Design of a curved stabilizer with damping orifices for reducing axial run-out of flexible optical disks

Ki-Wook Song, Abdelrasoul M. M. Gad, Yoon Chul Rhim

Abstract:

The idea of a curved stabilizer with damping orifices is applied to the high speed rotating flexible optical disk system in order to reduce the disk deflection and the axial run-out of the disk. A track of orifices is drilled along the edge of a curved annular stabilizer. The effects of the diameter and length of each orifice, number of orifices, and radial position of the orifices on the reduction of axial runout of the disk are investigated experimentally together with the effects of the inner radius for the air flow, initial gap height, and rotational speed. The experimental results showed that the curved stabilizer with orifices can reduce the axial run-out of the disk at 10,000 rpm within 0.010 mm over the entire span of the disk.

Keywords:

Flexible optical disk, curved stabilizer, damping orifice, axial run-out.

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A New Structural Stiffness Model for Bump-type Foil Bearings: Application to Generation II Gas Lubricated Foil Thrust Bearing

Abdelrasoul M. Gad and Shigehiko Kaneko

Abstract:

Abstract A new structural stiffness model for the compliant structure in foil gas bearings is introduced in the first part of this work. The model investigates the possibility that the flat segment between bumps, in bump foil strip, may deflect laterally and separate from the rigid bearing surface, also it considers the interaction between bumps in the bump foil strip, the friction between the bump foil and the surrounding structure. The validity of the analytical solution was verified through direct comparison with previous numerical and analytical models. In the second part of this work, the introduced bump foil model is used to investigate the static characteristics of Generation II gas foil thrust bearing. The numerical simulations of the coupled fluid-structure interactions revealed that the foil thrust bearings share many features with their rigid bearing counterpart and the results showed clearly that the load carrying capacity of foil thrust bearings increases non-linearly with the rotation speed and is expected to reach an asymptote as the rotation speed exceeds certain value. The effects of ramp height and interface friction (i.e., friction at bump foil/rigid bearing interface and bump foil/top foil interface) on the static characteristics of Generation II foil thrust bearings are investigated.

Keywords:

Structural Stiffness Model, Generation II Foil Thrust Bearings, Microturbomachinery.

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( 3 )

Prediction of the Elastoaerodynamic Behavior of Compliant Foil Thrust Bearing Using a New Bump Foil Model

Abdelrasoul M. GAD and Shigehiko KANEKO

Abstract:

Abstract: Accurate modeling of the compliant structure in gas foil thrust bearings is the key issue for predicting their Elastoaerodynamic performance. Hence, at the first part of this paper, a new structural stiffness model for the compliant structure in foil gas bearings is introduced. The model overcomes the shortcomings of previous analytical models and investigates the possibility that the flat segment between bumps, in bump foil strip, may deflect laterally and separate from the rigid bearing surface. Also, the interaction between bumps in the bump foil strip, the friction at bump foil/top foil interface, and the friction at bump foil/ rigid bearing interface are considered. The performance of the introduced analytical model with four different load distributions was analyzed and compared with previous numerical and analytical models so as to check the validity and flexibility of the presented model. In the second part of this paper, the introduced bump foil model is coupled to the compressible Reynolds equation to investigate the Elastoaerodynamic performance of Generation II gas foil thrust bearing. The numerical simulations of the coupled fluid-structure interactions revealed the fact that the foil thrust bearings share many features with their rigid bearings counterpart and it was found that the load carrying capacity of foil thrust bearings increases nonlinearly with the rotation speed. Also, the effect of ramp height on the load carrying capacity and friction torque were investigated.

Keywords:

Key Words : Gas foil thrust bearing, bump foil model, Elastoaerodynamic behavior

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CFD-based Design and Performance Characteristics of Generation II Foil Thrust Bearing for Microturbomachinery Applications

Abdelrasoul M. Gad and Shigehiko Kaneko

Abstract:

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Keywords:

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Performance characteristics of gas-lubricated bump-type foil thrust bearing

Abdelrasoul M Gad and Shigehiko Kaneko

Abstract:

Abstract: In the present study, the static and dynamic characteristics of Generation II bump-type foil thrust bearings are investigated. For the static characteristics, a 2D compressible Reynolds equation containing effects of centrifugal forces is derived to model the fluid flow in the thin gas film. The compliance of the bearing is calculated using analytical structural stiffness model. The fluid flow equation is coupled to the structural stiffness model and the coupled fluid-structure interaction problem is solved iteratively to obtain the steady state characteristics of the bearing. For the dynamic characteristics, small perturbations method is used to obtain the linearized equations for the pressure components of dynamic force coefficients. The effects of rotation speed, ramp height, nominal film thickness, friction coefficients at bump foil interfaces, and bump foil stiffness on the static and dynamic characteristics of Generation II foil thrust bearings are thoroughly analyzed.

Keywords:

Foil thrust bearing, generation II, centrifugal force effect, elastohydrodynamic lubrication, static and dynamic characteristics

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Tailoring of the Bearing Stiffness to Enhance the Performance of Gas-Lubricated Bump-Type Foil Thrust Bearing

Abdelrasoul Gad and Shigehiko Kaneko

Abstract:

Abstract: This study aims to tailor the bearing stiffness for enhancing the load carrying capacity of foil thrust bearings. New architectures for the bump foil are introduced with structural stiffness tailored in radial and circumferential directions to ensure a converging gas film under high axial loads while maintaining a reasonable bearing compliance to accommodate thermal as well as mechanical distortions. The flow in the gas film is modeled with 2-D compressible Reynolds equation including effects of centrifugal forces in the gas film. The Couette Approximation technique is used to calculate the temperature distribution in the gas film and small perturbations method is used to calculate its dynamic coefficients. Enhanced load capacity could be obtained with the introduced bump foil designs.

Keywords:

Keywords: Foil thrust bearing, stiffness tailoring, hydrodynamic lubrication, static and dynamic characteristics

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Fluid Flow and Thermal Features of Gas Foil Thrust Bearings at Moderate Operating Temperatures

Abdelrasoul Gad and Shigehiko Kaneko

Abstract:

Abstract. This study aims to analyze the flow characteristics and the thermal features of foil thrust bearing. The flow in the gas film is modeled with 2D compressible Reynolds equation including effects of centrifugal forces in the gas film. The Couette Approximation is adopted for the analysis of temperature distribution in the gas film, and the small perturbations method is used to calculate its dynamic force coefficients. The results show that the Couette Approximation can be used to calculate the temperature distribution in foil thrust bearing with reasonable accuracy and the analysis of the fluid flow reveals that most of the side-leakage occurs in the low-temperature converging region removing less than 5% of the heat generated in the gas film. Furthermore, with the proper control of cooling flow rate through the bump foils, more than 70% of the heat generated in the gas film can be removed.

Keywords:

Keywords: Foil thrust bearing, thermal elastohydrodynamic lubrication, static and dynamic characteristics

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Polishing of fused deposition modeling products by hot air jet: Evaluation of surface roughness

Mohamed Adel, Osama Abdelaal, Abdelrasoul Gad, Abu Bakr Nasr, AboelMakaram Khalil

Abstract:

In this study, a novel low-cost polishing process is applied on the surface of Fused Deposition Modeling (FDM) products. The developed polishing technique impinges a jet of hot air exit from a nozzle to FDM surfaces. The hot air locally melts the staircase on the surface and leaves it smoother by the effect of sintering phenomenon. Accordingly, the process introduces three main parameters: air jet temperature; air jet velocity; and nozzle translational velocity over the part surface. An experimental test rig was constructed to evaluate the polishing process and its parameters using surfaces with average pre-processed Ra values of 7.5 ± 0.5 μm. The process shows significant and reproducible improvements in surface roughness inherent with a glossy surface; whereas, an average reduction ratio up to 88% was reached which corresponds to Ra of 0.85 μm. It was found that there is an allowable range of nozzle translational velocity for every combination between jet velocity and jet temperature; otherwise, lower nozzle velocity than allowable causes overheating and surface deterioration. Furthermore, the study presents in-depth investigation to these deterioration phenomena appeared on the surface. As a result, this investigation demonstrated the possible defects in FDM part surfaces and also evaluated different process parameters. Moreover, it was observed that surface defects are reduced in the polished surfaces. For a concise conclusion, it was found that the condition of low jet velocity and high jet temperature gives the best polishing result over the allowable nozzle velocities.

Keywords:

Fused deposition modeling Polishing Hot air Surface roughness Surface defects Sintering

Published In:

ENHANCING THE SURFACE ROUGHNESS OF FUSED DEPOSITION MODELING PRODUCTS

M. Adel *, Osama, Abdelrasoul, Abu Bakr, Aboel Makaram

Abstract:

Fused deposition modeling (FDM) is the most versatile additive manufacturing technology owing to the low-cost materials that handle. However, FDM produce very rough parts which limit its use in molds and other industrial applications owing to stair-case effect. To obtain smoother surfaces, a post-processing phase may be introduced. In this research, a non-contact finishing process to FDM parts using hot air was developed. The hot air is directed locally at the stair-case in the surface till melting it which results after cooling to a smoother surface. An experimental setup was constructed to study the effects of different process parameters including air temperature, air flow rate and the moving velocity of air nozzle over parts surface. An improvement in the Roughness Average of a surfaces measured microscopic peaks and valleys (Ra) down to values of sub-micron was recorded from specimens with average surface roughness from 7 to 8 μm.

Keywords:

fused deposition modeling -surface roughness- non-contact machining

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