

## Lubricants in the Age of Biodiesel

### Abstract

The use of alternative fuels and especially biodiesel is widespread in Western Europe. Biodiesel quickly found its way into the Western European fuels market due to environmental regulations, rising oil prices and political concerns about oil dependence. Most of the diesel sold in Europe now contains some percentage of plant derived fuel. This rapid advance of biodiesel occurred ahead of the understanding of the consequences of biofuel dilution into crankcase lubricant and the resulting effect on the lubricant performance. In this paper we examine the impact on low temperature pumpability when crankcase lubricants are exposed to biodiesel dilution. The oil drained from a widely used European engine was evaluated after running on various biodiesel fuels, and the concentration and composition of biodiesel in the crankcase as well as soot loading were examined. Our results show that the choice of viscosity modifier (VM) can be crucial to viscometric performance of the oil, both fresh and aged, in vehicles that use biodiesel.

### Introduction

Concerns over security of petroleum product supply and the effect of fossil fuel on climate change are driving the use of renewable energy resources. The use of biofuels, including biodiesel, is legislated in several industrialised and developing nations. The term "biodiesel" usually refers to a fuel containing a certain fraction of the plant derived fatty acid methyl esters (FAME), although biodiesel production from animal sources is increasing. In the biodiesel nomenclature, Bxx, B indicates the presence of biologically derived fuel and xx - its percentage. For example, B30 contains 30% of biofuel and 70% of regular diesel; B100 is pure biofuel. The most common plant sources are rapeseed, soy and palm oils that are expected to account for 80% of FAME production globally<sup>[1]</sup>.

Western Europe has the highest demand for biodiesel. Rapeseed, the main local plant source of FAME, does not meet the growing demand. Thus the use of soy and palm methyl esters becomes a reality in Europe together with the small amounts of FAME from the more exotic oilseed sources. Biodiesel as a fuel has similar combustion properties to the

petroleum derived diesel, but its chemical composition is different. The chemical composition dictates such properties as fuel cold flow, volatility, and effect on the fuel injection system. Because biodiesel is much less volatile than petroleum derived diesel, it has a tendency to accumulate in a crankcase lubricant when non-combusted fuel gets past the piston rings. This results in lubricant dilution and alteration of its properties. Furthermore, the chemical composition and properties of FAME derived from various plant sources differ significantly. Thus interaction of biodiesel with the crankcase lubricant and in-service properties of this lubricant can depend on the source of biodiesel used. An understanding of the properties of these types of FAME and how they impact lubricant performance is important.

Some work has been done to understand the extent of biodiesel dilution in the lubricants and its effect on oxidation, deposits, wear, corrosion and soot formation<sup>[2-10]</sup>. The use of biodiesel in general has a negative effect on oxidative stability of the lubricant, deposit formation and corrosion. The use of biodiesel, however, usually results in low soot formation.

In this paper we explore the effect of in-service biodiesel dilution on low temperature pumpability of the crankcase lubricant. We evaluate the oil drained from a widely used European engine after running on bio-fuel and examine the concentration and composition of biodiesel in the crankcase as well as soot loading. We show that the choice of viscosity modifier (VM) can be crucial to viscometric performance of the oil, both fresh and aged, in the engine that uses biodiesel.

### Experimental

#### a. The oils

Similar SAE 5W-40 top tier European oils differing only in the viscosity modifier type were blended for this study in Group III base oil. Three VM chemistries were tested: amorphous hydrogenated styrene-diene star VM (A-Star), semi-crystalline OCP (SC-OCP), and amorphous OCP (A-OCP). Oils were blended to similar kinematic viscosities at 100°C (KV100) and exhibited excellent fresh oil viscometrics (Table 1).