Structure of Organic Friction Modifiers Tribofilm in Reciprocating Conditions

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Friction is inextricably linked to fuel economy, which is currently one of the biggest drivers for developments in the automotive sector. Boosting engine energy efficiency through lubrication typically entails implementing a primary approach: reducing friction without compromising the durability of engine components. This is frequently accomplished by introducing a lubricating oil to establish a protective barrier between interacting surfaces. Organic friction modifiers (OFMs) are currently under consideration to replace chemical additives with phosphate and sulphur content. They are often assumed to form a thin film on the metal surface that reduces friction and acts as a protective barrier to wear and corrosion. However, the exact molecular-level mechanisms by which OFMs achieve a reduction in friction and wear are not known.

This study investigates the tribology and tribofilm formation of OFMs with different head groups on steel surfaces under boundary lubrication conditions. OFMs tested were glycerol monooleate (GMO), triolein and the mixed GMO in PAO4 base oil. A TE77 tribometer was used to investigate the additives' friction behaviour and film-forming properties. Tests were carried out in a load of 40N, corresponding to a maximum contact pressure of 0.98GPa at temperatures 60°C and 100°C. Friction was tracked throughout experiments and the chemical composition was subsequently examined using ToF-SIMS. The width of the wear was measured using white light interferometry (WLI) in an NPFlex instrument. The lowest friction coefficients were achieved by the GMO at a temperature of 60°C. The ToF-SIMS data indicate that GMO hydrolyses and forms oleic acid, which is then adsorbed on the steel surfaces, preventing metal-to-metal contact. Correlations between the characteristics of the formed tribofilm, and tribological performance will be discussed.