Dynamic Characterization of Compliantly Damped Porous Gas Bearings

NEW PROPOSAL

Dr. Adolfo Delgado, Associate Professor
Surya Balaji, Research Assistant

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Introduction

Porous carbon has emerged as a potential candidate to enable hydrostatic lubrication of bearings for turbomachinery applications. Porous carbon provides an even distribution of gas that can increase bearing load capacity and provides a low friction surface capable of surviving intermittent contact. Porous carbon bearings have been extensively used for linear motion applications (low surfaces speeds) and, more recently, in small rotating devices or larger machines operating at sub-critical speeds (i.e. MRI gantry). When considering super-critical applications (i.e. most turbomachinery applications), current porous carbon bearing designs lack the level of damping required for limiting vibration to acceptable levels and provide a safe stability margin. Compliantly damped hybrid gas bearings (HGB), shown in Fig. 1, provide an alternative design with more damping than porous carbon and foil bearings [2]. HGB includes a supply port discharging to a shallow recess that helps increase load capacity and a low friction coating to allow intermittent contact without bearing failure. These two features could be improved by replacing the pad surface with porous carbon to obtain an even aerostatic pressure distribution and low friction surface without relying in coatings.

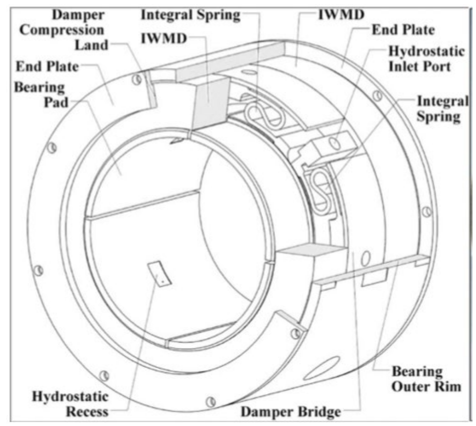

Figure 1. Compliantly damped hybrid gas bearing [1].

One of the technical challenges associated with the implementation of porous carbon into HGBs is the attachment of the pads to the bearing steel structure. The current attachment method in porous carbon bearings is to epoxy the pad to an aluminum housing and install the bearing with an interference to preload the pads. This solution provides limitations in terms of the bearing static and dynamic performance and presents clear reliability issues. An alternative to solve the interface issue is to generate intrinsic bonding between carbon and steel using cost-effective approaches.

Proposed work

The proposed work will aim at building and testing a compliantly damped porous carbon bearing including supply ports. The main challenges to address are the connection between porous carbon and the pad support, and the design of compact dampers with reduced stiffening effect. The following are the proposed tasks:

Year 1:

The first task will be to fabricate the pads and perform pressure tests up to 200 psi. The second task will be to design, fabricate the gas bearing and identify dynamic performance without rotation. Finally, a new test rig will be commissioned for performing component and system-level tests.

Year 2:

Once the new test rig is commissioned, the bearing will be tested at a component- and system-level using a dummy rotor up to 30,000 RPM. The rotor, donated to the Turbomachinery laboratory, is part of a turboexpander system used in pressure letdown stations for natural gas distribution applications. The actual machine features magnetic bearings to simplify sealing and overall architecture. This application, not suitable for GFBs, provides a good platform for evaluating the capabilities of HGB at a system-level. There is currently no machine in this size-class supported on process gas-lubricated bearings.

Budget	
Graduate Student Payroll, 12 months @ $2200/month	$ 26,400
Fringe Benefits	$ 5,000
Tuition and fees	$ 9,000
Pad materials and manufacturing	$ 4,600
Total	$ 45,000

References

[1] Bugra E. H., 2008, "Compliant Hybrid Journal Bearings Using Integral Wire Mesh Dampers," J. Eng. Gas Turbines Power, **131**(2), p. 022503.

[2] Delgado, A., 2015, "Experimental Identification of Dynamic Force Coefficients for a 110 MM Compliantly Damped Hybrid Gas Bearing," J. Eng. Gas Turbines Power, **137**(7), p.072502.