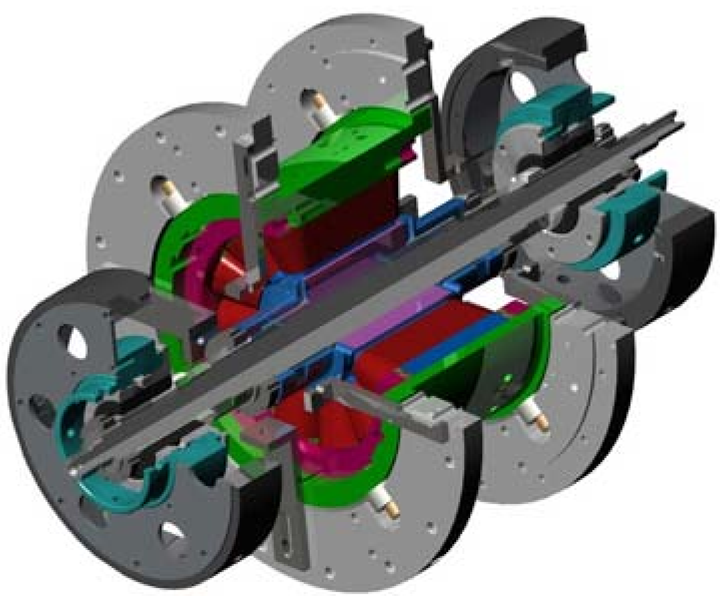
High-Temperature Hybrid Rotor Support System Developed

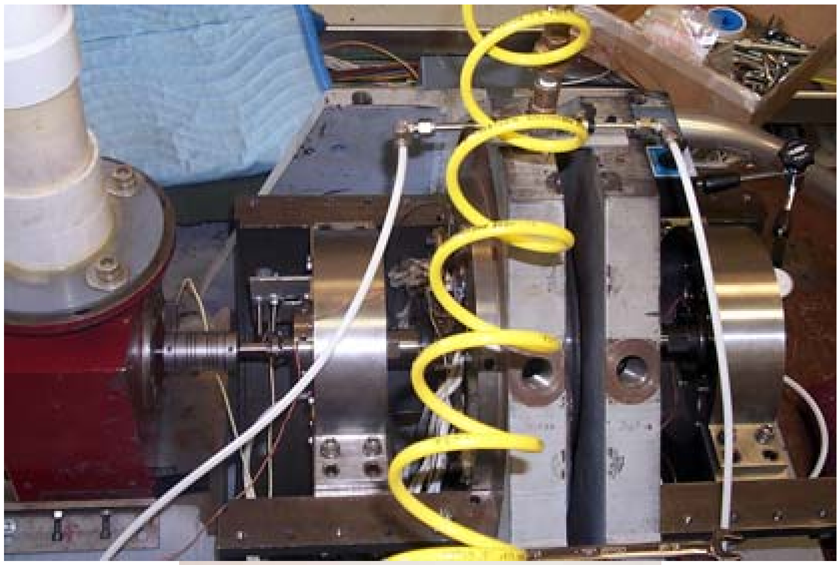
The Army Research Laboratory Vehicle Technology Directorate and the NASA Glenn Research Center demonstrated a unique high-speed, high-temperature rotor support system in September 2003. Advanced turbomachinery is on its way to surpassing the capabilities of rolling-element bearings and conventional dampers. To meet these demands, gas turbine engines of the future will demand increased efficiency and thrust-to-weight ratio, and reduced specific fuel consumption and noise. The more-electric engine replaces oil-lubricated bearings, dampers, gears, and seals with electrical devices. One such device is the magnetic bearing. The Vehicle Technology Directorate and Glenn have demonstrated the operation of a radial magnetic bearing in combination with a hydrostatic bearing at 1000 °F at 31,000 rpm (2.3 MDN[1]). This unique combination takes advantage of a high-temperature rub surface in the event of electrical power loss or sudden overloads. The hydrostatic bearings allow load sharing with the magnetic bearing. The magnetic-hydrostatic bearing combination eliminates wear and high contact stress from sudden acceleration of the rolling-element bearings and overheating. The magnetic bearing enables high damping, adaptive vibration control, and precise rotor positioning, diagnostics, and health monitoring. The following illustration shows a model of the test facility used at Glenn for this technology demonstration.



Model representation of test facility.

Long description. Cutaway of a solid model of the test rig. This shows the individual hydrostatic and magnetic bearings.

A high-temperature heteropolar radial magnetic bearing is located at the center of gravity of the test rotor. There is a 0.022-in. radial air gap between the rotor and stator. Two rub surface hydrostatic bearings were placed on either side of the magnetic bearing. The rotor is supported by a 0.002-in. hydrostatic air film and the magnetic field. The prototype active magnetic bearing cost $24,000 to design and fabricate and a set of four high-temperature, rub-surface, hydrostatic bearings cost $28,000. This work was funded by the Turbine-Based Combined Cycle program.



Left: High-temperature hydrostatic/magnetic bearing test facility. Right: High-temperature, rub surface hydrostatic bearing.

Long description of left figure. Actual bearing hardware. The axial position of the drive turbine, coupling, and hydrostatic and magnetic bearings can easily be seen. Long description of right figure. The actual hydrostatic bearing is shown relative to an inch scale.

[1]One million × shaft diameter in millimeters × rotational speed in revolutions per minute.

Find out more about this research:
U.S. Army Research Laboratory, Vehicle Technology Directorate at Glenn at http://www.grc.nasa.gov/WWW/army/
Glenn's Structural Mechanics and Dynamics Branch at http://structures.grc.nasa.gov/5930/

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