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Low-friction wear-resistant coatings for high-temperature foil bearings

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Abstract

Compliant foil bearings offer many advantages over rolling element bearings in high-speed and high-temperature applications. However, implementation of foil bearings in these applications requires development of solid lubricant coatings that can survive the severe operating conditions encountered at high speeds and high temperatures. The objective of this paper is to present results on development of an advanced coating system for use with compliant foil bearings that permits higher operating speeds and temperatures. In order to evaluate the coating performance and to select the best coating combination for implementation, tests were conducted using a high-temperature, high-speed tribometer. In these tests, Inconel test substrates, representative of a portion of a foil bearing, were coated with several different Korolon™ coatings. The counterface disks were coated with a dense chrome, plasma sprayed PS304, hard chrome and Korolon™ 1350B. Each test was conducted for 500 start–stop cycles up to 810 °C foil pad temperature under 13.8 kPa normal loading.

The test results confirmed the excellent tribological behavior of Korolon™ coatings for high-speed, high-temperature foil bearing applications. While the tribological behavior of Korolon™ coatings were determined to be a function of temperature, in most cases a minimum coefficient of friction less than 0.1 was observed during startup/shutdown periods. Based on the measured coefficient of friction and post-test visual inspection of the mating surfaces, the hard chrome coating proved unacceptable for high-temperature applications due to extensive surface cracking. The other disk coatings exhibited excellent tribological performance.

Following these tests, a foil journal bearing was designed and a composite coating consisting of Korolon™ 1350A with an overcoat of Korolon™ 800 was applied to the bearing top foil; and a dense chrome coating was applied to the journal surface. The foil bearing and journal were installed in a 240-lb thrust turbojet engine and operated successfully to 54,000 rpm for over 70 start–stop cycles and 14 h.