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INVESTIGATION OF EFFECT OF SHAFT TEXTURE ON THE PERFORMANCE OF JOURNAL BEARING

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ABSTRACT

Journal bearing consists of a shaft or journal which rotates freely in a supporting metal called sleeve or shell. Their design and construction may be simple, but the theory and operation of these bearings can be complex. The performance of the journal bearing can be illustrated in terms of the pressure profile generated. The parameters affecting the pressure profile are load carrying capacity, number of revolutions and shaft surface texture. The effect of the parameters mentioned above, have been examined. It has been compared with the shaft without texture to determine the improvement in the performance.

Keywords: *Journal bearing, surface roughness, Shaft surface texture, Pressure profile.*

I. INTRODUCTION

The bearing and shaft requires a level of surface texture that allows lubricants to be retained in small packages as well as allowing the bearing to roll with minimum friction. Thus a high degree of surface finish required. And the primary effort is made to minimize the surface roughness of the component.

Shaft surface texturing is very useful in improving the performance of the journal bearing. There are many examples like honed cylindrical surfaces, aerodynamic lubricated magnetic hard disks and forming tools such as rolls for sheet metal forming.

The effect of shaft surface texture can be measured with the help of pressure profile generated. Pressure profile of a journal bearing is shown in Figure 1. In the present work the performance of the journal bearing is measured under the effects of the parameters such as shaft texture, speed of the shaft and load carrying capacity. By varying the parameters stated above, the performance of the journal bearing was observed in the context of pressure profile generated.

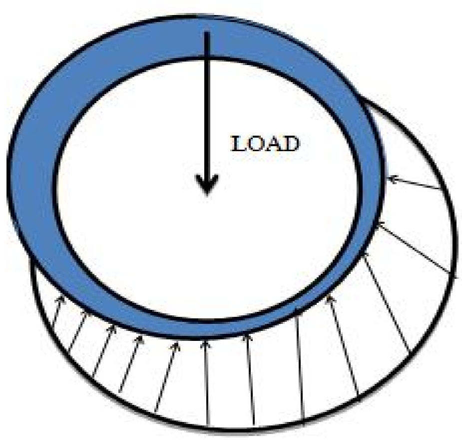

Figure 1: Pressure distribution in journal bearing

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II. LITERATURE REVIEW

The effects of circumferential groove on the minimum oil film thickness in the engine bearings. The fluid film pressures have been calculated by using infinitely short bearing theory for the convenience of the analysis. Circumferential 3600 groove only reduces the absolute magnitude of the oil film thickness but 1800 half groove affects the shape of film thickness curve and position of minimum oil film thickness [1].

T. Nagaraju et al stated the effect of journal and bearing surface roughness on the performance of a capillary compensated hole entry hybrid journal bearing system has been studied [2].

Petterson and Jacobson [3] have studied the friction and wear properties of boundary lubrication surfaces. Significant improvement in load capacity, wear resistance of tribological mechanical components can be achieved by forming regular micro surface structure in the form of micro-dimples on their surfaces [4].

Performance enhancement by laser surface texturing of parallel thrust bearings are experimentally investigated. Test results are compared with a theoretical model and a positive correlation is found over the relative operating conditions. [5]

Nacer Tala et al [6] represented the effect of textured area on the performance of a hydrodynamic journal bearing. They concluded that presence of cavities increases the fluid film thickness and decreases the friction force. Full texturing appears ineffective to generate hydro-dynamic load capacity in the contact by the cavities effects.

An analysis of pressure distribution of journal bearing in a various shaft surface texture and velocity variations using a proposed neural network. The effect of the parameters which act on journal bearing, on the pressure development and load carrying capacity have been examined such as number of revolutions and shaft surface texture by Cem Sinanoglu and Fehmi Nair [7].

III. JOURNAL BEARING APPARATUS

The experimentation has been carried out on the journal bearing apparatus as shown in Figure 2 for different shaft texture at Laboratory of Dynamics of Machinery, Mechanical Engineering department, B. V. Mahavidyalaya, V. V. Nagar, Gujarat, India.

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 = 4.2 kg
5. Weight of the shaft = 11.763 kg
6. Weight of balancing load = 2 kg
7. Motor = D.C. 0.5 HP, 1500 rpm variable speed
8. Motor control = 4 Amp, D.C. dimmer for motor speed control
9. Manometer board with 16 tubes of 300cm, height with suitable scales and adjustable oil supply tank.
10. Recommended oil = SAE 40, Supply required = A.C. 1 ph. 230v.

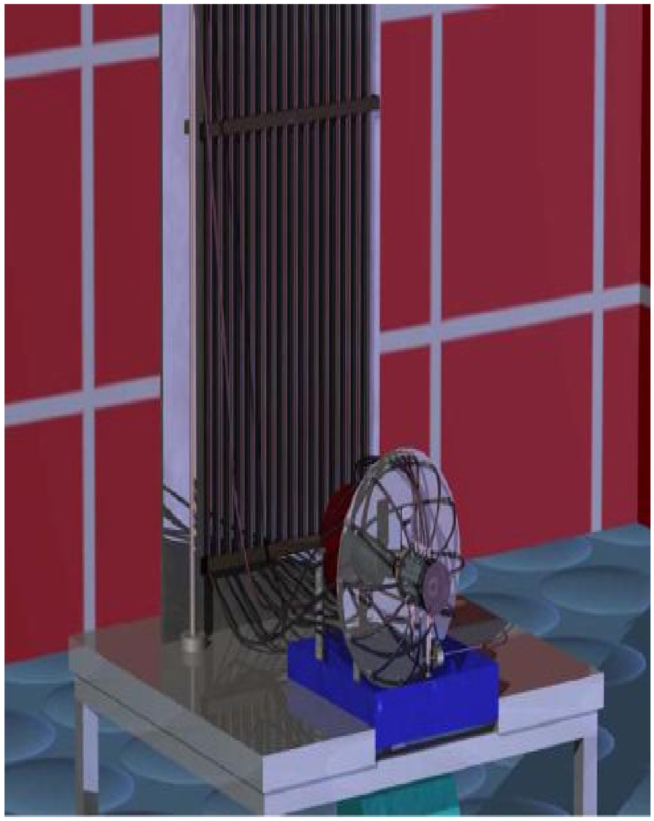

Figure 2: Journal bearing apparatus

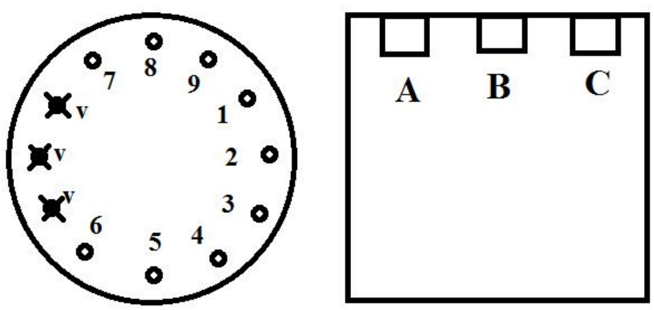

Figure 3: Detailed view of the setup

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

IV. SHAFT TEXTURING AND EXPERIMENTATION

For the experiments, in order to measure the pressure distribution, 12 manometer tubes were placed around the circumference with 30^0 between the tubes and 3 more tubes were located along the bearing length. The experiments were conducted at 32 ◦C for steel shaft with various surface textures. Shaft-I has smooth surface. The surface of the shaft-II has straight knurling texture, shaft-III has profile of crossed knurling texture and shaft-IV has the texture of a tool mark. The profile of the shaft-II, III and IV were measured with measuring microscope.

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The following shafts have been experimented for different combinations of speed of the shaft and load attached to the bearing. For higher level of speed of the shaft of 1890 rpm and higher loading condition of 7kg subjected to the bearing, the shafts with different textures have been compared.

4.1 Shaft with No Texture:

Figure 4: Shaft with no texture

The radial pressure profile generated by the shaft with no texture has shown in Figure 5 and longitudinal pressure profile is shown in Figure6.

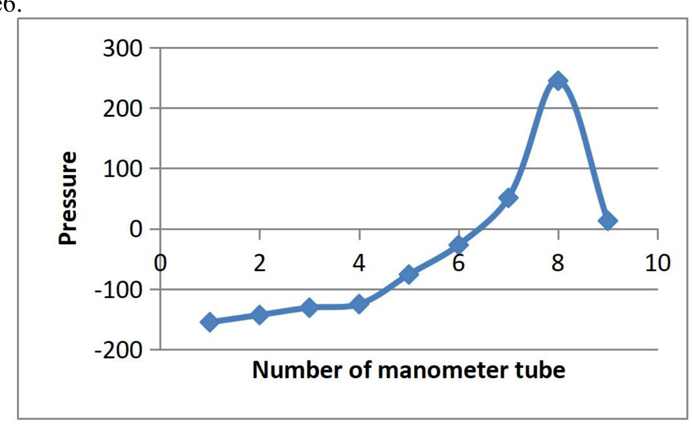

Figure 5: Radial pressure profile of shaft with no texture

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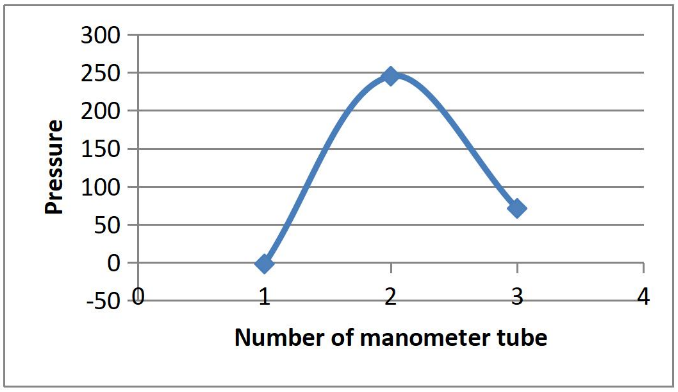

Figure 6: Longitudinal pressure profile of shaft with no texture

4.2 Shaft with Straight Knurling

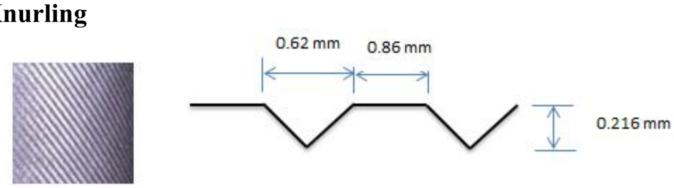

Figure 7: Detailed view of straight knurling shaft

Figure 7 describes the profile generated by the texturing of straight knurling showing its dimensions. The radial pressure profile generated by this shaft is shown in Figure 9 and longitudinal pressure profile is shown in Figure 10.

Figure 8: Shaft with straight knurling

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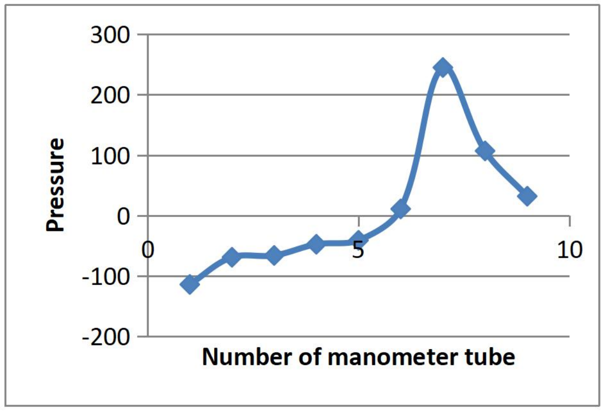

Figure 9: Radial pressure profile of shaft with straight knurling

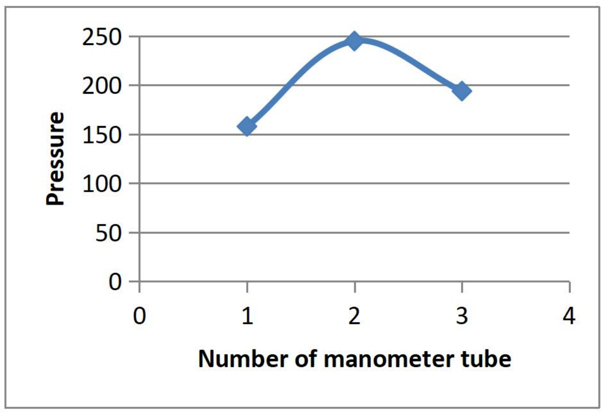

Figure 10: Longitudinal pressure profile of shaft with straight knurling

4.3 Shaft with Crossed Knurling

The shaft with crossed knurling is shown in Figure 12 and its detailed view is shown in Figure 11.

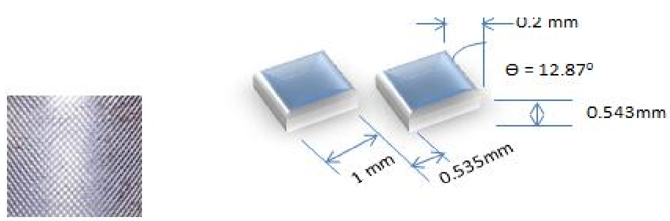

Figure 11: Detailed view of crossed knurling shaft

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Figure 12: Shaft with crossed knurling

The radial pressure profile generated by this shaft is shown in Figure 13 and longitudinal pressure profile is shown in Figure 14.

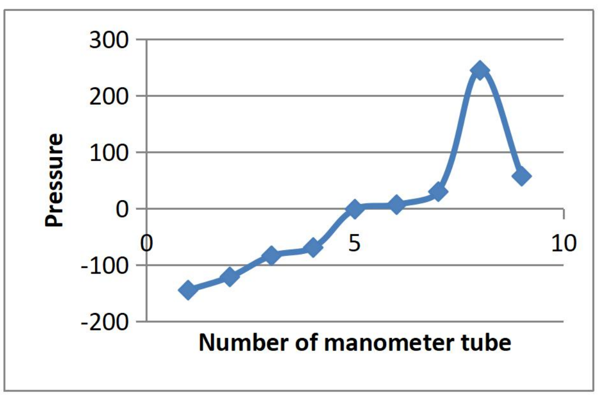

Figure 13: Radial pressure profile of shaft with crossed knurling

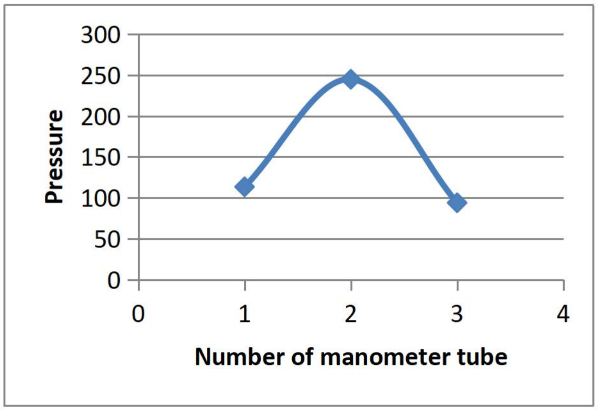

Figure 14: Longitudinal pressure profile of shaft with crossed knurling

4.4 Shaft with a Took Mark

Figure 15 describes the cavities generated by the texture of a tool mark on the shaft.

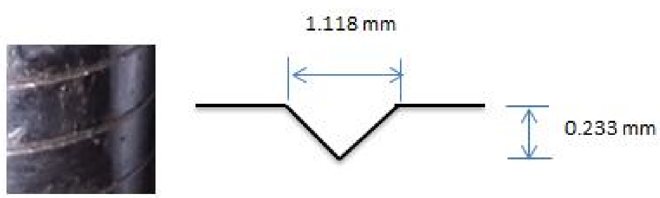

Figure 15: Detailed view of shaft with a tool mark

FIguer 16: Shaft with a tool mark

The shaft with a tool mark has been experimented under the load of 7kg subjected to the bearing and running the shaft at the higher speed of 1890 rpm to obtain the pressure profile generated by shaft and compare it with the other shaft to examine the effect of the context shaft texture on the performance of the journal bearing in terms of pressure profile.

The radial pressure profile generated by the shaft with a tool mark is shown in Figure 17 and the longitudinal pressure profile is shown in Figure 18.

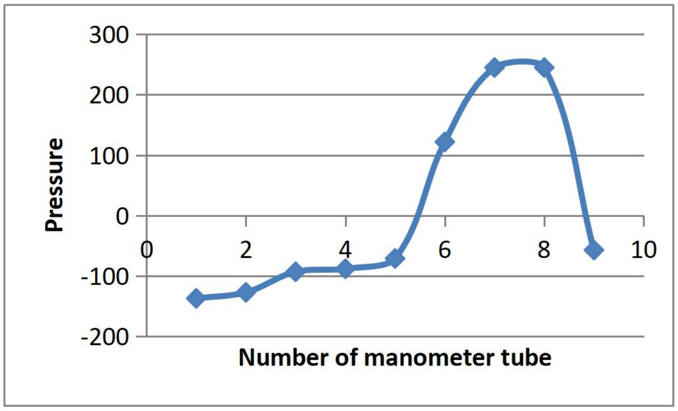

Figure 17: Radial pressure profile of the shaft with a tool mark

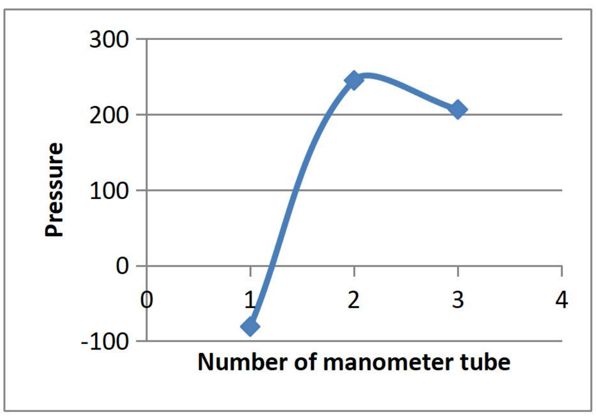

Figure 18: Longitudinal pressure profile of the shaft with a tool mark

V. RESULTS AND ANALYSIS

After experimentation of the different shaft textures at the constant speed of 1890 rpm and higher loading conditions of 7kg which is subjected to the bearing, they have been compared in terms of the radial and longitudinal pressure profile generated by the shafts.

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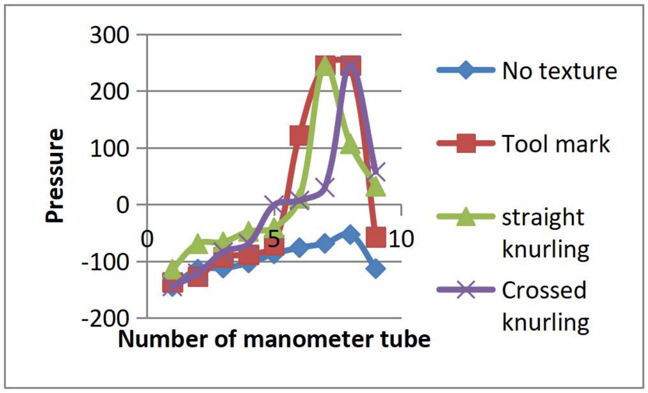

Figure 19: Comparison of radial pressure profile of different shaft textures

Figure 19 describes the radial pressure profile generated by different shaft textures at constant speed of 1890 rpm and loading condition of 7kg. Figure 20 describes the comparison of the longitudinal pressure profile generated for the same.

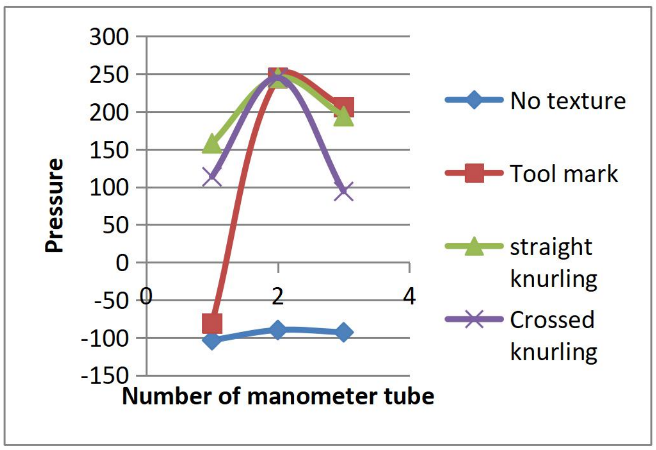

Figure 20: Comparison of longitudinal pressure of different shaft textures

VI. CONCLUSION

In this research, the effects of shaft surface texture on the performance of the bearing pressure and on the load were investigated. The surfaces of the shafts has been in two types- smooth, that is without profiles; with profiles, that is, straight knurling, crossed knurling and shaft with the tool mark.

The shaft with crossed knurling can carry more loads than the shaft with straight knurling and shaft with a tool mark. (from Figure 19 and Figure20) After experimentation of the different

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