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THE ROLE OF HIGH PERFORMANCE FOIL BEARINGS IN AN ADVANCED, OIL-FREE, INTEGRAL PERMANENT MAGNET MOTOR DRIVEN, HIGH-SPEED TURBO-COMPRESSOR OPERATING ABOVE THE FIRST BENDING CRITICAL SPEED

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ABSTRACT

The demand for high power density, reliable, low maintenance, oil-free turbomachinery imposes significant demands on the bearing system. The full benefits of high speed, permanent magnet driven machines, for example are realized at speeds exceeding the capabilities of rolling element bearings. The high speeds, and a desire for oil-free operation also make conventional liquid lubricated bearings an undesirable alternative. The modern, oil-free foil bearing provides an excellent alternative, providing low power loss, adequate damping for supercritical operation, tolerance of elevated temperatures and long life. In this paper, the application of modern foil bearings to a high speed, oil-free turbo-compressor is discussed. In this demanding application, foil bearings support a 24 pound, multi-component rotor operating at 70,000 RPM with a bending critical speed of approximately 43,000 RPM. Stable and reliable operation over the full speed range has been demonstrated. This application also required low bearing start-up torque for compatibility with the constant torque characteristic of the integral permanent magnet motor. This work discusses the rotor bearing system design, the development program approach, and the results of testing to date. Data for both a turbine driven configuration, as well as a high speed integral motor driven configuration are presented.