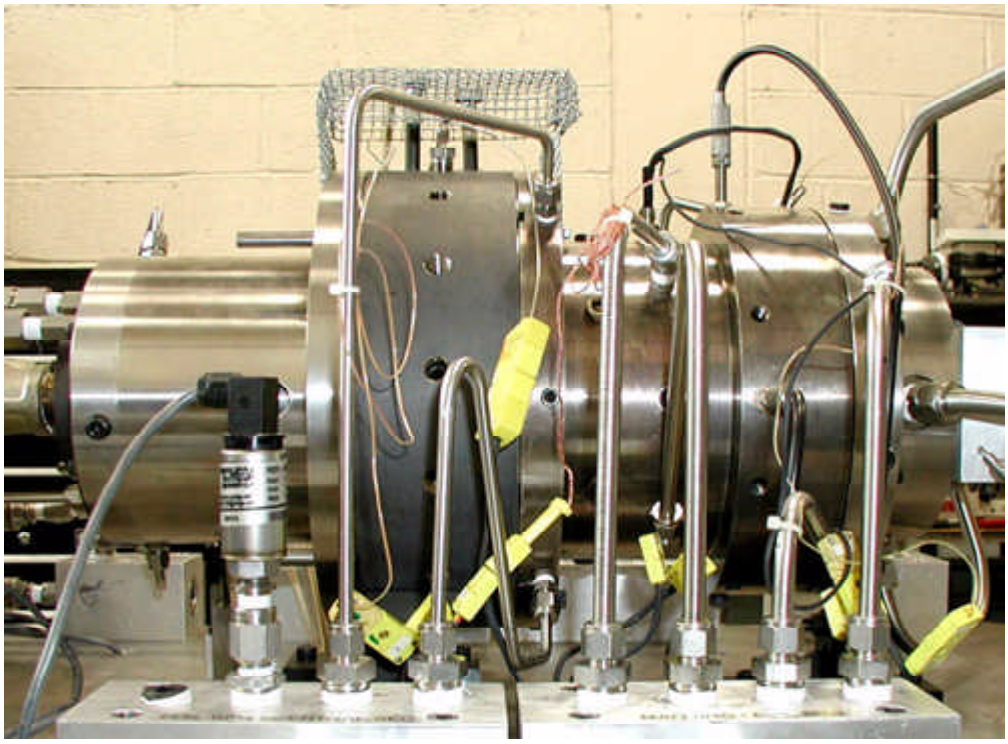
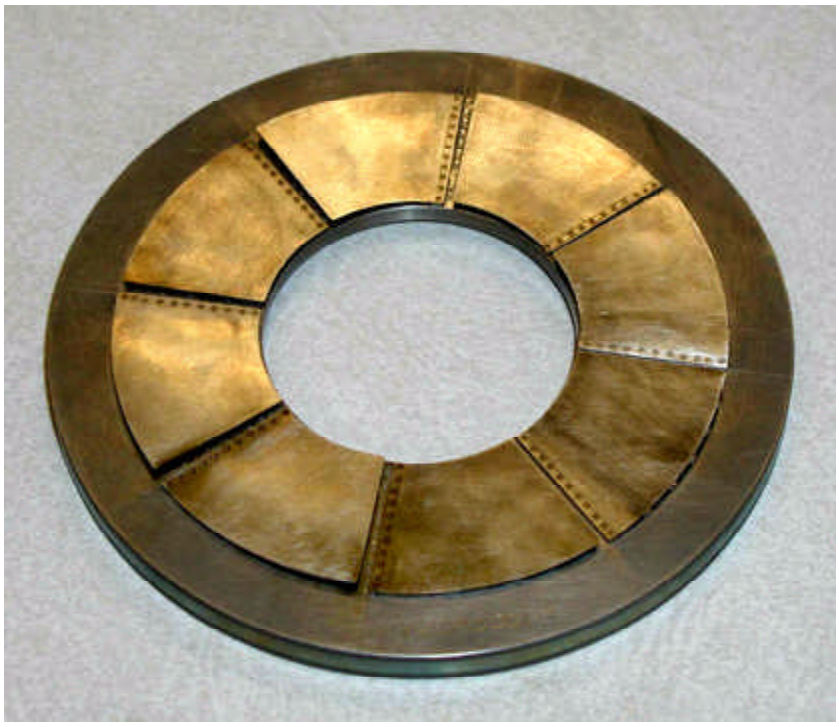
Oil-Free Turbomachinery Research Enhanced by Thrust Bearing Test Capability



Thrust foil air bearing test rig.



Thrust foil air bearing.

NASA Glenn Research Center's Oil-Free Turbomachinery research team is developing aircraft turbine engines that will not require an oil lubrication system. Oil systems are required today to lubricate rolling-element bearings used by the turbine and fan shafts. For the Oil-Free Turbomachinery concept, researchers combined the most advanced foil (air) bearings from industry with NASA-developed high-temperature solid lubricant technology. In 1999, the world's first Oil-Free turbocharger was demonstrated using these technologies. Now we are working with industry to demonstrate Oil-Free turbomachinery technology in a small business jet engine, the EJ-22 produced by Williams International and developed during Glenn's recently concluded General Aviation Propulsion (GAP) program. Eliminating the oil system in this engine will make it simpler, lighter (approximately 15 percent), more reliable, and less costly to purchase and maintain.

Propulsion gas turbines will place high demands on foil air bearings, especially the thrust bearings. Up until now, the Oil-Free Turbomachinery research team only had the capability to test radial, journal bearings. This research has resulted in major improvements in the bearings' performance, but journal bearings are cylindrical, and can only support radial shaft loads. To counteract axial thrust loads, thrust foil bearings, which are disk shaped, are required. Since relatively little research has been conducted on thrust foil air bearings, their performance lags behind that of journal bearings.

To remedy this situation, the state-of-the-art Thrust Bearing Test Rig was added to our laboratory. This unique test facility was designed and manufactured by Mohawk Innovative Technology of Albany, New York, under a Small Business Innovation Research (SBIR) Phase III contract. The test rig can test thrust foil bearings to 80 000 rpm under loads as high as 3500 N (700 lb) and at temperatures to 650 °C (1200 °F). The

test bearing and runner are heated by electric resistance heating, both by a coil around the test articles and by heating air that is blasted at the spinning bearing runner. Together, these heat sources simulate the hot environment that is expected inside the turbofan engine. A hydrostatic (externally pressurized) bearing is used to support the test thrust bearing and allow torque, which translates into bearing friction, to be accurately measured while still allowing heavy loads to be applied to the test bearing. The turbine-driven rotating runner side of the rig employs foil journal bearings to control the radial motion of the shaft, making the rig itself a secondary test bed for Oil-Free bearing technologies. An active magnetic thrust bearing counteracts the thrust loads from the test thrust foil bearing.

Tests using the facility are underway, and data are being fed back to industry to modify and improve bearing design and manufacturing. This rig will also allow NASA scientists and engineers to develop and test solid lubricants that are applied to the bearing foils or runner and can enhance bearing performance and life.

Find out more about Oil-free Turbomachinery research.

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