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The performances of palm mid olein as lubricant in journal bearing application

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ABSTRACT – Journal bearing is one of the major components especially for the equipment dealing with continuous rotating speeds and heavy load. Lubricant also plays an important role to determine the performance of journal bearing. In this study, the pressure distribution of Palm Mid Olein (PMO) lubricant was investigated along the bearing circumferences and compared with Mineral oil based lubricant (SAE 40) using journal bearing test rig. It was found that at lower load, PMO presented higher maximum pressure compared to SAE 40. It was also observed that the increase in radial load caused an increase in maximum pressure. However, the position of maximum pressure has not changed with increasing radial loads.

1. INTRODUCTION

As the machinery technology is keep expanding all over the world, the very high efficiency of machining operation is crucial to achieve optimum desired output. The competition is becoming more interesting as technologist nowadays coming out with brilliant ideas to provide tremendous improvement over the years [1]. Journal bearing is one of the machine elements that contribute high impact to the machine optimization itself. It has been revolution in many years and playing a big role in machining industry especially in rotating equipment. Nowadays industry is demanding high efficiencies of rotating equipment and less energy consumption [2]. Journal bearing consists of two major parts known as shaft or journal and bearing or bushing. As a fundamental, the shaft is freely moving inside the bearing and transmits the power to the other mechanism in the system for various purposes [3]. Commonly journal bearing is operated in hydrodynamic lubrication regime. This is the condition where the load carrying surface of the bearing is separated by the thick film lubricant to avoid metal to metal contact thus reduce coefficient of friction [4-6]. Generally, the pressure profile distribution of fluid film is one of the main criteria to evaluate the bearing performance.

The investigation on journal bearing performance usually started from the basic Reynolds equation. It has been used by researchers as fundamental concept for further derivations. The Reynolds basic equation compromises the relation of pressure, velocity and friction [7]. The general equation for pressure distribution throughout the bearing circumferential given by Reynolds is as follow:

$$\frac{d}{dx}\left(\frac{h^3}{\mu}\frac{dp}{dx}\right) = 6U\frac{dh}{dx}$$

However, a few assumptions have been made to comply with this equation as followed:

(a) The lubricant is Newtonian
(b) The flow is laminar
(c) The lubricant is incompressible
(d) No changes in viscosity throughout the bearing
(e) The fluid’s inertia is neglected
(f) Constant pressure in axial direction

In this study, Palm Mid Olein was used as lubricant in journal bearing test rig. The aim of this study is to investigate the performance of Palm mid Olein by evaluating the pressure profile along the bearing circumference with respect to the changes in applied radial load.

2. METHODOLOGY

The journal bearing test rig was used in the experiment as shown in Figure 1. The tested bearing was equipped with 12 pressure sensors installed on the bearing circumference with interval of 30°. The lubricant was contacted to the diaphragm sensors through 0.5mm holes drilled on the inner surface of the bearing. The bearing was then mounted on the shaft axially. The pressure sensors inverted the signal and gave the real time pressure reading.

During the test, journal speed was maintained at 200 rpm while load was applied at 10 kN and 20 kN. The length to diameter ratio of the bearing was 0.5 with clearance of 52μm. Palm Mid Olein (PMO) and Mineral Engine Oil (SAE 40) were used in this study as lubricant. The kinematic viscosities of PMO and SAE 40 at 40°C were 0.0299 Pa.s and 0.0897 Pa.s respectively.

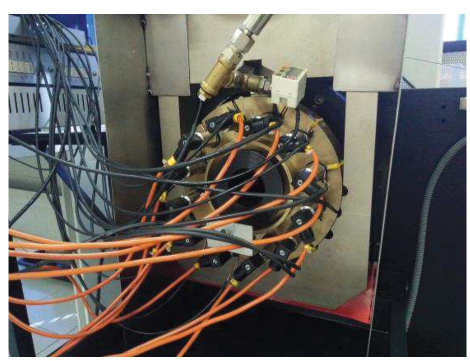

Figure 1 Journal bearing test rig.

3. RESULTS AND DISCUSSION

The graph of pressure distribution along the bearing circumference was plotted as illustrated in Figure 2. With the same operating condition, it was found that the maximum pressure was observed at 195° for both SAE 40 and PMO. The PMO exhibited higher maximum pressure than SAE 40 at 6.440 MPa while SAE 40 had shown the pressure of 5.682 MPa. The higher the pressure represented, the higher the ability of the lubricant to counter the forces either from the radial load, changes in viscosity or other factors. This is so important to remain the film thickness of the lubricant to prevent journal and bearing from being contacted. The reduction in film thickness would lead to asperities contact and increase the coefficient of friction.

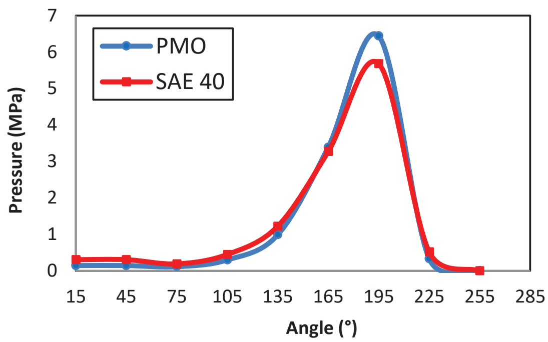

Figure 2 Pressure distribution at load of 10kN.

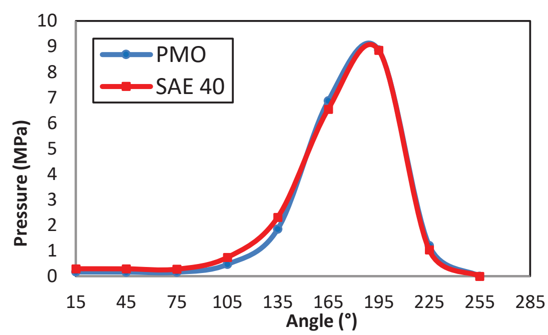

Figure 3 Pressure distribution at load of 20kN.

As the radial load increased, the maximum pressure also increased as shown in figure 3. These results were expected as the theory had described that the applied radial load is directly proportional with maximum pressure. It was observed that at higher load, the maximum pressure of PMO is higher than SAE 40 but the difference was not significant. PMO recorded the maximum pressure of 8.867 MPa while SAE 40 showed 8.854 MPa. The position of maximum pressure remained at the same location of angle 195°.

4. CONCLUSION

From the results, it can be concluded that PMO demonstrated higher maximum pressure compared to SAE 40 at lower radial load. The maximum pressure was increased parallel to the increasing of load. There was no significant difference on maximum pressure between PMO and SAE 40 at higher load. The position of maximum pressure was not changed with respect to the increase of radial load.

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