Quantitative hydrogen ingress and its effect on surface and near surface damage during rolling/sliding wear of self-mated 100Cr6 steel

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Hydrogen as an environmentally adapted alternative to fossil energy carriers is on the rise. However, the specific energy density of hydrogen is not high enough to efficiently use it as an energy carrier, and thus it needs to be pressurised. Rolling element bearings, which are a key component in hydrogen compressors, are susceptible to hydrogen embrittlement. Due to leakage in the sealings, the bearing lubricant can be contaminated with significant amounts of hydrogen, and bearings may undergo premature failure. In order to enhance the understanding about hydrogen embrittlement and rolling element bearing damage, the hydrogen ingress and the resulting damage in rolling/sliding conditions need to be investigated. Studies on hydrogen embrittlement so far have focused on providing a qualitative understanding of hydrogen embrittlement in bearing steels. In order to identify a critical limit when hydrogen may induce accelerated bearing damage, a systematic characterisation of wear mechanisms and surface degradation coupled to quantitative measurements of hydrogen ingress is necessary.

The current study quantitatively analyses the hydrogen ingress into bearing steel in rolling/sliding contact. Hydrogen ingress is triggered by performing tribotests on a micro-pitting rig (MPR), where the lubricant as well as operating parameters are modified in order to introduce different amounts of hydrogen into the samples. Thereafter, post-test thermal desorption analysis (TDA) is performed to quantify the hydrogen ingress into the bearing steel exposed to different rolling/sliding wear conditions. Additionally, the surface and near surface damage is characterised using interferometry, optical microscopy, and scanning electron microscopy. Finally, the identified damage mechanisms are linked to the quantitative amount of hydrogen present in the sample to map the most damaging operating conditions for rolling element bearings in hydrogen compressors with respect to hydrogen embrittlement.

Keywords: hydrogen embrittlement, rolling element bearing, micro pitting rig (MPR), thermal desorption analysis (TDA)

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