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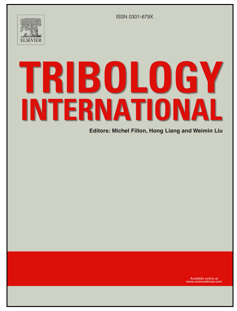

On the thermoelastic instability of foil bearings

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On the thermoelastic instability of foil bearings

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ABSTRACT

Published experimental evidence reveals that foil bearings are prone to damage due to thermal runaway under certain operating conditions where thermoelastic instability sets in. This paper describes a methodology and a closed-form solution for prediction of the critical speed at which a foil bearing can become thermoelastically unstable. The theoretical predictions have been verified with several published experimental results. While the model pertains to a journal bearing-type configuration, it can be readily extended to other bearing configurations.

Keywords: Foil bearings; thermoelastic instability; thermal runaway; hot spots

1. INTRODUCTION

The foil bearing technology emerged over sixty years ago to mitigate the inherent issues of rigid-surface air bearings such as the limited self-generated hydrodynamic film pressure, self-excited vibration due to a large amount of tangential force components, and high manufacturing costs necessary to maintain stringent tolerances in the bearing surfaces [1]. By incorporating flexible metal foils on the bearing surface, as shown in Fig.1, most of the above issues were alleviated and foil bearings could function successfully at high eccentricity ratios while maintaining the film pressure throughout the film with higher minimum film thickness than their rigid-bearing counterparts [2]. With the advancement of design analysis tools and high-temperature coatings, the application of foil bearing has become manifold from the air cycle machine in aircrafts, to turboexpander for cryogenic applications [2-6] to micro-power generator system [7] and micro