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100mm Diameter Self-Contained Solid/Powder Lubricated Auxiliary Bearing Operated at 30,000 rpm

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A major breakthrough development of a self-contained solid/powder lubricated auxiliary hydrodynamic bearing has recently been achieved successfully. This bearing was operated at speeds to 30,000 rpm, equivalent to three million DN, and loads to 445 N (100 lb). Uniqueness of this bearing lies in its application of dry particulate powders to provide a long life, low power loss backup bearing. Impetus behind this development is the necessity for high performance auxiliary bearing systems in magnetic bearing supported rotors. Potential applications include ground and space based Flywheel Energy Storage Systems, Auxiliary and Integrated Power Units and Gas Turbine engines. The two main technology components of this bearing are the pelletized powder lubricant delivery system and the powder lubricated journal bearing design. Using 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. Tests conducted on this powder lubricated bearing included 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

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NOMENCLATURE

f	= friction coefficient
W_n	= external load on pellet
N	= rotational speed, rpm
P_d	= particle diameter, m
W	= normal load on pad slider
U_0	= average velocity
L	= length of pad slider
B	= width of slider pad
h_L	= minimum film thickness
h_0	= inlet film thickness
δ_1, δ_2	= surface roughness, μm, for surfaces 1 and 2, respectively
U_1, U_2	= upper and lower film velocities
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