A Numerical Design Tool for Textured Hydrodynamic Bearings

INTRODUCTION

Artificial surface textures are capable of enhancing the tribological performance of lubricated contacts. However, as the optimum texture geometry highly depends on the application and even operating conditions, a careful design of surface textures is crucial. This project is aimed at developing a robust and fast numerical texture design tool for tilting pad thrust bearings. A purposely developed bearing test rig is used to validate the numerical model.

NUMERICAL MODEL

INPUT *.txt file

START

INPUT *.csv file

END

MESH

Based on 2D Reynolds equation
- Different mesh sizes for different contact areas
- Placement of additional points around discontinuities
- Mesh can be aligned with texture edges

PRESSURE DISTRIBUTION

- Based on 2D Reynolds equation
- Mass-conserving cavitation algorithm
- Gauss-Seidel method with SOR
- FVM with special discretization schemes
- Reduced computation time for discontinuities & concentrated inertia

BEARING EQUILIBRIUM

- Multicore computation of Jacobian
- Use of equivalent untextured results
- Optimized solution strategy based on Newton-Raphson, Broyden and continuation method

THERMAL EQUILIBRIUM

- Iterative, effective temperature method
- Hot-oil-carry-over effect
- McCoull and Walther’s temperature/viscosity relation

VALIDATION USING CFD

- Specific load (MPa)
- Minimum film thickness (µm)
- Friction torque (Nm)
- Speed (rpm)
- See Full Figure

TEXTURE DESIGN OPTIMIZATION

- Nonlinear constrained optimization using interior point algorithm
- Optimization of texture depth, circumferential and radial texture extend

EXPERIMENTS ON BEARING TEST RIG

- Influence of texturing under HD operation & validation of numerical model
- Influence of texturing start-up and shut-down

CONCLUSIONS

Applying special discretization schemes to handle discontinuities, employing parallel computing, strategically utilizing Broyden’s method and using results form the equivalent untextured bearing can significantly reduce the computation time of numerical tools to study textured surfaces. These advanced modelling techniques make a computational optimization of texture designs possible in minutes and facilitate the application of surface texturing for hydrodynamic bearings.

The authors acknowledge the financial support of the Engineering and Physical Sciences Research Council (EPSRC) via grant EP/K039435/1 and John Crane UK Ltd.

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