Transient wear simulation based on three-dimensional finite element analysis for a dry running tilted shaft-bushing bearing

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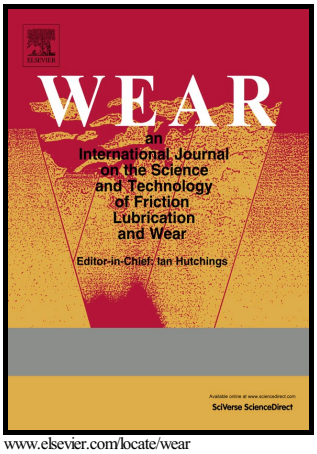

www.elsevier.com/locate/wear

PII: S0043-1648(18)30097-8
DOI: https://doi.org/10.1016/j.wear.2018.05.008
Reference: WEA102419

To appear in: *Wear*

Received date: 22 February 2018
Revised date: 8 May 2018
Accepted date: 9 May 2018

Cite this article as: Adrian A. Schmidt, Timo Schmidt, Oliver Grabherr and habil. Dirk Bartel, Transient wear simulation based on three-dimensional finite element analysis for a dry running tilted shaft-bushing bearing, *Wear,* https://doi.org/10.1016/j.wear.2018.05.008

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Abstract

This paper presents a method to predict dry sliding wear. It is developed for the wear simulation on a tilted shaft-bushing bearing of an automotive turbocharger wastegate system. Therefore the simulation of complex dynamic behavior with its respective contact situations is required and is performed by nonlinear, transient, three-dimensional finite element analysis (FEA). Simultaneous wear calculation on all contact surfaces is possible considering individual wear coefficients. In order to reduce computing time, the resulting ablation depth is extrapolated. Subsequently the mesh is adjusted by implementing nodal displacements. The progress of the calculated wear volume matches well with theoretical considerations for different mesh qualities. Mesh refinement only leads to a higher resolution of the results but good convergence is achieved.

1. Introduction

Downsizing of combustion engines is a common strategy to fulfill stricter emission regulations. In order to still meet the engine performance targets, turbochargers are used to increase the specific power output of smaller engines. A bypass valve (wastegate) is used to control the boost pressure produced by the turbocharger. The kinematic system which actuates the wastegate contains a shaft-bushing bearing. This bearing experiences complex load situations and is vulnerable to wear.

Wear reduction is an essential element in extending lifetime. Colbert *et al.* have shown that the durability of shaft-bushing bearings can be improved by design optimization [1]. According to Wibmer *et al.* time consuming and expensive experiments are one approach to understand and optimize wear behavior [2]. Another approach is simulation, which contributes to this optimization and leads to faster and more efficient development.

Wear can be simulated for lubricated and for dry running systems. Lubricated tribosystems are part of many important applications and a large variety of scientific work is dedicated to them. For example Debler [3], Schmidt [4] and Frölich