THE EFFECTS OF DC AND AC ELECTRIFICATION ON THE TRIBOLOGY OF GEAR MATERIALS LUBRICATED BY ICE AND EV TARGETTED ADDITIVE PACKAGES

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ABSTRACT
The growing popularity of electric vehicles (EVs) presents a vastly different set of tribological challenges to what is commonly experienced in the development of internal combustion engine (ICE) vehicles. Not only does the high torque production and high rotor speeds experienced in EV motors extenuate existing tribological challenges in the automotive sector; the drastically different architectures of EV drivetrains also present entirely new challenges to be explored [1]. One key challenge which is surprisingly overlooked in existing literature is the inherent electrified nature of EV drivetrains. Many forms of stray electric current are prevalent within such systems, which cause the deterioration of key mechanical components through several electrochemical and electromechanical wear mechanisms [2].

In this study, a novel electromechanical apparatus was implemented to investigate the effects of direct current (DC) and alternating current (AC, 50 Hz) electrification across AISI 52100 bearing steel ball-on-disc unidirectional sliding contacts, lubricated in the mixed regime by commercially available transmission fluids. Three lubricants were compared at 80 °C under both unelectrified ($I_{RMS} = 0$ A) and AC ($I_{RMS} = 2$ A) conditions. The three lubricants used in testing were a group IV poly-α-olefin (PAO4) synthetic base oil and two commercially available transmission fluids – currently implemented within ICE vehicles and EVs respectively.

The key findings of this study highlight a reduction in friction under electrified conditions, at the expense of expedited material wear and tribo-chemical surface modification. White-light vertical-scanning interferometry (VSI) and scanning electron microscopy (SEM) were implemented to quantify material removal; whilst energy-dispersive x-ray spectroscopy (EDX) allowed for the chemical comparison of sample surfaces prior to and following tests under these varying conditions.

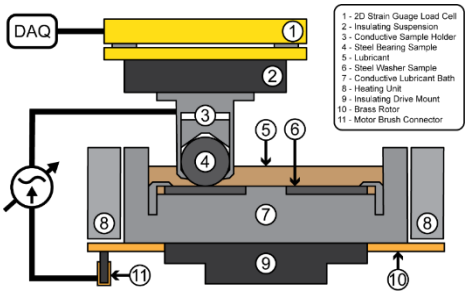

Fig.1. Schematic depiction of the electrified unidirectional ball-on-disc tribometer apparatus.

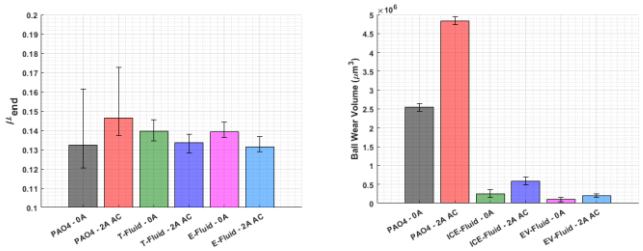

Fig.2. Illustrating the friction and wear behaviours of electrified (AC) and unelectrified contacts.

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