Analysis of Gas Lubricated Foil Thrust Bearings Using Coupled Finite Element and Finite Difference Methods

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Load performance of gas lubricated, compliant surface foil thrust bearings has an interlocking relationship with the compliance of the bearing and hydrodynamics of convergent wedge surface. Compliance of the bearing consists of supporting spring elements (elastic foundation) and a smooth elastic top foil. In this paper, a class of gas lubricated foil thrust bearings has been investigated analytically utilizing a novel approach which combines Finite Difference (FD) and Finite Element (FE) methods. Solution of the governing hydrodynamic equations dealing with compressible fluid is coupled with the structural resiliency of the foil bearing surfaces. FD method is utilized for hydrodynamic analysis while FE is used to model structural resiliency. Influence coefficients were generated to address the elasticity effects of combined top foil and elastic foundation on the hydrodynamics of thrust bearing, and were used to expedite the numerical solution. Within 2 to 3 iterations the convergence criterion was reached. The overall program logic proved to be an efficient technique to deal with the complex structural compliance of various foil bearing. Case study has been conducted and sample solutions are provided. Unlike prior analytical investigations, the essential effect of the top foil on the performance of the bearing has been elucidated.

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