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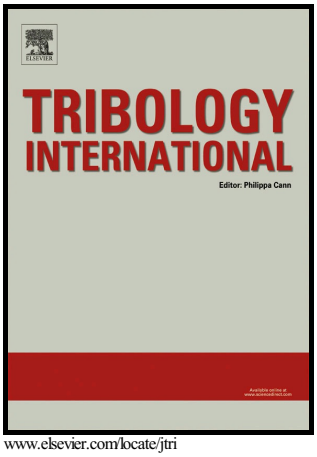

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Influence of Step Load on Tribological Properties of Self-Lubricating Radial Spherical Plain Bearings with PTFE Fabric Liner

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Abstract:

The tribological properties of self-lubricating radial spherical plain bearings with polytetrafluoroethylene/aramid fabric woven liners under step loads were experimentally investigated. Using scanning electron microscopy and energy-dispersive X-ray spectroscopy, the wear mechanisms of the liners were analyzed. The results showed that the wear loss, frictional temperature rise, and film forming capability were affected by the load ratio, swivel frequency, and load cycle. During the operation of the bearings, adhesive wear and abrasive wear occurred in the frictional pairs. As the load ratio increased, the adhesive wear and abrasive wear were aggravated.

Keywords: Plain bearing; Solid lubricant; Friction; Wear

1. Introduction

Self-lubricating radial spherical plain bearings are widely used in engineering because of advantages such as high load carrying capacities and maintenance-free function [1–3]. To realize the self-lubricating function, a layer of self-lubricating material is bonded on the internal spherical surface of the outer ring of the bearing. Common self-lubricating materials used in the bearings include metal backing composite materials, polymer and filled polymer composite materials, and polytetrafluoroethylene (PTFE) fabric composite materials [4–6]. Because of their high load-carrying capacity, good anti-friction performance, and eco-friendliness, aramid/PTFE fabric-reinforced woven composites are widely used as self-lubricating liners of radial spherical plain bearings. Their performances are influenced by complex factors such as the materials, structures, and operating conditions [7–9]. The load properties significantly affect the tribological properties of the bearings and determine the macroscopic stress fields on the bearing frictional surfaces. The load types that the bearings generally support include constant loads, pulse loads, and cyclic loads. Under practical operating conditions, the bearings usually undergo variable loads rather than constant loads. Thus, investigating the tribological properties and wear mechanisms of the liners under variable loads is important.

Most experimental studies on self-lubricating materials were conducted using a pin-on-disk tester or a block-on-ring tester [10, 11]. However, the real tribological properties of self-lubricating materials used on spherical plain bearings experiments cannot be experimentally evaluated using a pin-on-disk tester or a block-on-ring tester. In addition, most experiments on spherical plain bearings were performed under constant load conditions, and very little attention has been paid to the tribological properties of the bearings under variable loads. Recently, the tribological properties, modification methods, and damage mechanisms of self-lubricating materials have been investigated by simulating spherical sliding operating conditions [12–15]. In [12], the fatigue failure mechanisms and fatigue behaviors of the liners used in radial spherical plain bearings were investigated, revealing that even under constant radial loads, cyclic pressure can occur on the liner frictional surface and the counter surface, resulting in the fatigue failure of the liners. In [13], PTFE/aramid fabric woven liners were modified by ultrasonic. The tribological properties of the