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Performance of a Complaint Foil Seal in a Small Gas Turbine Engine Simulator Employing a Hybrid Foil/Ball Bearing Support System©

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Operation of a non-contact compliant gas foil seal (CFS) in a high temperature hybrid dynamic simulator representative of a small gas turbine engine spool is discussed. At the hot section of the simulator two oil-free components, a CFS and a compliant foil bearing (CFB) were mounted and at the cold (compressor) section of the simulator, an oil-mist lubricated ball bearing was installed. The preliminary numerical study on the fluid flow and thermal analysis of a CFS was discussed in the previous work by the authors. The experimental results for successful operation of the foil bearing and foil seal at temperatures up to 560°C and speeds up to 55,000 rpm are presented. The surface of the CFS and CFB journals for high temperature tests were coated with PS304 solid lubricant film, developed by NASA The CFS performance at different operating speeds and temperatures and differential pressures was investigated. In a similar test, a leakage flow comparison was made among a labyrinth seal, a brush seal and a CFS. The experimental results indicate superior performance of the CFS over the two other types of seals. Unlike brush seal, CFS showed no evidence of rub or induced wear on the journal or seal surface.

KEY WORDS

Gas Seal; Compliant Foil Seal; Unlubricated Seal; Fluid Film Compliant Foil Bearing; High Temperature Seal; Gas Turbine Engine; Solid Lubricant; Labyrinth Seal; Brush Seal; Wear

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NOMENCLATURE

D	= shaft or rotor diameter
ΔP	= differential pressure across the seal
Ψ	= non-dimensional mass flow rate (Eq. [1])
$\Psi 1$	= $\dot{m}\ (T^{0.5})/P_u/D$ (Fig. 20)
T	= fluid temperature
P_a	= ambient pressure
$\dot{m}$	= mass flow rate
ρ	= mass density
P_u	= upstream pressure
C_0	= initial clearance
k	= stiffness
x,y	= coordinates