BIODERIVED LOW-EMISSION ENGINE LUBRICANTS

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The ability to meet accelerated and more stringent NO_x and particulate emission standards is a key challenge to continued implementation of fuel-efficient diesel engine technology for transportation applications. A number of emission reduction strategies are being pursued to meet the new standards including improved combustion control, exhaust gas recirculation (EGR), and exhaust gas aftertreatment. Aftertreatment devices along with EGR systems are sensitive to sulfur and require the use of low-sulfur fuel (< 10 ppm S, compared to current 500 ppm S levels). Aftertreatment devices are also susceptible to sulfur (as well as P and metal-bearing compounds) in engine lubricants that are entrained in exhaust gases, and thus there is a desire to reduce, in fuels and lubricants, the level of compounds containing elements that will poison or foul aftertreatment devices. However, elimination of these compounds will have a deleterious impact on the ability of the lubricant to protect critical engine components. Anti-wear, EP, TAN, TBN additives and detergents are a few of the compounds that rely on the presence of metals, S, and P to protect the engine yet they poison or foul aftertreatment devices that have not previously been used. Consequently, there is a push to develop low-emission engine lubricant packages that minimize the use of compounds containing elements that poison aftertreatment devices.

Bioderived lubricants offer a potential solution – they do not contain S, P, and metallic compounds that are known to poison and foul aftertreatment devices. Yet there are several issues that remain to be addressed prior to their acceptance as lubricants, namely: (1) their ability to function as boundary layer lubricants, (2) their resistance to high temperature oxidation, (3) their corrosion properties, and most importantly (4) their cost.

ANL, INEEL, ISU, and industrial partners are establishing a team to (1) generate novel bacterial and plant-derived fatty acid derivatives with new chemical and physical properties, and (2) to evaluate these novel plant-products in terms of their tribological properties as biolubricants and bioadditives for low-sulfur diesel fuels. Novel chemistries will utilize iso-methyl-branched and anteiso-methyl-branched chain fatty acids, which are fatty acids found in some bacteria (e.g., *Bacillus* and *Streptomyces*). These saturated and branched fatty acids offer improved fluidity at lower temperature in combination with enhanced thermal stability that is not currently found in conventional vegetable oils. In addition, we plan to examine plant-derived wax-esters. With the exception of jojoba oil, wax-esters are naturally only produced in small quantities as part of the plant's cuticle. However, these cuticle-associated wax-esters have a wide range of chemical composition, and thus they offer a wider range of potential physical and chemical properties that can be evaluated for their application as biolubricants.

The bottom line is that ANL, INEEL, and ISU (along with our industrial partners) will assess the critical needs of the lubricant, determine if bioderived compounds will provide the necessary properties, AND, develop the technology needed to economically produce these biofuels.