INFLUENCE OF OIL VISCOSITY ON TILTING PAD THRUST BEARING OF BRONZE MATERIAL HAVING CATENOIDAL PROFILE

Prashant B. Shelar

Student, Walchand College of Engineering, Sangli (India)

ABSTRACT

Tilting Pad thrust bearings are used to transfer high and axial loads from rotating shafts. The surface above pads has significant impact on bearing life. The performance of bearing can be determined in terms of operating temperature and oil film thickness. This parameters are affected by oil viscosity which in turn may affect for power loss and inducing of vibrations into system. The objective of this paper is to study the effect of temperature on oil viscosity which in turn affects the test setup. Thus an experimental study has been carried out which finds out the oil viscosity results which provides validation of theoretical result.

Keywords: Bearing Life, Operating Temperature, Oil Film Thickness, Power Loss, Oil Viscosity

I.INTRODUCTION

In the era of technological development, there is need of more analysis over the bearing pad surface, compact size of bearing which influences to high load carrying capacity and decreasing Power consumption. Abramovitz [1] theoretically studied the effect of pad curvature on operating condition. He assumed convex type of surface over the pad and concluded that with the use of this surface, it would result in 10% increase in load carrying capacity as compared to flat pad. Thus, at early industrial development the study on bearing were theoretically made and hence it must be now be experimentally verified.

S.B. Glavatskih [2] studied the effect of oil viscosity grade on the performance of tilting pad thrust bearings is examined in a wide range of shaft speeds and specific bearing loads. He analysed the influence of oil viscosity grade on pad temperature pattern.. The thermal effect of oil viscosity grade on pad temperature pattern can be determined. Designers and the end-users of rotating machinery are often confronted with the question as to which oil viscosity grade should be chosen to provide the most efficient bearing operation. It is commonly supposed that thinner oils provide lower energy consumption and lower operating temperatures. At the same time, low-viscosity oils develop thinner oil films, which can affect thebearing safety. Hence, thicker oils are usually used at low speed and thinner ones at high speed. However, to what extent will the main operating parameters be affected if the thrust bearing operates with an oil of higher or alternatively lower viscosity grade.

P.B. Shelar [3] studied that the Bearing temperature increases with the increase of speed and load. The temperature grid method gives a good temperature over the pad. The maximum temperature is observed towards the trailing edge of pad. The Fluid pressure increases with increase in thrust load. The experiment showed that the pressure shifts to trailing edge and the maximum pressure is observed towards the trailing edge of pad.

A.P. Singh and C. Bagci [4] studied the effects of continuous circumferential surface profiles on the performance characteristics of a sector-type thrust bearing have been investigated. A computer-aided finite difference numerical solution of the Reynolds equation in polar form is determined with pressure distributions for an optimum inclination of a sector pad. These pressure distributions are then used to calculate the performance characteristics such as Axial (Thrust) Load-carrying capacity, flow rate, side leakage, friction power loss, coefficient of friction and temperature rise. The results for the non-dimensional performance coefficients which are defined as a function of the aspect ratio are then presented in the form of chart.

A.J.Leopard [5] describes the development of a modified system of lubrication for tilting pad thrust bearing which results in considerable saving in power loss and also improvements in bearing safety factor.

A. Dadouche et. al. [6] analysed the characteristics of a fixed-geometry thrust bearing in typical operating conditions and experimental results in order to validate future thermohydrodynamic models. The influence of the applied Axial (Thrust) Load, the rotational speed and the feeding temperature on the thrust bearing performance is presented and discussed.

A. Patil and S. Chavan [7] studied the effect of the film shape on the Axial (Thrust) Load carrying capacity of a hydro dynamically lubricated bearing. Flat faced tapered bearing and the Rayleigh's step bearing of constant film thickness have been the primary forms of film shapes for slider bearing studies and design data developments. He compared the experimental results of pressure temperature distributions in slider bearing with flat surface and with different single continuous surface profiled (Cycloidal, Catenoidal, Quadratic) sector shaped pads. Pressure results presented in paper provided a platform for validation of theoretical models. An experimental study had performed to investigate the influence of single continuous surface profiled sector shaped pads in tilting pad thrust bearing. He found that with cycloidal shaped surface profiled sector shaped pads the pressure generated within fluid film is enhanced which in turn causes enhancement in Axial (Thrust) Load bearing capacity of hydrodynamic bearing.

II. DETAILS OF EXPERIMENTATIONS

2.1 Experimental test rig

The experimental setup of tilting pad thrust bearing is available in Walchand College of Engineering, Sangli. The objective is to study the effect of temperature on oil viscosity which in turn affects the test setup. Thus an experimental study has been carried out which finds out the oil viscosity results which provides validation of theoretical result.

2.2 Instrumentation

Viscosity is measure of internal resistance to motion of fluid, mainly due to forces of cohesion between the fluid molecules. Kinematic Viscosity is a measure of fluids resistance to flow and shear under the forces of gravity. If the viscosity of oil is too low, the lubricant cannot be maintained between the moving surfaces a result of which excessive wear may take place, on other hand if the viscosity of oil is too high then excessive fraction due to shearing of oil itself would result. The Oil selected is ISO VG 32[2].

Lubricating Oil Properties

Table 2.1 Lubricating Oil Properties

Properties	Value
Kinematic Viscosity At 40^0 c At 100^0 c	 94 centistokes 14.3 centistokes
Density At room temperature	 865 kg/m^3

2.3Temperature measurement of oil

Heat generation in the oil film and accompanying temperature rise are the most important factors in the bearings. Temperature rise is the factor indicating the operating conditions of bearing.Keeping in view the bad effects of excess temperature rise on bearing performance, it is very important to know accurately the highest temperature generated within oil [2].

The Viscosity of the lubricating oil is measured with the help of Redwood Viscometer.

The Viscosity Measurement is done two times -

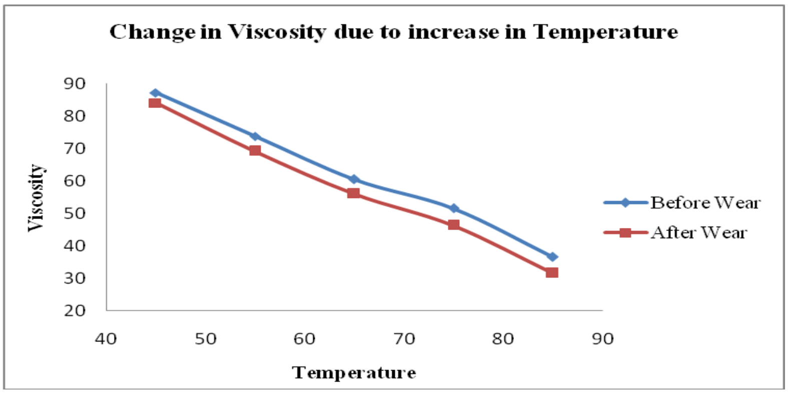
a) Initial viscosity of oil, (b) After Bronze pad Test

III. RESULT

The oil temperature is recorded for the specific oil before testing and after testing of the pad bearings. The Viscosity of the lubricating oil is measured with the help of Redwood Viscometer.

Table 2.2 Temperature and Kinematic Viscosity

Sr. No.	Temperature (°C)	Kinematic Viscosity (centistokes)	
		Before Testing	After Testing
1	45	87.254	84.0364
2	55	73.88	69.1757
3	65	60.4978	56.0309
4	75	51.5605	46.3391
5	85	36.6167	31.6100



Graph 1 Temperature (°C) vs Viscosity (centistokes)

IV. CONCLUSION

It can be seen that as Temperature increases there is decrease in oil Viscosity. Graph shows that as Temperature increases the oil starts to flow easily i.e. time required is less which means that the oil density and viscosity is affected.This Temperature rise changes the bearing clearance through heating of bearing material, thus affecting bearing performance.

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