ELECTROSTATIC MONITORING OF BOUNDARY AND MIXED LUBRICATION

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ABSTRACT

Previous work has shown that electrostatic charge signals can be used to detect the onset of wear in lubricated tribocontacts. Preliminary investigations have shown the viability of this system when tested on a laboratory-based pin-on-disc rig, a reciprocating laboratory wear rig [1-3] and in an FZG gear scuffing rig [4]. These preliminary experiments have indicated several charging mechanisms could be involved, namely tribocharging, surface charge variations, debris generation and exo-emissions.

This paper details further studies looking at the levels of charge generated under boundary and mixed ($\lambda < 3$) lubrication regimes for base oils and formulated lubricants using a pin-on-disc facility. A sliding ball on flat geometry of bearing steel (En31) was used as detailed in [5]. Charge levels prior to scuffing will be detailed and discussed in relation to contact potential differences induced by the presence of incomplete additive films, phase transformations, oxide formation/removal and other wear processes associated with boundary/mixed lubrication. Initial results will be presented that show the dynamic nature of charge within the wear track for mineral and synthetic base oils and formulated lubricants. This work shows major differences in charge level between base oil and formulated oil and behaviour within the contact and wear track. Precursor charge events prior to metal/metal interaction within the contact are identified and their use for early detection of wear and boundary film failure discussed.

The polarity of charge was dependent upon the base stock type. Negative charge was associated with synthetic base stocks, and positive charge with mineral stock, see Figure 1. This agrees with separate chargeability measurements of these oils and is related to the interactions between the double layer and fluid boundary layers which lead to charge separation. Charge sign inversion is discussed in relation to specific adsorption of charged species (additives) on the disc surface, the presence of oppositely charged impurities and the differential of adsorption and / or diffusion rates for the negatively and positively charged species within the oils. Post test surface profilometry of the disc wear track showed uniform wear depth eliminating any capacitance effects.

![Figure 1: Normalised electrostatic signals per rev. for (a) synthetic Exxon Turbo 2380 and (b) mineral Shell Vitrea ISO 32 lubricated 6mm dia. ball-on-disc sliding contact at initial load 50N, test 180N and 1400 rpm.](image)

REFERENCES