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Investigating the Effect of Texturing on the Performance of Journal Bearing

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ABSTRACT

In the present paper an attempt has been made to assay the effect of producing texturing surfaces on the pressure profile of journal bearing which improves its hydrodynamic performance. The parameters that affects the bearing performance selected for the study are speeds of shaft, loading conditions and different textures of bearings and shafts. During the experiments by varying above said parameters, its pressure profile generated for each combination with the help of manometer tubes and then comparison needs to be carried out.
Keywords: Journal Bearing, Bearing Texture, Shaft Texture, Pressure Profile, Bearing Performance

I. INTRODUCTION

Basic definition of journal bearing states that a journal bearing consists of a cylindrical shaft or a journal which rotates freely inside the shell called the bearing. It can be exemplify by a bearing is a shaft rotating inside a hole. Journal bearing, in general, are less expensive type of the bearing compared to other types. They are also compact, lightweight and they bear a high load carrying capacity.

In applications such as steam engine and railroad car a journal contact bearing is particularly referred to the plain bearing once used at the ends of the two axles of railroad wheels sets, enclosed by journal boxes. From the construction point of view the journal bearings should be made from a material that is resilient, low friction, low wear to the bearing and shaft, opposed to superior temperatures and resist to corrosion. Often the journal bearing is fabricated of two constituents, where one is soft and other one is hard. The hard part supports the load while the soft one supports the hard constituent. In general, as the surfaces will be harder, it will offer low coefficient of friction and greater the pressure required for the two to size.

Journal Bearing:

A journal bearing is an inclusive kind of bearing that contains a journal (bearing) or shaft that rotates without restraint in a support with a shell or metal sleeve. In journal contact bearing there are no rolling elements present. The construction and design of these bearings is very simple but the operation and theory is complicated.

II. METHODS AND MATERIAL

1. Literature Review

To gain the knowledge of the journal bearing, its working principal and to get acquainted with the behavior of the journal bearing under the application of the load the following research work have been investigated.

Minimum oil Film Thickness:

The fluid film pressures can be calculated by using the finitely short bearing theory for the convenience of analysis. Circumferential 3600 groove only reduces the absolute magnitude of the film thickness, but 1800 half groove affects the shape of film thickness curve and position of minimum oil film thickness. Clearance configuration of fluid film journal bearings can enhance the stability of full circular bearing at high rotational speeds. The load capacity of the bearing is same as full circular journal bearing for small length to diameter ratios and is free from the whirl instability[1]

Maximum Load Carrying Capacity

Rosenbrock method can be applied to optimize the load carrying capacity of hydrodynamic journal bearings. From the experiments M El-Sherbiny concluded that precision bearings with small clearances and low pressure ratios are recommended for applications involving low supply pressures, while bearings with large clearances and pressure ratios close to 0.5 are recommended for applications involving high supply pressures. Inclined and parabolic slider bearing the inlet-outlet film height ratio for the optimum load capacity depends on the power law index of lubricants.[2]

Effect of Shaft Surface Textured Area

The trapezoidal shaft can carry more loads than the saw shafts. The shaft that has the same profile but a lower profile height and pitch value can carry fewer loads.[3]

Effect of Textured Area

Full texturing appears ineffective to generate hydrodynamic load capacity in the contact by the cavitations effects. Partial texturing can generate hydrodynamic lift in bearing, when the texture is located in the declining part of the contact pressure field.[4]

Maximum Oil Film Temperature

Operation of plain circular journal bearing at high speed is restricted by the excessive temperature that is generated in the oil film and by the loss of stability. However, low costs of machining and high transmitted loads are the advantages of these types of bearings. The operation of bearing and its thermal state are effected by modifications of bearing design. These modifications should result in the higher speeds of operation and better thermal state of bearing. [5]

2. Design criteria for Journal Bearing Setup

1. Diameter of journal = 78.00 mm
2. Diameter of bearing = 81.00 mm
3. Shaft length = 76.5 mm
6. Weight of bearing with attachments = 5kg
7. Weight of balancing load = 2 kg
4. Motor = D.C. 0.5 HP, 1440 rpm variable speed
5. Motor control = D.C. motor speed variant
8. Manometer board with 16 tubes of 175 cm, height with suitable scales and adjustable oil supply tank.
9. Recommended oil = SAE 40
10. Supply required = A.C. 1 ph. 240v.

III. RESULTS AND DISCUSSION

1. Experimental Set-up

Figure 1. Journal Bearing Apparatus

2. Experiment procedure

- ✓ Fill the oil tank by using oil lubricating oil under test and position the tank at the desired height.
- ✓ Drain out the air from all the tubes on the manometer and check level balance with supply level.
- ✓ Check that some oil leakage is there. Some leakage of oil is necessary for cooling purpose.
- ✓ Check the direction of rotation and increase the speed of motor slowly.
- ✓ Set the speed and let the journal run for about half an hour until the oil in the bearing is warmed up and check the steady oil levels at various tapping.

- ✓ Add the required loads and keep the balancing rod in horizontal position by moving balancing weight on the rod and observe the steady levels.
- ✓ When the manometer levels have settled down, take the pressure readings on manometer tubes. For circumferential pressure distribution and tubes for axial pressure distribution.
- ✓ Repeat the experiment for various speeds and loads.
- ✓ After the test is over set dimmer to zero position and switch off main supply.
- ✓ Keep the oil tank at lower most position so that there will be no leakage in the idle period

3. Experiment data

The experiment has been performed without the any texturing on shaft and as well as bearing. The results and the graphs are shown below.

Pressure generated in shaft with no texture and with no load at 165 rpm

Table 1. Experimental data

No of tubes	Height (m)	Pressure (bar)
1	0.845	0.028644
2	0.9	0.023414
3	0.89	0.024796
4	0.77	0.035051
5	0.63	0.047028
6	0.504	0.057801
7	0.43	0.064129
8	0.392	0.067378
9	0.418	0.065155
10	0.488	0.059169
11	0.622	0.047712
12	0.753	0.036511
A	1.08	0.0085505
B	0.665	0.044035075

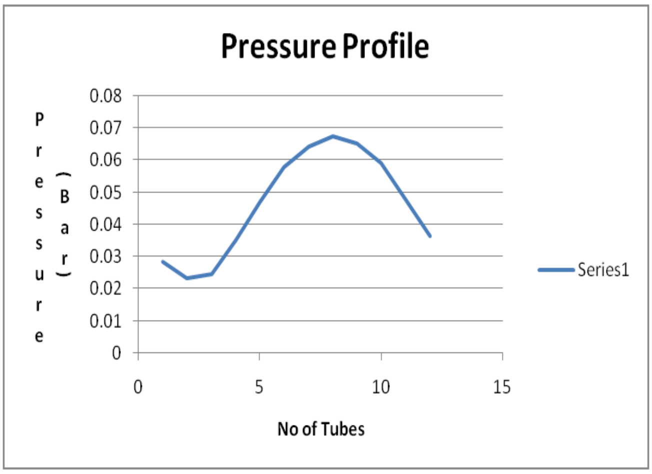

Figure 2. Radial Pressure Profile

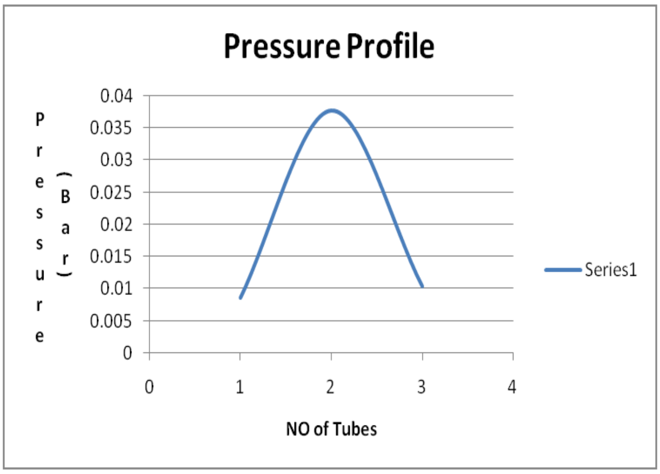

Figure 3. Longitudinal Pressure Profile

IV. CONCLUSION

At present, the setup is being operated at low speed of 165 rpm. As per the results, Practical values of the experiment are very similar to that of calculated pressure. Now we are going to perform on the basis of shaft texture (cross knurling) and bearing texture (straight knurling) which will help to find out the effect of different conditions on the performance of the bearing and bearing pressure. From the experiments the best surface texture can be optimized which can carry more loads and improves the bearing performance.

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