Study of Performance Characteristics of Journal Bearing With Micropolar Fluid and Comparison to Newtonian Fluid

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Abstract— Journal bearings are very familiar engineering components and are utilised in almost all types of machinery. Combustion engines and turbines virtually depend on journal bearings to obtain high efficiency and reliability. A journal bearing incorporate of a shaft rotating within a stationary bush. The hydrodynamic film which supports the load is generated between the moving surfaces of the shaft and the bush. The sliding action is acting along the circumference of a circle or an arc of a circular and carrying radial loads are known as journal or sleeve bearing. In these bearings, the forms a sleeve around a shaft. The part of the shaft which rotates in the bearing is called "journal".

Keywords: Journal Bearing, Micropolar Fluid, Newtonian Fluid

I. INTRODUCTION

The journal bearing are classified as:

A. *Full Bearing:*

In these bearings, the bearing completely envelops the journal. This type of bearing is commonly used in Industrial machinery to accommodate bearing loads in any direction.

B. *Partial Bearing:*

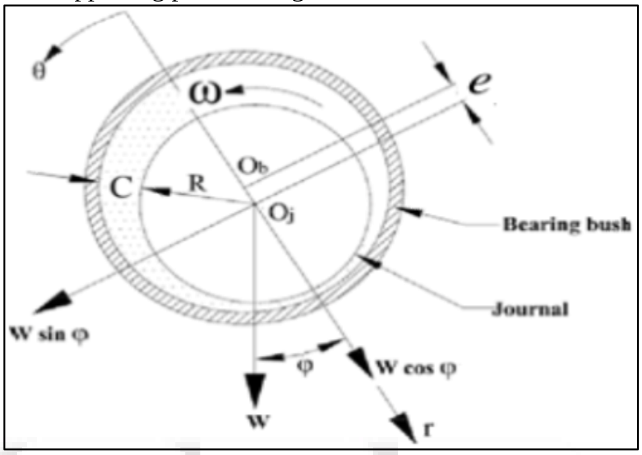
The enveloping angle is not 360° but is 120° .The full bearing and partial bearings are also known as clearance bearings. The friction in a partial bearing will be less than in Full bearing, but its applications are limited to only those situations where the load is always in one direction.

C. *Fitted Bearing:*

This is a special case of partial bearing in which the sizes of the journal and bearing are equal and hence there is no clearance.

D. *Plain Journal Bearing (360°):*

Design over view Plain bearings are composed of a cylindrical shaft of radius R, called a journal, rotating with an angular velocity ω, about its axis in a cylindrical bushing of radius R+c and length L. The centre of bearing is labeled as O*b* and center of journal as Oj as shown in figure. Under steady state conditions the journal centre remains at a constant eccentricity e and attitude angle ϕ for a given load W acting on the shaft. The plain journal bearing is the elementary and most familiar radial bearing design, where a plain cylindrical shell encircles the shaft. Plain sleeve bearing have the highest cross coupling of all bearings and are suitable for highly loaded and low-speed shafts. Advantages are economical cost and ease of manufacture. Examples include automotive crank-shaft bearing and low speed or highly loaded turbo machinery applications. In a plain bearing, the position of the journal is directly related to the external load. When the bearing is sufficiently supplied with oil and external load is zero, the journal will rotate concentrically within the bearing. However, when the load is applied the journal moves to an increasingly eccentric position, thus forming a wedge shaped oil film where the load-supporting pressure is generated.



II. LITERATURE REVIEW

There is a vast amount of literature related to Analysis and behavior of journal bearing with micropolar fluid or non-newtonian fluids. Many research publications, journals, reference manuals, newspaper articles, handbooks; books are available of national and international editions dealing with basic concepts of FEA. Many other publications indicate the success story of implementation of FEA on various components. The literature review presented here considers the major development in implementation of FEA. Eringen was the first scholar to propose the theory of micro polar fluids to simplify the traditional analysis of micro polar fluids. In 1972, Eringen also proposed the theory of thermo-microfluids, and it was also succeeded to interpret the behaviour of some kind on non-newtonian fluids. In 1975, Shukla and Isa presented the generalized Reynolds's equation for micropolar fluid with the applications of one- dimensional slider bearings. Meanwhile, Prakash and Sinha analysed the infinitely long journal bearing with the lubrication of micropolar fluid. In 1978, Zaheeruddin and Isa learned the steady- state characteristics for one-dimensional journal bearings and took both the infinitely short and long bearing under micropolar lubrication into consideration.

In 1989, Khonsari and Brewe also presented the analysis of the performance of finite journal bearing lubricated with micropolar fluid. In 1996, Lin performed the analysis of lubricants and three dimensional irregularities. In 2002, Das et al. studied the performance of the steady-state characteristics of Hydrodynamic journal bearings with the consideration of misalignment. In 2004, Wang and Zhu presented a study of the lubricating effect of micropolar fluids in a dynamically loaded journal bearing. It was found that the application of micropolar fluid lubricants can increase the fluid film pressure and fluid film thickness, and decrease the side leakage flow. In 2005, Das et al proposed the linear stability analysis for the Hydrodynamic journal bearing lubricated with Newtonian fluids.

III. Aims and Objective

The present work deals with the dynamic behaviour of a Plane Journal Bearing working in condition of Micropolar lubrication. As from the characteristics of Micropolar fluid the Plane Journal Bearing is being observed under the increase in fluid film pressure and fluid film thickness but a decrease in the side flow as compared to Newtonian fluids. On the basis of the theory of micropolar fluids, the modified Reynolds's equation for dynamic loads is derived. Result from the numerical analysis indicated that the effects of micropolar fluids on the performance of a dynamically loaded journal bearing are evaluated. Applying the half sommerfeld's boundary conditions, the pressure distribution in journal bearing is obtained and the dynamic characteristics in terms of the components of stiffness and damping coefficients, friction drag and side flow obtained with respect to the micropolar property for varying eccentricity ratios. The results show that micropolar fluid exhibit better stability in comparison with Newtonian fluid. The finite element analysis of journal bearing has done by using programming software package MATLAB. Results from the numerical analysis indicated that the effects of micropolar fluids on the performance of a dynamically loaded journal bearing depend on the size of material characteristic length and the coupling number. It is shown, compared with Newtonian lubricants that under a dynamic loading the micropolar lubricants produce an obvious increase in the oil film pressure and oil film thickness, but a decrease in the side leakage flow. It is also shown that the friction coefficient for a dynamically loaded journal bearing with micropolar fluids is in general higher than that of Newtonian fluids, which is not the same as the results for a steadily loaded journal bearing. Furthermore, a parametric study of flow and friction for different mass parameters keeping micropolar parameters fixed is undertaken. It is indicated that, with the increase of the mass parameters, the crank angles compatible to the maximum flow are changed and the maximum friction coefficients are obviously decreased further for the Newtonian fluids or for the micropolar fluids.

IV. Conclusion

Hydrodynamic analysis of the Journal bearing has been done using CAE tool MATLAB. From the results obtained from hydrodynamic analysis, some discussions have been made. On the basis of the current work and comparing the result of Newtonian and Micropolar lubricant, it is concluded that the numerical study of plain journal bearing gives out some following results.

- The modified equation derived on the basis of the micropolar theory in this paper is more general than the classical Reynolds equation for dynamic loads.
- With the same dynamic loads applied, the micropolar fluids yield a higher oil film pressure and oil film thickness then Newtonian fluid.
- The feature of increasing load capacity for micropolar fluid is more evident at higher eccentricity ratio and lower width-to-diameter ratio then Newtonian

References

[1] C. Eringen, Simple microfluids, Znf. J. Eng. Ski, 2(1964) 295.
[2] A.C. Eringen, Theory of micropolar fluids, J. Math. Mech, 16 (1966) 1.
[3] S.J. Allen and K.A. Kline, Lubrication theory for micropolar fluids, Trans. ASME,(1971) 646.
[4] Ariman TT, Sylvester ND. Micro-continuum fluid mechanics:-a review. Int J Eng Sci 1973; 11:905–30.
[5] Khader MS, Vachon RI. Theoretical effects of solid particles in hydrostatic bearing lubricant. J Lubr Tech 1973; 95:104–5.
[6] Ariman TT, Sylvester ND. Applications of micro-continuum fluid mechanics. Int J Eng Sci 1974; 12:273–93.
[7] J. B. Shukla and M. Isa, Generalized Reynolds equation for micropolar lubricants and its application to optimum one-dimensional slider bearings: effect of solid particle additives in solution, Proc. ht. me &. Eng. London, 17 (1975) 280.
[8] J. Prakash and P. Sinha, Lubrication theory for micropolar fluids and its application to a journal bearing, Znt. J. Eng. Sci, 13 (1985) 217.
[9] J. Prakash, Sinha P. Cyclic squeeze films in micropolar fluid lubricated journal bearings. J Lubr Tech 1976; 98:412–7.
[10] Sinha P. Dynamically loaded micropolar fluid lubricated journal bearings with special reference to squeeze films under fluctuating loads. Wear 1987; 45:279–92.
[11] Sinha P. Effect of rigid particles in the lubrication of rolling contact bearings considering cavitation. Wear 1987; 44:295–309.
[12] Zaheeruddin Kh, Isa M. Micropolar fluid lubrication of one dimensional journal bearings.

