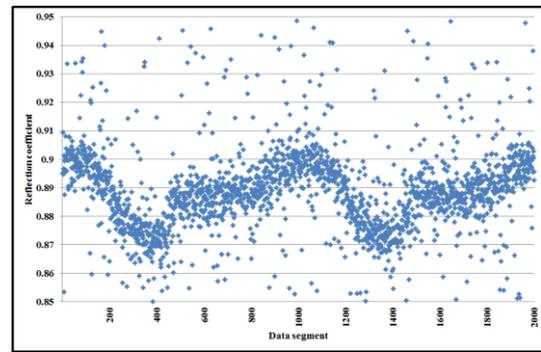


Figure 4 Reflection coefficient of 2000 signal segments at 0 $^{\circ}$ groove locations.

4. CONCLUSIONS

Measurement of viscosity profiles by shear wave ultrasonic shows the similarity to temperature profiles trends. As temperature change the viscosity tend to change. In conclusion, this experimental works shows that the inlet groove locations did affect the oil behaviour in hydrodynamic lubrications.

5. REFERENCES

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