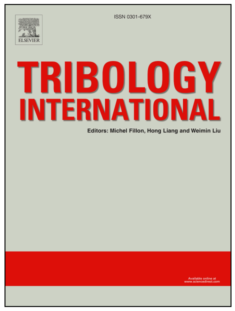
Accepted Manuscript



Experimental analysis of the hydrodynamic effect during start-up of fixed geometry thrust bearings

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PII: S0301-679X(17)30579-0

DOI: 10.1016/j.triboint.2017.12.021

Reference: JTRI 5005

To appear in: *Tribology International*

Received Date: 12 September 2017

Revised Date: 14 November 2017

Accepted Date: 15 December 2017

Please cite this article as: Henry Y, Bouyer J, Fillon M, Experimental analysis of the hydrodynamic effect during start-up of fixed geometry thrust bearings, *Tribology International* (2018), doi: 10.1016/j.triboint.2017.12.021.

Experimental analysis of the hydrodynamic effect during start-up of fixed geometry thrust bearings

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Keywords: texture, tapered land, pocket, flat land, friction

Abstract:

Most of the investigations on thrust bearings were performed under a steady-state condition and this regime is now well understood. Contrary to this, the behavior during the first period of start-up is sparsely studied. Start-ups of thrust bearings are critical periods where a mixed lubrication regime occurs. This regime can be detrimental for the lifetime of the system. It is usually mentioned in the literature that the textures act as micro reservoirs which can be beneficial to help lift-up during start-up. This is an intuitive hypothesis and there are no experimental results to prove it. This study uses an experimental approach in order to analyze the behavior of different kinds of thrust bearings with fixed geometry. It mainly focuses on the capability of textured thrust bearings to lift up during start-up. This study shows that only specific texture geometry can help the formation of a fluid film. The results are compared to those obtained with classical geometries like tapered land, pocketed and untextured flat-land thrust bearings. The original results show a relatively good ability of flat-land thrust bearings to generate a lift-up during the start-up period.

An experimental device is used to measure, at high frequency, the friction torque as well as the electrical resistance across the fluid film to determine the lubrication regime. The comparative analysis allows us to explain the factors which modify the contact.

1. Introduction

It is well known that the first evidence of the surface micro topography influence on hydrodynamic pressure was found in 1966 by Hamilton [1]. Pits or cavities created on two surfaces in relative motion provide a lower power loss, even for parallel surfaces. The small irregularities on the interacting surfaces were found to be a mechanism which allows parallel surfaces to support load by creating a local step bearing. The effect of the textured surface consists in creating an alternative converging film region like a Rayleigh step or a pocketed parallel slider. Surface texturing was employed to reduce the friction and increase the load capacity under a hydrodynamic regime. Some interesting review articles, strongly reporting on the effect of surface texturing on hydrodynamic lubrication, were recently published [2] [3]. A new machining technologies process can facilitate the industrialization of textured surfaces. Various recent texturing techniques are employed: a burnishing process [4], etching techniques, laser texturing, beam texturing, reactive ion etching, lithography [5] The choice of process depends mainly on the material and on the shape of the cavities to be created.

The research on surface texturing gained new momentum in 1996, when Etsion et al. published one of their first papers on surface texturing [6]. A few years later, they focused their researches on the textured thrust bearings. The first experimental results on the steady-state condition reveal a substantial reduction in friction torque [7] and were confirmed by Marian et al. in 2007 [8] and Henry et al. in 2015 [9]. This tendency was also observed on a tilting pads thrust bearing by Glavatskih's team [29]. The maximum reduction of the coefficient of friction observed was approximately 10%. However,