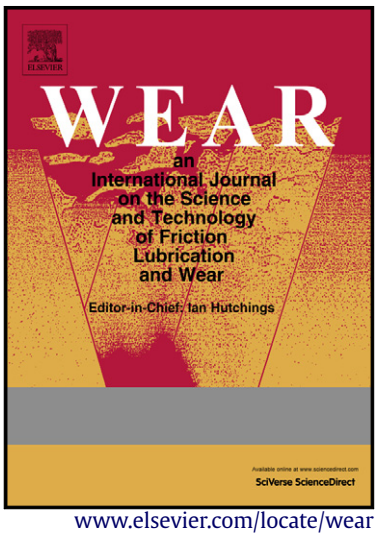


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# Influence of Run-In Procedures and Thermal Surface Treatment on the Anti-Wear Performance of Additive-Free Lubricant Oils in Rolling Bearings

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## Abstract

When rolling bearings are operated in the boundary and mixed friction regime, there is a risk of wear which can be minimized by the application of suitable lubricants with anti-wear additives. These lubricants form surface-bound additive-based tribolayers under tribological strain. The trend towards a reduction of additive concentration requires new methods of effective wear protection. In this study, two additive-free lubricants were investigated, using highly wear-critical cylinder roller thrust bearings. The results show that both oils exhibit insufficient wear protection. This protection can be increased for one of the oils by an iron oxide-based tribolayer which is built up during a suitable run-in procedure. Furthermore, it is shown how the run-in tribolayer can be reproduced by a thermal treatment of the bearings. The increase in wear protection can be explained by a better lubricant-surface interaction due to the tribolayers, which leads to a better separation of the steel surfaces. The tribolayers are characterized using EPMA, FIB-TEM, and nano-indentation analyses.

## 1 Introduction

### 1.1 Wear protection in rolling bearings

Adhesive and abrasive wear usually occurs when solid surfaces come into contact. This condition cannot be avoided in some applications of rolling bearings, due to mixed or boundary friction (e. g. in wind energy turbines rolling bearings are operated under high loads and low speeds). Today, in most systems the risk of wear is avoided by adding inexpensive and effective anti-wear (AW) additives to the lubricant. These additives can prevent a wear process by building up separating tribological boundary layers.

Stricter regulations require the use of lubricants with less and less additives because of their poor environmental compatibility and potential negative effects on machine components, such as sealings and filters [1-3]. Lubricants with a low level of additives or additive-free lubricants usually exhibit less effective wear protection.

It was shown that artificial coatings (physical vapor deposition layers) are able to provide wear protection with additive-free lubricants due to their mechanical properties [4]. However, this technology and other special methods of wear protection (e.g. the use of specially treated steels or ceramics) create additional production costs. Therefore, these measures are only taken when lubricants with effective AW-additives cannot be used.

The anti-wear performance of lubricants with AW-additives in rolling bearings can be significantly enhanced with run-in procedures [5, 6]. In these procedures, lubricants with otherwise low anti-wear performance form boundary layers on the rolling bearing surface under slightly more moderate operating conditions (less solid surface contact). Once the layers are built up, the same lubricant can provide wear protection under severe conditions. This showed that lubricants with insufficient AW-properties can provide wear protection