Analysis of Spherical Texture on Characteristics of Hydrodynamic Journal Bearing

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Abstract- The objective of the present paper is to provide the experimental data for the study of solidification of phase change material (PCM) in the cylindrical container. The pure water was considered as a PCM, copper was chosen for the cylindrical container and the liquid nitrogen was taken as the cooling fluid. The experiments were done for different sizes of cylindrical cavities, whose dimensions were 20×20, 20×30, 30×30, 30×40 and 40 × 40 (diameter in mm× height in mm). The PCM was taken initially at room temperature for all the cavities. The temperature variation is presented at different time steps during the solidification of PCM. The result shows that the convection from the atmosphere has a significant effect on upper surface. As the diameter of the cavity changes, for the same height, then notable change in solidification time is observed while as the height is changed, for the same internal diameter, the change in solidification time is observed to be less significant. It is also found that when the depth increases from 20mm to 30mm for the same internal diameter (20mm), the solidification time increases by only 3.78% and when the depth increases from 30mm to 40mm, the solidification time increases by 2.69%. But when the internal diameter increases for the same height, there is more change.

Keywords: PCM, solidification, conduction and convection, ice track

I. INTRODUCTION

Tribology is the branch of science which deals the surfaces, that are rub together or we can say that it is a scientific and systematic method to deal with interacting surfaces so that characteristics of the system can be improved. Tribology contains the study of chemistry, physics and mechanics of rubbing surfaces which include friction wear and lubrication of materials. From the ancient civilization various attempts have been made to minimize friction and wear so that we can transport men and materials from one place to another place in an economical way. This was the biggest challenge faced from past till now. In the nineteenth and the twentieth century lubrication came into picture which is usually put between interacting surfaces to minimize friction and wear.

When shaft starts rotating he observes that the oil is coming out of that hole, to prevent this he put a plug on that hole. However, he noticed that plug is been thrown out from that hole, from there he concluded that oil film is being formed in between shaft and bearing that generates sufficiently high pressure to through the plug out of the hole. At the same time Petroff was interested in calculating friction in journal bearings. For this he conducted some experiments and came out with some relationship between frictional force and operating parameters of bearing. However, he didn't notice that the oil film also generates the pressure which was given by tower hence he should be given the credit for enhancing the concept of hydrodynamic fluid film lubrication.

With the help of these developments, Reynolds formulated the concept of formation of hydrodynamic fluid film lubrication in journal bearings and developed Reynolds equation for hydrodynamic lubrication. The results gave by Reynolds were approximate as he didn't go for the integration of Reynolds equation. Summer field obtained the analytical expression for pressure distribution, load carrying capacity, frictional force etc. by integrating the Reynolds equation.

II. PREVIOUS WORK

There are a few papers which have been contemplated and alluded on my work.

Priest et al [2020] It is now easy to improve the tribological performance by surface texturing technique, which includes decrease in friction parameter, increases life, load capacity and lowers the energy consumed by producing the micro dimples on bearing surface. The technology of surface texturing is expected to be a very sufficient in future because it improves tribological properties of component.

Petterson and Jacobson [2019] determine the behavior of wear and friction properties of boundary lubricated textured surfaces. In this they determine how lubricant can be supplied to the interface and how to separate wear particles according to their sizes, shapes and orientation. Series of surface textures of parallel grooves or square depression of various characteristics have been produced by various techniques such as anisotropic etching of silicon wafers and lithography.

Siripuram et al. [2019] there are various types of shapes of microstructures such as spherical, cylindrical, hemi spherical, triangular cross-section, square etc. and according to his experimental results square asperities gives the largest leakage rate and triangular asperities gives the smaller leakage rate.

Kovalchenko et al. [2017] have studied laser texturing expanded the contact parameters in terms of speed and load of hydrodynamic lubrication. Laser surface texturing technique is more efficient at higher loads and speed provided that viscosity of lubricant should be high.

Mehenny et al. [2017] had done a theoretical analysis to determine the influence of circumferential waviness of the journal in automotive engine on the lubrication of bearing. Assumption was made that surfaces of bearing and shafts have to be rigid and lubricant is viscous.

III. METHODOLOGY

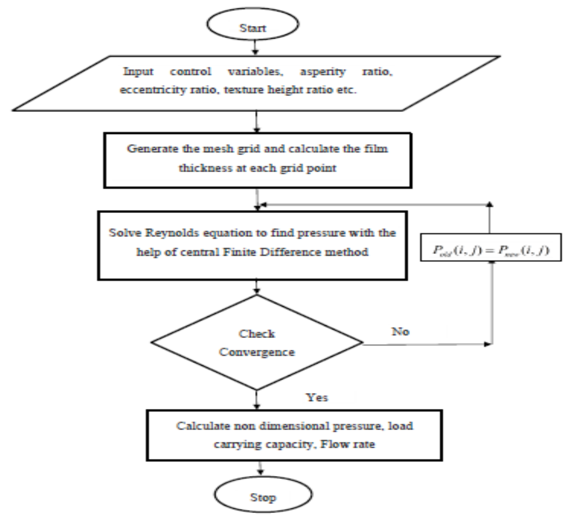

Figure 1: Flow Chart (Static Characteristics)

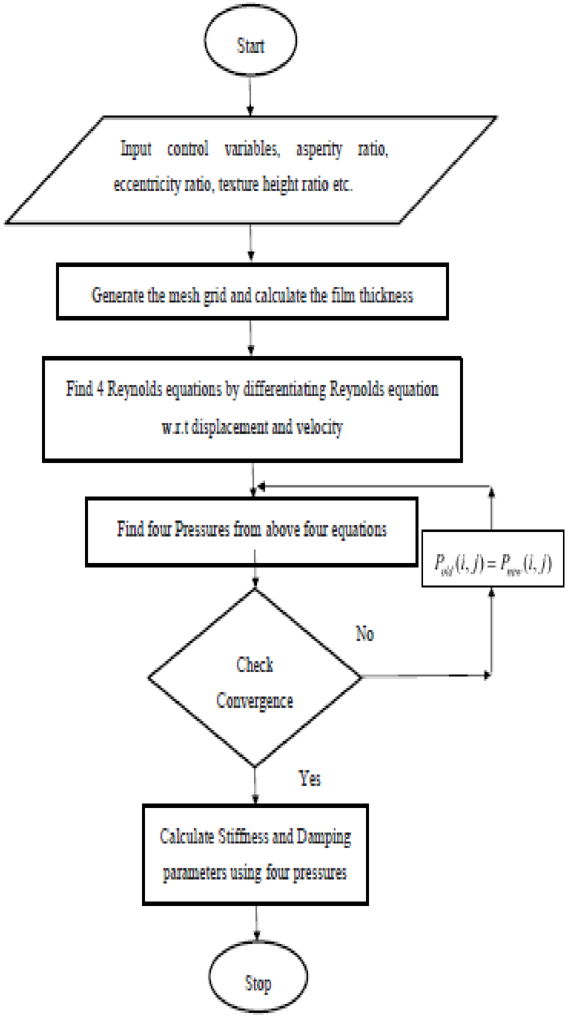

Figure 2: Flow Chart (Dynamic Characteristics)

IV. RESULTS AND ANALYSIS

The below graph is in between eccentricity ratio Vs non dimensional load for negative spherical asperity. We have taken eccentricity ratio as abscissa because radial clearance is in our control, we can increase or decrease eccentricity ratio by varying radial clearance. Eccentricity ratio is the ratio of eccentricity to the radial clearance.

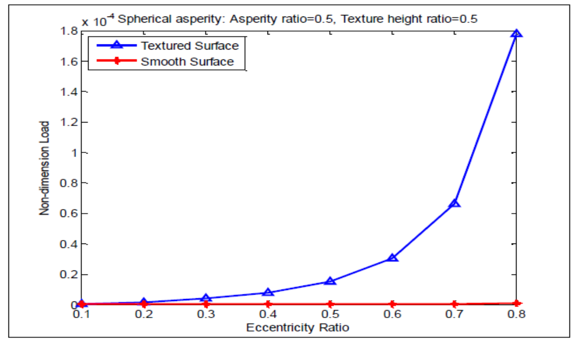

Figure 3: Eccentricity Ratio Vs Non Dimensional Load

From fig 3 we get that on increasing eccentricity ratio load carrying capacity of both normal and textured bearing increases, but in latter case it increases more than normal journal bearing because in textured journal bearing more pressure will be there due to the more convergence which happen due to the texture formation on the surface of bearing and due to this more pressure it can carry large amount of load, so by varying eccentricity ratio from 0.1 to 0.8 we see that after reaching eccentricity ratio 0.6 there is an sudden increment in load carrying capacity of texture journal bearing.

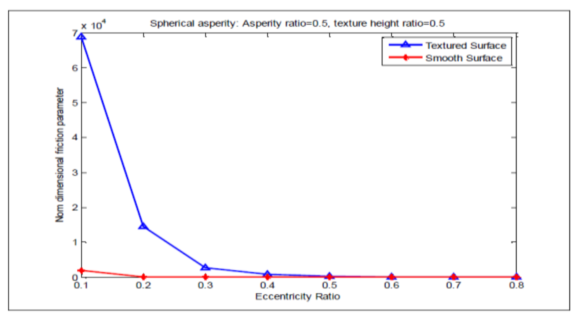

Figure 4: Eccentricity Ratio Vs Friction Parameter

In industries friction is the term which is generally used now and then, friction is directly proportional to power, more the friction, more will be the wastage of power. In order to minimize the wastage of power we have to control friction. In above figure blue colour is for textured journal bearing and red colour is for normal journal bearing.

As we can see from the figure that during starting, non-dimensional coefficient of friction parameter is more in textured journal bearing than normal journal bearing, but as soon as we reach the eccentricity ratio i.e. 0.6 it becomes almost equal or less after that as shown in figure 4.

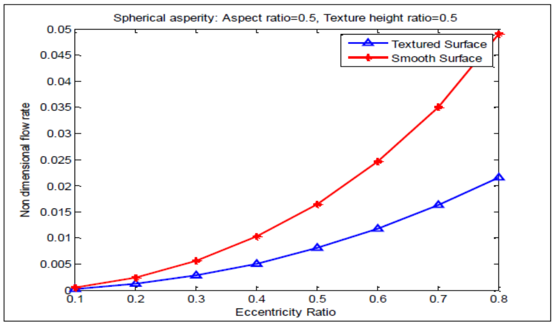

Figure 5: Eccentricity Ratio Vs Non Dimensional Flow Rate

To control friction in journal bearing, lubrication is provided inside the journal bearing so that we can control power loss by reducing friction. Figure 5 shows a comparison of flow rate of lubricant inside the normal journal bearing and inside the spherically textured journal bearing.

From figure we can see that lubricant flow rate in textured journal bearing is less than that of normal journal bearing, it is because, in spherically textured journal bearing, texture behaves as a reservoir which stores lubricant and provide it during starving condition, so there is less wastage of lubricant in textured journal bearing as compared to normal bearing.

V. CONCLUSION

On increasing in asperity ratio, non-dimensional load carrying capacity increases for spherically textured hydrodynamic journal bearing. With increase in number of textures, non-dimensional load carrying capacity decreases. On increasing asperity ratio, coefficient of friction parameter for spherically textured hydrodynamic journal bearing decreases. With increase in number of textures, coefficient of friction parameter increases for spherically textured hydrodynamic journal bearing. On increasing texture height, non-dimensional load carrying capacity increases for spherically textured hydrodynamic journal bearing. With increase in texture height, coefficient of friction parameter decreases for spherically textured hydrodynamic journal bearing. Study the behaviour of dynamic characteristics of spherically textured journal bearings by distributed texture partially on the bearing surface. To provide spherical texture on piston cylinder arrangement between piston and piston rings and analyze its effect on the dynamic characteristics of the system. Study the behaviour of dynamic characteristics of journal bearing, by applying different shapes of texture. Experimental validation of results.

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