TRC PROPOSAL SYNOPSIS 2016-2017

Drag-Reducing Textured Fluid Journal and Thrust Bearings

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INTRODUCTION AND JUSTIFICATION

Bearing lubricant viscosity induces a friction drag torque on the journal which is a source of parasitic power loss in a machine. This lessens the efficiency of the machine and also adds cost due to friction heating of the lubricant requiring coolers and other auxiliary equipment. A recent study reveals that around 11% of energy consumed by industries, transportations and utilities sectors can be saved by tribology methods [1]. An intuitive solution for friction reduction in bearings is to reduce oil viscosity. However, this compromises bearing performance because the load capacity will be reduced as well. A novel approach has appeared in the literature to reduce drag loss without reducing lubricant viscosity and load capacity. Test results [2, 3] have shown that using surfaces texturing approaches on bearing surfaces can reduce friction drag in bearings. The main body of the literature on bearing surface texturing is on thrust bearing applications. However, theoretical studies on journal bearings also appear in the publication [4]. Moreover, experimental work also demonstrates possible friction reducing benefits by using textured surfaces in journal bearings [5, 6].

Although previous studies suggests a possible beneficial effects of textured surfaces, not all types of surface textures lead to positive improvement of bearing performance. The surface of a journal bearing to be textured is inside a cylindrical space which limits options to apply efficient and accurate texturing techniques. Dimpling a surface is accomplished with machining and chemical etching according to open literature. These considerations have motivated the following goals for the proposed research (a) develop a better theoretical and experimentally based understanding of the surface texturing effect on bearing drag reduction and dynamic performances and (b) apply a more economic technique, e.g., 3D printing, to produce surface texture, and (c) explore application to bearings that can be manufactured in easy to etch parts, i.e. partial arc or tilt pad brgs.

DELIVERABLES

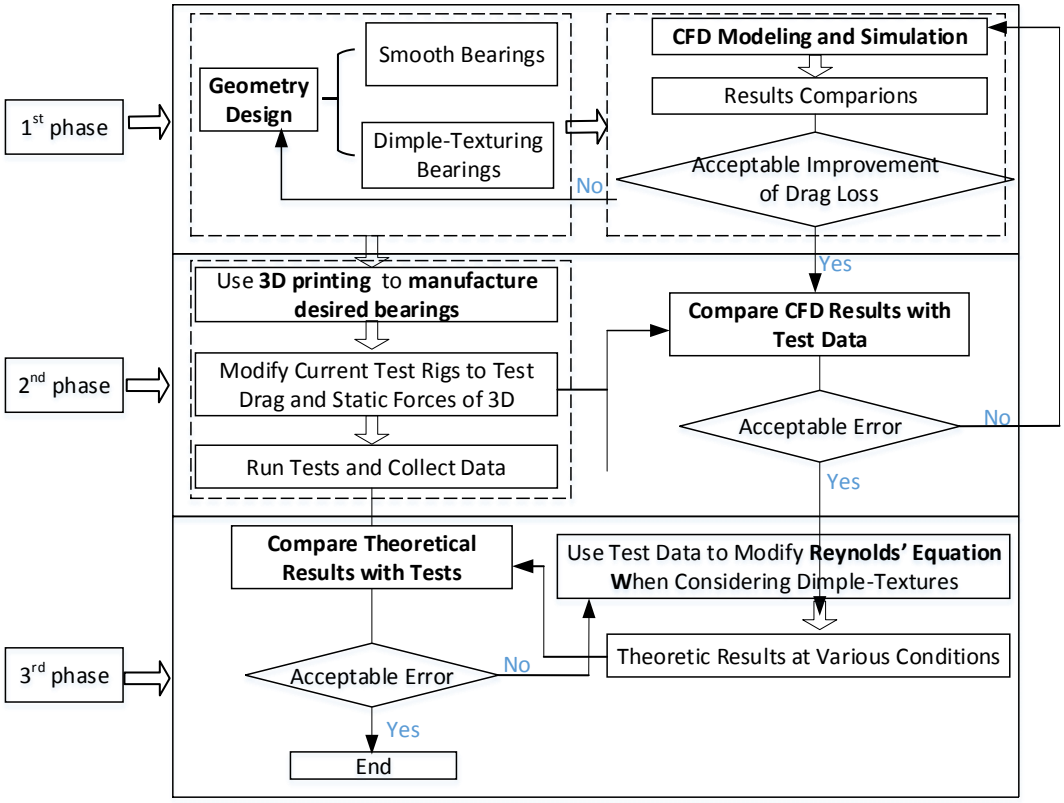
- Lit. review on development and applications of surface-textured journal brgs.
- Numerical simulations and experimental test results to examine how critical factors such as friction coefficient, load coefficients, dynamics coefficients and temperature vary with different sets of textures.
- Summarize the simulation and test results into a set of guidelines including tables, plots, etc. for bearing designers and users to reference.
- Development of a modified Reynolds' equation or bulk flow model to integrate the identified surface texture model into an arbitrary bearing model.
- Brg. design software utilizing a modified Reynold's equation or bulk flow model
- A final report including models, major findings and predictions.

COSTS 1 PhD Student, 12 months at $2,000/mo. Salary, $197/mo. Insurance, 0.6% Fringe on salary, approx. $9000 Tuition and Fees, Test equipment, $7200, ***Total: $45,000***

STATUS OF CURRENT WORK New Proposal.

HOW WILL THE WORK BE ACCOMPLISHED

The work will be divided into three phases, as shown in the following flow chart.



References

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[2] Stephens, L. S., et al. 2004, Deterministic Micro Asperities on Bearings and Seals Using a Modified LIGA Process, ASME Journal of Engineering for Gas Turbines and Power, v 126, pp 147 – 154.

[3] Venkatesan, S. 2005, Surface Textures for Enhanced Lubrication: Fabrication and Characterization Techniques, Master Thesis, University of Kentucky.

[4] Qiu, Y., and Khonsari, M. M. 2011, Performance Analysis of Full-Film Textured Surfaces With Consideration of Roughness Effects, Journal of Tribology, v 133, paper ID number: 021704 .

[5] Lu, X., and Khonsari, M. M. 2007, An Experimental Investigation of Dimple Effect on the Stribeck Curve of Journal Bearings, Tribology Letter, v 133, pp: 169-176.

[6] K.K. Gupta, et al. 2013, Study on Effect of Surface Texture on the Performance of Hydrodynamic Journal Bearing, International Journal of Engineering and Advanced Technology, 3 (1), pp 49-54.