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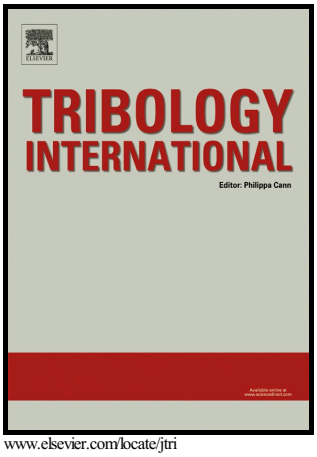

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Improving Stability and Operation of Turbine Rotors Using Adjustable Journal Bearings

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ABSTRACT

A theoretical study on the application of parametric excitation through fluid film journal bearings in order to extend the stability margins is presented in this paper. The proposed 2-arc and 3-arc journal bearing configurations are able to provide periodical stiffness and damping variation in certain frequency and amplitude introducing parametric anti-resonances or resonances in the system, leading to stable or unstable operation respectively. Furthermore, the use of the proposed bearings as a mean for real time adjustment of the journal center and the shaft-line is highlighted for further investigation. The theoretical application of the proposed bearings to a medium size industrial steam turbine of higher speed demonstrates the extension of stability margins at rotating speeds even five times supercritical.

KEY WORDS
Journal bearings; steam turbines; stability in hydrodynamics; parametric excitation

1. INTRODUCTION

Journal bearing induced instabilities in rotating machinery is a problem that in general is prevented by using journal bearings of multi-lobe elliptical profile or of tilting-pad scheme. The multi-lobe elliptical journal bearings do contribute in locating the instability threshold at higher speeds than the operational speed range by increasing the effective eccentricity [1]. Tilting-pad bearings do have the advantage of minimizing the cross-coupling stiffness and damping coefficients eliminating in this way the tangential to the whirl fluid film forces that raise instability [2-3]. However, plain cylindrical journal bearings loaded in such extent that would locate the journal at a sufficient eccentricity would not suffer from instability at a specific range of operational speed as found in [4]. This was a notification that raised the power of the slender generator rotors. Although the generators had to increase their length in order to increase power, the heavy loaded journal bearings could set instability thresholds at higher than 3000/3600RPM speeds.

Modern turbine rotors of small and medium size steam turbines (30-200MW) do not always rotate at synchronous speeds of 50/60Hz but towards more efficient thermodynamics the geared turbines of higher range of operating speeds (>5000RPM) do apply in many power plants. In order to avoid instability issues the tilting-pad bearings are often implemented in such applications. However, the multi-lobe elliptical bearings do offer stable operation and they are quite often implemented in the design having also the advantage of lower cost.