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Effect of Bearing Surface Texture on Journal Bearing Pressure Distribution

Singh Pratibha [1], Rana Chandreshkumar P [2]

[1]A.D Patel Institute of Technology, Gujarat Technological University, Vallabh Vidyanagar,Anand, Gujarat, India

[2]Vadodara Institute of Engineering & Research, Gujarat Technological University, Kotambi, Vadodara, Gujarat, India

Abstract: ***In the present paper an analysis is performed to study the influence of textured surfaces which may improve hydrodynamic performance. It is examined under the parameters like speed of the shaft, bearing context texture and different loading conditions. By varying the parameters bearing performance is observed in the context of pressure profile generated for each combination of force, speed and bearing texture. Once determining the effects of the parameters on the performance of the journal bearing, for each bearing texture the optimum combination can be found. It is observed that with the increase of loads at constant speed the percentage increase of maximum pressure is more in textured journal bearing w.r.t smooth journal bearing and with the increase of speeds at constant load and constant oil supply pressure, percentage increase of maximum pressure is more in textured journal bearing w.r.t smooth journal bearing.***

Keywords: Journal Bearing, Bearing Texture, Pressure Distribution, Bearing Performance**.**

1. Introduction

Surface texturing technology has been newly explored technique in the tribology community is a method of improving the friction and lubrication performance of various mechanical components. The surface texture, such as micro-dimples or grooves, has been a well known approach to improve tribological performances of sliding surfaces. Trends on where and how implanting such texture has started to emerge since modification of the bearing shape has already been investigated experimentally. Over the past decade, experiments were carried out to investigate the effects of micro-dimples on various surfaces including silicon carbide, metals, and elastomer, under high-speed low-load and low-speed high-load conditions, by water and oil lubrication [1].The goal of this paper is to test these two texture configurations where a bearing is subjected to a load.

The texturing of sliding surfaces with regular patterns has received considerable attention as a means of improving their tribological performance. However, a better understanding is still needed of the affects on tribological performance of different surface textures. It is necessary to identify, using a more fundamental approach, the effect of each of the variables that define the pattern generated by the texturing process[2].hen you submit your paper print it in two-column format, including figures and tables. In addition, designate one author as the “corresponding author”. This is the author to whom proofs of the paper will be sent. Proofs are sent to the corresponding author only.

2. Literature Survey

S Sinanoglu et al studied that the presence of surface textures may also benefit because it works as a lubricant reservoir and storing and supplying the lubricant directly to the contact zone and reduce friction and wear problems[3]. Pettersson et al presented an analysis of the pressure development of journal bearing in a various shaft surface texture and velocity variations using a proposed neural network. The surface of the shafts has been in two types: smooth, that is, without profiles; with profiles, that is, trapezoidal and saw. The trapezoidal shaft can carry more loads than the saw shafts. In addition, the shaft that has the same profile but a lower profile height and pitch value can carry fewer loads[4]. Ashwin Ramesh et al, We report experimental and numerical investigations of the friction characteristics of micro textured surfaces. The textures are of size 28–257 mm on stainless steel surfaces fabricated using micro-casting. Friction characteristics of these surfaces were tested under submerged conditions using a pin-on-disk configuration. Numerical simulations solved the Navier–Stokes equations to predict the texture induced lift [6].

Tala-ighil et al. used a finite-difference numerical model to study the effect of surface textures on the lubrication of a journal bearing system under steady state condition [7]. T S Reddy Ganji et al has performed analysis on load carrying capacity, friction variable and flow coefficient of micro elliptical textured journal bearing. In which texture density and texture depth are varied for better performance of journal bearing. maximum load carrying capacity observed at full texture density, Oil flow increasing with increase in texture depth and density, Friction variable is decreasing, it sense that improvement in bearing performance [8].

In this paper, we focus our attention to influence of surface textures on the performance of hydrodynamic journal bearings in terms of pressure profile. The goal of this paper is to compare groove configurations and non-textured configuration corresponding to two different loadings and speed. In this current research effect of surface texture is examined under the parameters like speed of the shaft, bearing context texture and different loading conditions. Results are provided with different loads, speeds, and pressure on smooth and textured journal bearing.

3. Methods / Approach

The performance of the journal bearing is examined under the parameters like speed of the shaft, bearing context texture and different loading conditions. By varying the bearing surface texture, force applied and speed of the shaft, the bearing performance is observed in the context of pressure profile generated for each combination of force, speed and bearing texture.
Once determining the effects of the parameters on the performance of the journal bearing, for each bearing texture the optimum combination can be found.

3.1 Test Bearing

Bearings of different textures have been produced to carry out experiments and to examine the effect of the bearing texture on the performance of the bearing by measuring the pressure profile generated. Keeping the shaft as a reference and designing a bearing to it considering all the constraints.
Length/Diameter ratio = 0.85

$\frac{r}{c} = 600 – 1000$

No texture

Figure 1: Detailed view of bearing with no texture

Textured
The detailed view of the bearing with turning as per case 2 is shown in Figure 2. It also reveals the information about its depth and width of the texture produced.

No of grooves 8
Distance between grooves 8 mm
Width of grooves 1 mm

Figure 2: Detailed view of textured bearing

3.2 Experimental Setup

Figure 3: Journal bearing setup detailed view

In the detailed view of the journal bearing as shown in Figure 3 one could see that the circumferential pressure as of the journal bearing can be measured. There are 12 circumferential manometer tubes provided on the surface of the bearing cover.

3.3 Specifications of the Laboratory Setup

1. Diameter of journal = 81.50 mm
2. Diameter of bearing = 82.125 mm
3. Bearing length = 69.40 mm
4. Weight of bearing with attachments =
5. Weight of balancing load = 2 kg
6. Motor = D.C. 0.5 HP, 1500 rpm variable speed
7. Motor control = 4 Amp, D.C. dimmer for motor speed control
8. Manometer board with 16 tubes of 300cm, height with suitable scales and adjustable oil supply tank.
9. Recommended oil = SAE 40
10. Supply required = A.C. 1 ph. 230v.

3.4 Experimental Programme or Procedure of Experiment

Procedure of the experiment:

1. Fill the oil tank by using oil lubricating oil under test and position the tank at the desired height.
2. Drain out the air from all the tubes on the manometer and check level balance with supply level.
3. Check that some oil leakage is there. Some leakage of oil is necessary for cooling purpose.
4. Check the direction of rotation and increase the speed of motor slowly.
5. 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 tappings.
6. Add the required loads and keep the balancing rod in horizontal position by moving balancing weight on the rod and observe the steady levels.
7. When the manometer levels have settled down, take the pressure readings on 1.12 manometer tubes. For circumferential pressure distribution and tubes for axial pressure distribution.
8. Repeat the experiment for various speeds and loads.
9. After the test is over set dimmer to zero position and switch off main supply.
10. Keep the oil tank at lower most position so that there will be no leakage in the idle period.

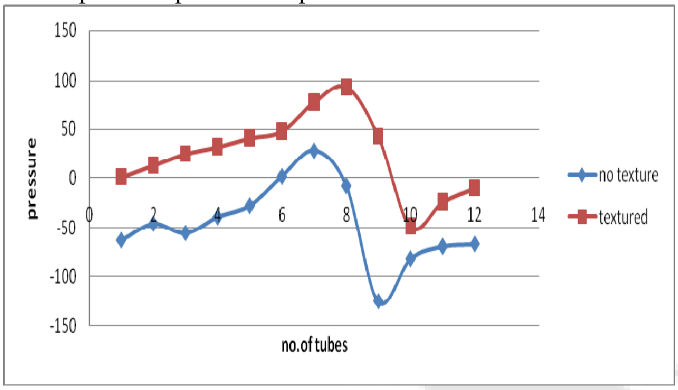
4. Result and Discussion

After investigating the effect of load, speed and bearing texture on the bearing, the profile pressure has been measured, and then it has been compared with each other in terms of the pressure profile generated. It is also identified how the bearing can carry more loads with generating less pressure.

1. Comparison of pressure profile for no load condition at 1370 rpm.

Figure 6.1 shows the comparison of radial pressure profile generated for all the bearing at no load condition and running the shafts at 1370 rpm.

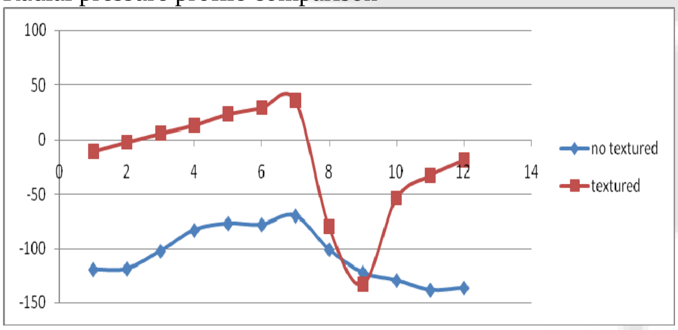
Radial pressure profile comparison



2. Comparison of pressure profile for no load condition at 1890 rpm.

Now the bearing has been compared at the same loading condition but raising the speed of the shaft to 1890 rpm and the radial pressure profile of each bearing has been compared as shown in Figure 6.2.

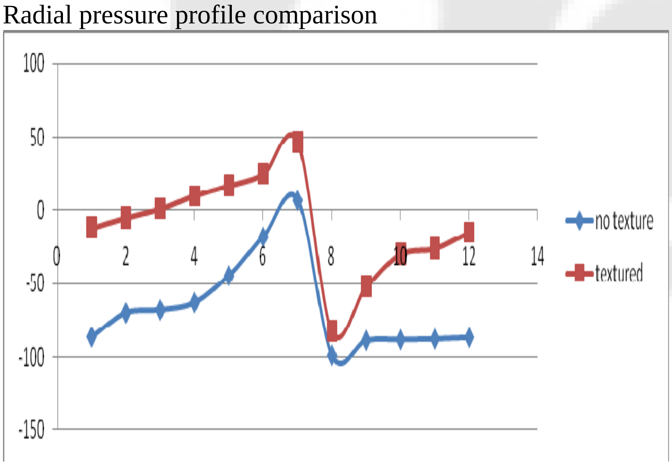
Radial pressure profile comparison



3. Comparison of pressure profile with loading condition at 1370 rpm.

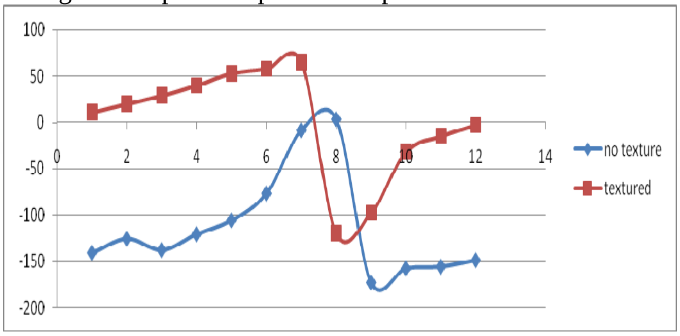
The bearing with different context texture and the bearing with no texture has been compared with each other while running the shaft at 1370 rpm and subjected to the load of 7kg.

Radial pressure profile comparison



4. Comparison of pressure profile with loading conditions at 1890 rpm.

The bearings now compared with each other while running the shaft at 1890 rpm and the bearing is subjected to the load of 7kg. Radial pressure profile comparison



5. Conclusion

- Experiment shows that the textured surface affected the journal bearing performance. It is observed that pressure increases more in textured journal bearing as compared to smooth journal bearing.
- From above figures it can be concluded that textured bearing can carry more loads and it has the optimum pressure profile as compared to bearing with no texture
- With the increase of loads at constant speed percentage increased of maximum pressure is more in textured journal bearing w.r.t smooth journal.
- With the increase of speeds at constant load percentage increased of maximum pressure more in textured journal bearing w.r.t smooth journal bearing. It is concluded that influences of surface textures are affected by speed variation.
- From the above results for a particular application of higher or lower loading condition, higher or lower speed levels, the optimum shaft context texture can be applied for the better performance of the Journal bearing for a larger life span.

6. Future Scope

- For more precise and accurate results Design of experiment methods like ANOVA and Taguchi can be applied.
- More Number of parameters like temperature effect, effect of oil used, Change in r/c ratio, change in l/d ratio can be added to get effects of such parameters on the performance of the journal bearing.
- Other defects like vibration in bearing, oil side flow and vacuum can be investigated and reduced.
- Implementation of A.I techniques such as genetic algorithm, artificial neural network etc can be done to verify experimental results

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Author Profile

Ms. Singh Pratibha is a research scholar in Mechanical Engineering Department in A.D Patel Institute of Technology; Vallabh Vidyanagar Gujarat. She has completed her B.E in Mechanical Engineering from Bhavnagar University, Gujarat in 2011 and Pursuing M.E in Cad/Cam from Gujarat Tecnological University, (Gujarat) in 2014. She has got 1 year Teaching experience

Mr. Rana Chandreshkumar P is Asst. Prof, Dept of Mechanical Engineering, Vadodara institute of Engineering Kotambi, Vadodara. He has completed his B.E in Mechanical Engineering from GEC, Dahod, (gujarat) in year 2008 and Pursuing Master's in Production Engineering from Rajasthan institute of engg and technology, Jaipur, Rajasthan. He started his career as a GET Maintenance Engineer in machine department at SE FORGE LTD (Suzlon Energy Forge Limited, Vadodara, Gujarat.). He has 6 month industrial experience and 3 years teaching.