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THE EFFECT OF OIL CAVITY DEPTH ON TEMPERATURE FIELD IN HEAVY HYDROSTATIC THRUST BEARING*

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Abstract: For a heavy hydrostatic bearing with a high linear velocity, the results of numerical calculations often differ from practical conditions if the viscosity is considered as constant. In this article, the influence of the oil cavity depth on the temperature field in the heavy hydrostatic bearing is discussed in the context of variable viscosity. The viscosity-temperature relations for the gap oil film are first established by fitting B-Spline curves, then, numerical calculations for the temperature field in the heavy hydrostatic bearing of different oil cavity depths are carried out based on Finite Volume Method (FVM) under the same rotating speed, and the influence of the oil cavity depth on the temperature distribution in the gap oil film of the hydrostatic bearing is discussed. The results of numerical calculations provide the temperature distribution state inside the hydrostatic bearing, which would help the selection and the design of hydrostatic bearings in engineering practice.

Key words: hydrostatic thrust bearing, viscosity-temperature characteristic, Finite Volume Method (FVM), temperature field

Introduction

The temperature rise in a liquid hydrostatic thrust bearing comes mainly from two sources. It may be induced by the pump power consumption or caused by the work by the oil film shearing through the relative movement between the worktable and the base. When the temperature rise due to various pump power consumptions is equal to the heat dissipating capacity of the system, the system arrives at an equilibrium state under the working state of the hydrostatic bearing. Because the heating is the main cause that affects the hydrostatic bearing performance, the temperature field in the oil film is one of the most important issues in the analysis of the oil film state.

Recently, Canbulut et al.[1] studied the friction power and the pump power theoretically and by the neural network tracking experiment, and proposed a hydrostatic bearing with the minimum friction power and pump power through optimizations. In 2002, Fu et al.[2] took into consideration the viscosity varying with temperature and pressure, and the density varying with viscosity and pressure, and studied the three-dimensional temperature field in a circular journal bearing and obtained the temperature field in the oil film and bearing by solving the Reynold equation, the heat conduction equation for a three dimensional solid with boundary conditions of heat flux continuity. In 2008, Wang[3] numerically simulated the bearing lubricating film, and obtained the temperature distribution in the bearing with dynamic pressure oil film and analyzed the influence of the three dimensional temperature field on the practical lubrication performance of the bearing under a given load. The temperature changes in the oil of a hydrostatic bearing would cause the changes of the viscosity and the density. In 2004, Agrodzki and Lam[4] carried out studies based on the first law of thermodynamics, and it is found that the temperature rise is not only influenced by the surface friction, but is also related with the internal friction and the strain rate, and their theoretical results agree well with their experimental data, which provides some food of thought for subsequent studies on the temperature distributions in the hydrostatic thrust

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