



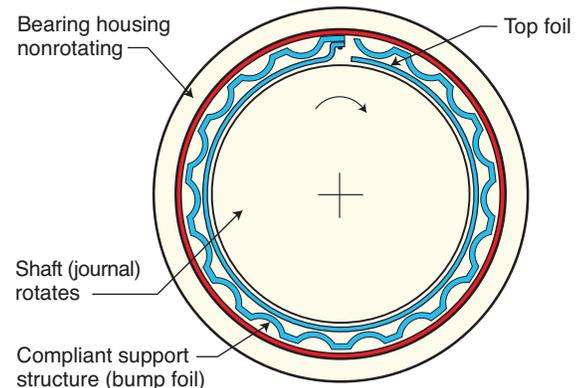
OIL-FREE TURBOMACHINERY—OIL-FREE MODELING

TECHNOLOGY OPPORTUNITY

NASA Glenn's Oil-Free Turbomachinery research team has pioneered and disseminated foil gas bearing models, tools, and techniques to assist in the industrial commercialization of a broad array of revolutionary Oil-Free gas turbines, compressors, blowers, motors, and other rotating machines. We have test capability to support industrial activities and guide development.

BENEFITS

- Foil gas bearings are deceptively simple devices that can be complex to understand and implement but research has resulted in several simple analytical models governing behavior, and computer-based tools exist to guide application.
- Foil gas bearing performance mirrors well understood hydrodynamic (self-generated) bearing operation when viewed within normal operating conditions (light load and high speed) allowing for first principle simple tool development.
- Substantial technology push over the last two decades has greatly “demystified” this valuable technology and provides a simple path to commercialization. Public domain know-how covers bearing design, manufacturing, coatings, testing, and applications.
- NASA-sponsored efforts have fostered the emergence of new foil bearing manufacturers providing multiple sources for the hardware, thus lowering costs and advancing performance.
- NASA expertise can be made available to partner with industry to learn to use foil gas bearings in future machines in a variety of ways including modeling work, feasibility studies, and experimental testing.



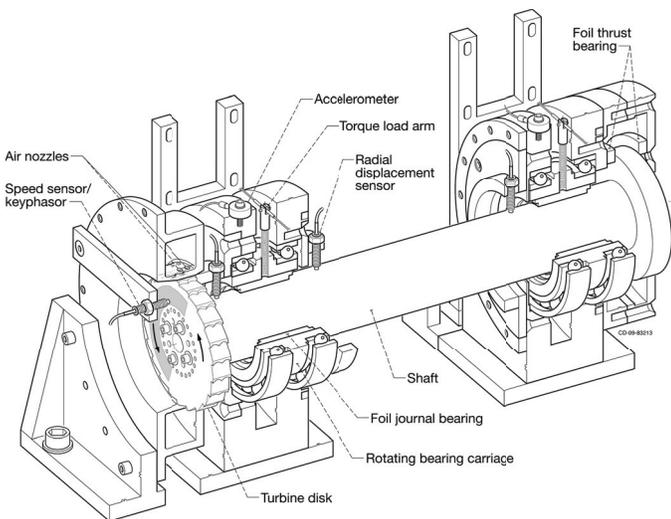
Foil journal bearing cross section. Models provide methods to predict load capacity, spring stiffness, and dynamic damping capabilities.

COMMERCIAL APPLICATIONS

- Oil-Free foil bearings have been commercialized in aircraft air cycle machines (ACMs) for cabin pressurization and cooling, cryogenic turbo-compressors, and microturbine electrical generators (15 to 250 kWe).
- Emerging applications include Oil-Free turbochargers for cars and trucks, larger turbine generators, general aviation (GA), BizJet, unmanned aerial vehicles (UAVs), and missile engines.
- Future applications are anticipated in auxiliary power units (APUs), regional jet and helicopter engines, revolutionary aeropropulsion engines, space power systems, and launch vehicle cryogenic turbomachinery.
- Near-term markets are emerging for Oil-Free wastewater aeration blowers, industrial blowers and point-of-use air compressors, electrically driven automotive superchargers, fuel cell blowers, and hybrid power train microturbines.

TECHNOLOGY DESCRIPTION

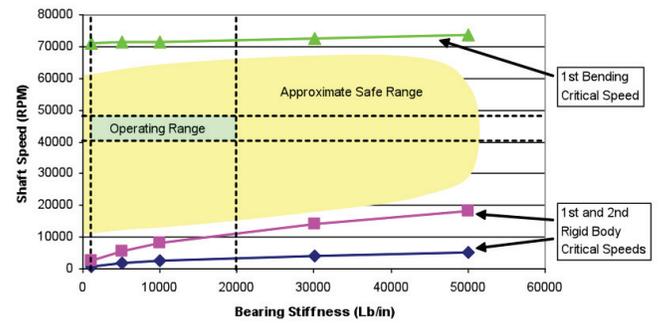
Historically, Oil-Free foil gas bearing design, performance prediction, and manufacturing have been confined to just a few industrial entities. For this reason, much confusion and misconceptions have arisen over their proper use and application. Research at NASA Glenn and elsewhere has resulted in simple algebraic modeling tools for bearing load capacity, stiffness, and damping that greatly aid foil bearing application to new rotor systems. Clearly written research papers describe the design and manufacturing process, and computer models are now available to predict rotordynamic stability of foil-bearing-supported machines. Put another way, there now exists adequate information for newcomers to the field to develop their own Oil-Free machines and reap the benefits.



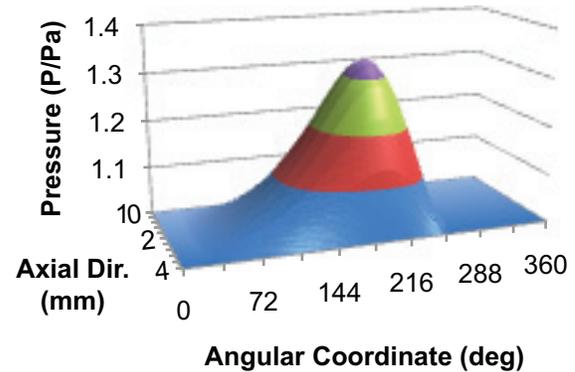
Experimental facilities for testing foil gas bearings including rotordynamic behavior, power loss, thermal management, and more.

OPTIONS FOR COMMERCIALIZATION

NASA has strived to disseminate sufficient information to enable multiple entities to participate in the development of Oil-Free machinery. Multiple industrial sources for foil air bearings now exist that are eager and capable of assisting Original Equipment Manufacturers (OEMs) and suppliers to apply this technology to rotating systems. Numerous bearing designs, some still under patent protection and others no longer restricted, are available for development and use. Further, recently developed design guidelines, manufacturing details and processes, and modeling tools are now readily available. The NASA Glenn research team can provide guidance and is seeking opportunities for partnerships.



Rotordynamic critical speed map for a proposed Brayton turboalternator using foil gas bearings.



Fluid-film pressure distribution inside a foil journal bearing as determined by a NASA-sponsored, University-developed design code.

LICENSING AND PARTNERING OPPORTUNITIES

Glenn’s Office of Technology Partnerships and Planning seeks to transfer technology to and from NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Oil-Free Turbomachinery—Oil-Free Modeling.

FOR MORE INFORMATION

For more information about this and other technology licensing opportunities, please contact
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