

THE EFFECT OF ESTERS ON WEAR AND TRIBOFILM FORMATION IN ELECTRIC VEHICLE (EV) LUBRICANTS

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KEYWORDS

Experiments in tribology; Lubricant additives; Tribofilms, Electric vehicles

ABSTRACT

Introduction

The aim of reducing global CO₂ output has increased interest and adoption of electrified transport, primarily Battery electric vehicles (BEVs). The adoption of EVs has slowly increased over time. One significant factor preventing the wider adoption of EVs is their limited range combined with a long recharge time (commonly termed ‘range anxiety’), when compared to internal combustion engine vehicles (ICEVs). The development of lubricants aimed at increased efficiency, through reduced viscosity, can help increase range. The reduction of viscosity and the new challenges associated with EVs present new challenges for lubricant/additive design when compared to traditional higher viscosity ICEV lubricant. High immediate torque, high RPM variations, increased copper use, filled for life and other factors. Due to these new challenges, it is important to develop dedicated high performance EV lubricants, rather than relying on transmission oil developed for ICEVs.

This experimental study aims to evaluate the effectiveness of two different esters as high treat rate additives (10% wt) on the friction and wear characteristics of a fully formulated EV lubricant, which uses phosphor based extreme pressure additives with a low to no sulphur count. In conditions developed to instigate tribofilm formation without progressing to micropitting.

Methodology

A blend of PAO and The EV additive pack (FO) was used as the base with the addition of a high polarity, high viscosity, ester A (FO + A) and a low polarity low viscosity ester B (FO + B). The tribofilms were formed using a Mini Traction Machine (ball on disc tribometer) programmed for Stribeck, traction and

constant timed steps in the low mixed lubrication regime, forcing tribofilm formation. Wear has been analysed optically via microscopy and with optical profilometry. Tribofilm formation and its chemical structure has been analysed with FIB/TEM and the complimentary spectroscopy techniques Raman, SIMS, and XPS.

Results

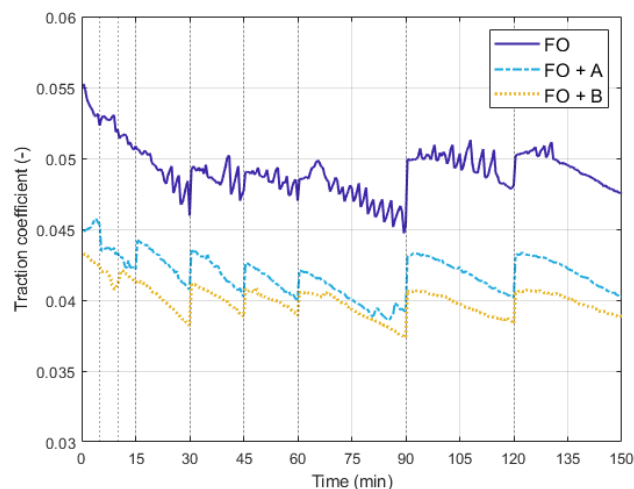


Fig.1 Traction coefficient against time for fixed time steps, with dotted lines indicating where stops occurred for Stribeck and traction curves.

The results show a reduction in wear with the use of both esters, along with alterations in the tribofilm thickness and chemistry. This is despite their difference in polarity between the two esters, suggesting that a more fundamental aspect of the esters chemistry causes a change in performance of the additive pack. The tribofilm structure and performance in relation to testing conditions will be discussed to explain the performance of esters in EV lubricants.