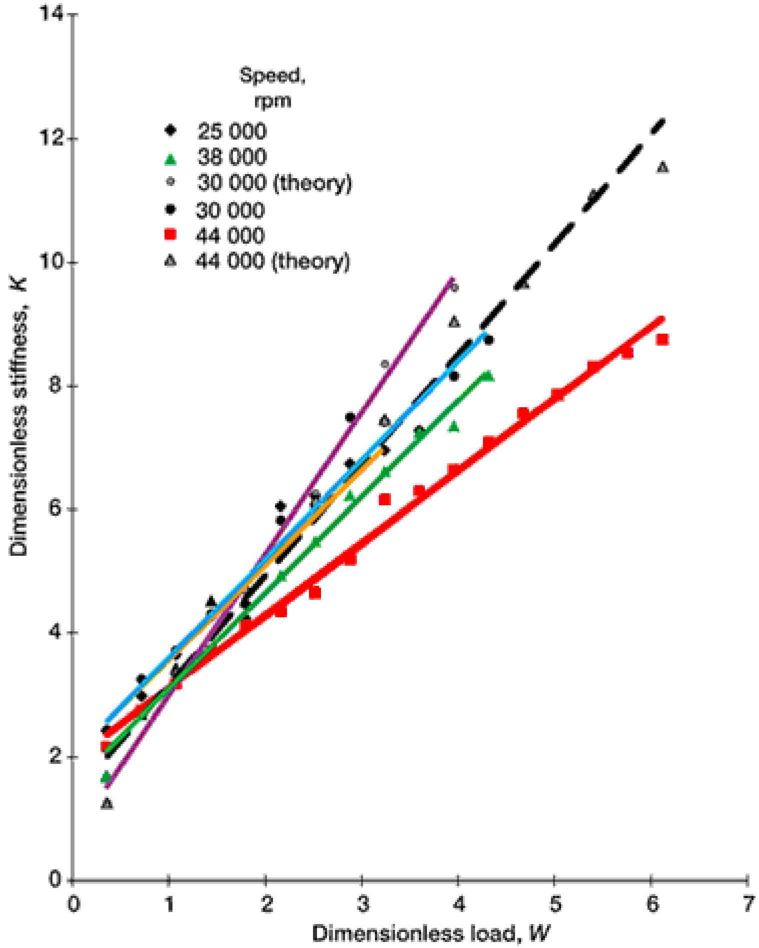
System Being Developed to Measure the Rotordynamic Characteristics of Air Foil Bearings

Because of the many possible advantages of oil-free engine operation, interest in using air-lubricated foil-bearing technology in advanced oil-free engine concepts has recently increased. The Oil-Free Turbomachinery Program at the NASA Glenn Research Center at Lewis Field has partially driven this recent push for oil-free technology. The program's goal of developing an innovative, practical, oil-free gas turbine engine for aeropropulsion began with the development of NASA's high-temperature solid-lubricant coating, PS304. This coating virtually eliminates the life-limiting wear that occurs during the startup and shutdown of the bearings. With practically unlimited life, foil air bearings are now very attractive to rotating machinery designers for use in turbomachinery. Unfortunately, the current knowledge base of these types of bearings is limited. In particular, the understanding of how these types of bearings contribute to the rotordynamic stability of turbomachinery is insufficient for designers to design with confidence.

Recent work in oil-free turbomachinery has concentrated on advancing the understanding of foil bearings. A high-temperature fiber-optic displacement probe system and measurement method were developed to study the effects of speed, load, temperature, and other environmental issues on the stiffness characteristics of air foil bearings. Since high-temperature data are to be collected in future testing, the testing method was intentionally simplified to minimize the need for expensive test hardware. The method measures the displacement induced upon a bearing in response to an applied perturbation load. The early results of these studies, which are shown in the accompanying figure, indicate trends in steady state stiffness that suggest stiffness increases with load and decreases with speed. It can be seen, even from these data, that stiffness is not expected to change by orders of magnitude over the normal operating range of most turbomachinery; a promising sign for their eventual integration into oil-free turbomachines. Planned future testing will generate similar plots for stiffness changes with temperature and geometry, as well as damping data. The data collected by this method represent a critical step toward understanding how to successfully apply foil air bearings to future oil-free turbomachinery systems.



Effect of speed and load on bearing stiffness.

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