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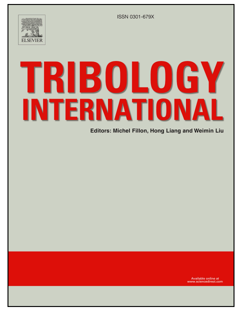

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An Investigation into the Transient Behavior of Journal Bearing with Surface Texture based on Fluid-Structure Interaction Approach

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Abstract

The influence of surface texture on the performance of the journal bearing operating under the transient condition is investigated by a fluid-structure interaction (FSI) approach. The key parameter of the current work is the displacement of the journal as well as the eccentricity ratio which better represents the actual operation of a journal bearing than the traditional approaches that rely on the steady state assumption. The results indicate that depending on its position in the circumferential direction, a surface texture may either enhance or impair the performance of a journal bearing in terms of the generation of the load-carrying capacity.

Keywords: Surface texture; Transient condition; Fluid-structure interaction (FSI); Eccentricity ratio; Journal bearing

1 Introduction

Surface textures are well-defined structures (such as dimples, grooves, etc.) constructed on the surfaces of tribological components to enhance their performance [1]. Their use is widespread in thrust bearings [2, 3], slider bearings [4, 5], journal bearings [6, 7], mechanical seals [8, 9], cylinder liners [10, 11], and the like. Research shows that the one most dominant feature of surface texturing is the capability of generating additional load-carrying support and its beneficial influence on the coefficient of friction. As summarized in references [1, 12], the existing literature offers different physical mechanisms to explain the nature of this phenomenon such as the local cavitation within the dimple [13], collective dimple effect each behaving as a tiny bearing [14], inlet suction [15], inertia effects [16], and balancing wedge action [17]. An interesting and significant relationship between surface texture and boundary slip is also indicated [12]. Regardless of the mechanism, it is widely acknowledged that the load-support mechanism of surface textures is strongly dependent on the operating conditions as well as the configuration of the bushing [1].

To predict the pressure distribution and load-carrying capacity (LCC), the majority of theoretical studies rely on the solution to the classical Reynolds equation, which is simplified from the Navier-Stokes (NS) equations in which the inertia effects and body forces are neglected and the pressure gradient across the film gap is assumed to be nil [1].

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