One Ring Holds and One Ring Breaks

CATEGORY OR KEYWORD

Boundary lubrication, oil additives

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Additives are normally incorporated into base oils to reduce friction and wear for interfaces operating under boundary lubrication conditions. One can broadly classify these additives into two types. The first type, such as amines, adsorbs strongly into counterfaces, preventing direct metal contact. The second type, most notably represented by zinc dialkyl-dithiophosphate (ZDDP), decomposes to form a tribofilm. In this talk, we will explore one alternative for each type, neither involving the use of phosphorus or sulfur.

We have synthesized a series of alkyl-cyclens. When incorporated as additives to polyalphaolefin (PAO), they adsorb strongly on oxide-covered steel surfaces due to their multi-dentate configuration. Because of this strong adsorption, cyclens provide significant friction reduction not only when compared with PAO, but also with a fully formulated lubricant, especially at elevated temperatures. This demonstrates that these strongly adsorbing cyclen molecules out-compete other surface-active additives in a fully formulated lubricant [1].

We have also explored a series of highly strained cyclic compounds soluble in PAO, e.g., cyclopropanecarboxylic acid (CPCa), cyclobutanecarboxylic acid (CBCa), etc. Under stress and together with frictional heating, they decompose to form tribofilms, providing significant reduction in friction and wear. These tribofilms have been shown to be oligomers or polymers, with molecular weight exceeding 1500. This approach represents a unique strategy to providing on-demand lubrication and wear control [2].

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