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Research on Temperature Field of Multi-pad Hydrostatic Thrust Bearing with Different Cavity Shapes

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Abstract. A simulation research concerning temperature field of multi-pad hydrostatic thrust bearing having rectangular cavity, sector cavity, ellipse cavity and I-shaped cavity was described in order to solve the thermal deformation of the hydrostatic thrust bearing in the heavy CNC equipment. The Finite Volume Method of CFX has been used to compute three-dimensional temperature field of gap fluid between the rotation worktable and the base. This study theoretically analyzes the influence of cavity shape on the bearing temperature performance according to computational fluid dynamics and lubricating theory. It has revealed its temperature distribution law. The simulation results indicate that an improved characteristic will be affected by cavity shape easily. Through this method, the safety of a multi-pad hydrostatic thrust bearing having different cavities can be forecasted, and the optimal design of such products can be achieved, so it can provide reasonable data for design, lubrication, experience and thermal deformation computation for hydrostatic thrust bearing in the heavy CNC equipments.

Keywords: Different cavity shapes, Multi-pad, Hydrostatic thrust bearing, Temperature field, Simulation research.

1 Introduction

Hydrostatic thrust bearings have been used in many industrial heavy applications due to their favorable performance characteristics. The following reports are important investigations concerning hydrostatic thrust bearings this time. T. A. Osman, M. dorid, Z .S. Safar and M. O. A. Mokhtar designed a test rig to study hydrostatic thrust bearing performance[1]. T. Jayachandra Prabhu and N. Ganesan have studied effects of tilt on the characteristics of multi-cavity hydrostatic thrust bearings under conditions of rotation and no rotation. The dimensionless load, flow, stiffness and damping were obtained and plotted for a range of the tilt parameter for experimentally useful aspects ratios [2-5]. V. K. Kapur and Kamlesh Verma studied the simultaneous effects of inertia and temperature on the performance of a

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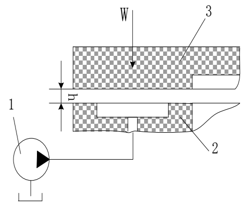
hydrostatic thrust bearing. Numerical results for pressure distribution and load-carrying capacity were obtained at different step positions and film thickness ratios for several values of thermal conductivity[6]. Statish C. Sharma analytically studied the performance of circular thrust pad hydrostatic bearing of various cavity shapes, i.e. triangular, square, rectangular etc. They compared results with the solutions obtained by an electrical analog technique [7]. Recently Statish C. Sharma analyzed the capillary compensated four cavities hydrostatic journal bearing with different geometric shapes of cavity. It was further reported that influence of cavity shape on the performance of capillary compensated circular thrust pad hydrostatic bearing. Owing to rapid technological advancements in manufacturing techniques, the other cavity shape can be easily manufactured and can be used widely in the many industrial heavy applications. This paper studied that influence of cavity shape on the temperature performance of a constant flow hydrostatic thrust bearing.

2 Working Principle of Hydrostatic Thrust Bearing

A constant flow hydrostatic thrust bearing with annular cavity multi-pad is shown in Fig. 1. The working principle of hydrostatic thrust bearing is that saving flow of the edge of oil cavity and worktable gap can form the loading capacity of hydrostatic bearing which can float the bearing spindle which can bear loads with the oil supplying system which can compulsively inject the lubricating oil into oil cavity between frictions [8].



1—pump; 2—worktable; 3—rotation table; h—oil film thickness

Fig.1. Sketch map of principle of work of quantitative supply hydrostatic thrust bearing

3 Mathematical Model

Flow problem of fluid between the rotation worktable and base belongs to a laminar flow problem, and its mobility must meet mass conservation equation, momentum conservation equation and energy conservation equation [9].

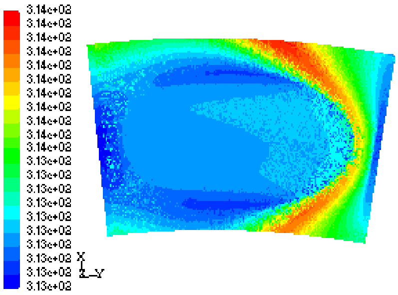


Fig. 5. Temperature field of ellipse cavity

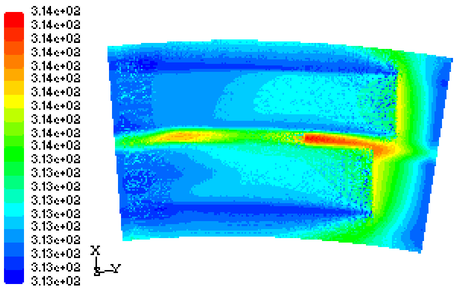


Fig. 6. Temperature field of I-shaped cavity

5 Conclusions

Numerical calculation of the three-dimensional temperature field of multi-pad hydrostatic thrust bearing having rectangular cavity, sector cavity, ellipse cavity and I-shaped cavity is achieved through Computational Fluid Dynamics and the Finite Volume Method. It solves the problem that temperature field cannot be measured directly in the heavy type hydrostatic thrust bearing because oil film is very thin in the fact project. The result shows that oil cavity temperature is affected by oil cavity shape. The temperature of I-shaped cavity is the maximum. The safety of a multi-pad hydrostatic thrust bearing having rectangular cavity, sector cavity, ellipse cavity and I-shaped cavity can be forecasted through this method, and lay a foundation for thermal deformation of hydrostatic thrust bearing in the heavy type equipments, and the optimal design of such products can be achieved.

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