On the Development of Self-Acting & Self-Contained Powder Lubricated Auxiliary Bearing

by

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Prepared for presentation at the STLE 2000 Annual Meeting
and for possible publication in Journal of Tribology Transactions

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ABSTRACT

This paper describes the operation of a self-acting, self-contained, solid/powder-lubricated, high-speed journal bearing, which has been successfully tested to 3 million DN for the first time. This operational milestone of 3 MDN is a major breakthrough in the development of solid lubricated bearings. Impetus behind this development is the necessity for high performance auxiliary bearing systems in magnetic bearing supported rotors in space mechanisms, flywheel energy storage systems, auxiliary and integrated power units and gas turbine engines. The two major technology components, are, the pelletized powder lubricant delivery system and the powder lubricated journal bearing design. Using the established criteria, powder materials suitable for the expected operating environments were reviewed. The selected powder lubricant properties and the design tool were used to fabricate the powder pellets and design the 100 mm diameter powder lubricated bearing; which was tested in a magnetically suspended rotor bearing test rig. The following tests were conducted on this powder lubricated bearing: short duration testing at low speeds, transient shock testing (simulating magnetic bearing failure), high speed testing and lubricant starvation testing. The acquired results spanned the range of the expected operating conditions, including lubricant feed rate, bearing temperatures and operational dynamic performance, clearly validating the lubricant delivery system and the overall powder lubricated bearing design analysis.

KEYWORDS

Solid Lubricants

Molybdenum Disulfide

Friction

Solid Lubricated

Hydrodynamic

Solid Lubrication

Powder Lubrication

Wear

Solid Lubricated

Quasi-Hydrodynamic Powder Lubrication

NOMENCLATURE

f	-	Friction coefficient
W_n	-	External load on pellet
N	-	*Rotational speed, rpm*
P_d	-	Particle diameter, μm
W	-	Normal load on pad slider
U_0	-	Average Velocity
L	-	Length of Pad Slider
h_L	-	Minimum film thickness
h_O	-	Inlet film thickness
δ_1, δ_2	-	Surface roughness, μm, for surfaces 1 and 2, respectively
U_1, U_2	-	Linear velocity of surface 1 and 2, respectively
V_1, V_2	-	Upper and lower surface velocities
PLQH	-	Powder Lubricated Quasi-Hydrodynamic Bearing
AMB	-	*Active Magnetic Bearing*
FFT	-	Fast Fourier Transformer
LVDT	-	Linear Variable Differential Transducer