Proceedings of Malaysian International Tribology Conference 2015, pp. 318-319, November 2015

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

Mohamad Ali Ahmad[1,*], Salmiah Kasolang[2], Jaharah A. Ghani[3]

[1)] Mechanical Engineering Section, Universiti Kuala Lumpur International College,
Jalan Teras Jernang, Section 14, 43650 Bandar Baru Bangi, Selangor, Malaysia.
[2)] Faculty of Mechanical Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.
[3)] Department of Mechanical and Materials Engineering, Universiti Kebangsaan Malaysia,
43600 UKM Bangi, Selangor, Malaysia.

[*]Corresponding e-mail: mohamadali@unikl.edu.my

Keywords: Ultrasound; transducer; hydrodynamic lubrication

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 -30^0, -15^0, 0^0, 15^0, 30^0 and 45^0 positions.

1. INTRODUCTION

Film thickness and viscosity an 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 get 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.

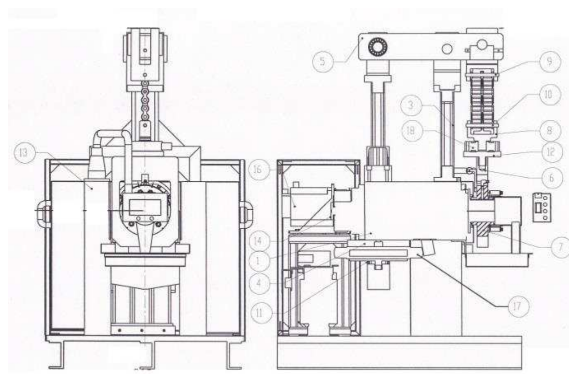

Figure 1 Journal bearing test rig.

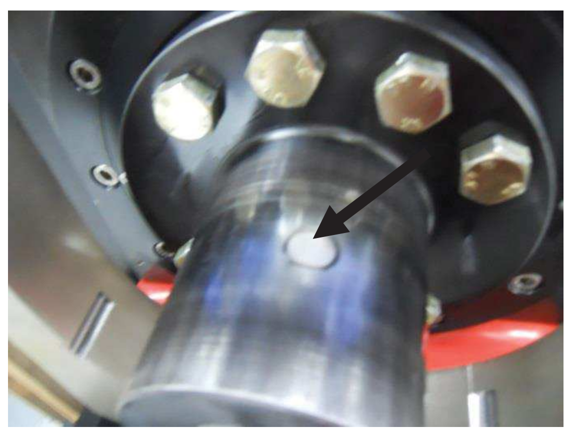

Figure 2 A purpose built longitudinal transducer placed into the shaft.

The journal was then mounted horizontally into the bearing. A pneumatic bellow 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 -30^0, -15^0, 0^0, 15^0, 30^0 and 45^0 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 µm
Load Applied, W	10 and 20kN
Journal Speed,	300 – 800 rpm
Lubricant Type	Shell Tellus S2 M
Lubricant viscosity	68 cSt @ 40^0C 8.8 cSt @ 100^0C
Pressure Sensor	
Model	MEAS (M5156)
Range	10 Mpa
Accuracy	0.001 ± 1% Mpa
Temperature Sensor	
Model	PT 100
Range	0 – 100 ^{0}C
Accuracy	± 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.

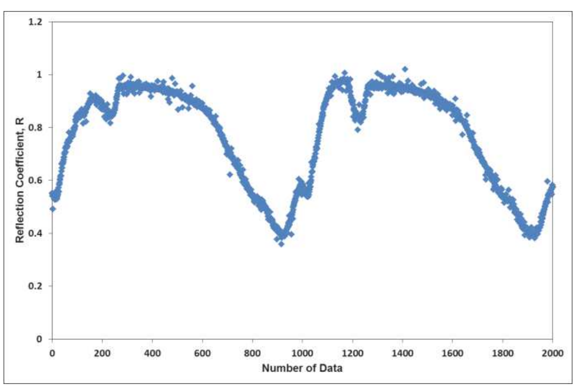

Figure 3 The reflection coefficient of the 2000 signal segments at 300 rpm.

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.

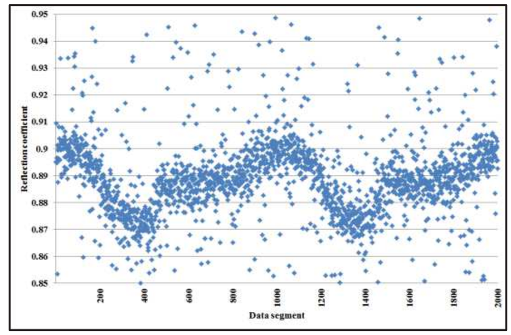

Figure 4 Reflection coefficient of 2000 signal segments at 0^o groove locations.

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

[1] M. A. Ahmad, S. Kasolang, R. S. Dwyer Joyce, and N. R. Abdullah, "The Effects of Oil Supply Pressure on the Circumferential Pressure Profile in Hydrodynamic Journal Bearing," Applied Mechanics and Materials, vol. 315, p. 6, 2013.

[2] M. A. Ahmad, S. Kasolang, and R. S. Dwyer Joyce, "Experimental Study of Oil Supply Pressure Effects on Bearing Friction in Hydrodynamic Lubrication," Applied Mechanics and Materials, vol. 315, p. 5, 2013.

[3] S. Kasolang, M. A. Ahmad, R.-D. Joyce, and C. F. M. Taib, "Preliminary Study of Pressure Profile in Hydrodynamic Lubrication Journal Bearing," Procedia Engineering, vol. 41, pp. 1743-1749, 2012.

[4] S. Kasolang, "An ultrasonic investigation of various aspects of hydrodynamic lubrication in a journal bearing," Degree of Doctor of Philosophy, Department of Mechanical Engineering, University of Sheffield, 2008.

[5] S. Kasolang and R. S. Dwyer-Joyce, "Observations of Film Thickness Profile and Cavitation Around a Journal Bearing Circumference," Tribology Transactions, vol. 51, pp. 231-242, 2008.

[6] S. Kasolang and R. S. Dwyer-Joyce, "Viscosity measurement in thin lubricant films using shear ultrasonic reflection," Proceedings of the Institution of Mechanical Engineers Part J-Journal of Engineering Tribology, vol. 222, pp. 423-429, May 2008.

[7] S. Kasolang, M. A. Ahmad, and R. S. D. Joyce, "Viscosity profile measurement in journal bearing by shear ultrasonic reflection," in Computer Engineering and Technology (ICCET), 2010 2nd International Conference on, 2010, pp. V5-41-V5-45.