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The Impact of Engine Heat on the Erosion of its Parts Using Biofuels

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ABSTRACT

Biodiesel is a renewable transportation fuel consisting of fatty acid methyl esters (FAME), generally produced by transesterification of vegetable oils and animal fats. In this review, the fatty acid (FA) profiles of 12 common biodiesel feedstocks were summarized. Considerable compositional variability exists across the range of feedstocks. For example, coconut, palm and tallow contain high amounts of saturated FA; while corn, rapeseed, safflower, soy, and sunflower are dominated by unsaturated FA. The aim of this study effect using biofuel on heat engine and erosion.

1. Introduction

Interest in biodiesel is continuing to increase in the word. And throughout the world. This is motivated primarily by: (1) concerns about greenhouse gas (GHG) emissions and global climate change, (2) a desire for renewable/sustainable energy sources, and (3) an interest in developing domestic and more secure fuel supplies (U.S. Congress,2007). In recent years, several countries (and states) have embarked on legislative and/or regulatory pathways that encourage increased use of biodiesel fuel – using both incentives and prescriptive volumetric requirements. For example, in the U.S., the Energy Independence and Security Act (EISA) of 2007 established a 0.5 billion gallon/year (bg/y) requirement for biomass-based diesel fuel in 2009, with this amount increasing to 1.0 bg/y by 2012. With the biodiesel landscape being in a state of rapid flux, the Coordinating Research Council (CRC) recently sponsored Project AVFL-17 to define the state-of-knowledge regarding biodistillates as blendstocks for transportation fuels. The complete final report from this updated study is available from the CRC website (Hoekman SK, 2009).

The subject of this paper is limited to a review of biodiesel compositions and properties, and the relationships between composition and properties as transesterification, by which the triglycerides are reacted with alcohols, in the presence of a catalyst, to produce fatty acid alkyl esters. A byproduct of transesterification is glycerine, also known as glycerol. Since the most common alcohol used to produce biodieselis methanol, unless otherwise indicated, the term “biodiesel” refers to neat material – i.e. 100% FAME, often designated as B100. Lower concentrations, such as B20, are properly referred to as “biodiesel blends,” not biodiesel itself. Renewable diesel fuel (also known as Green Diesel) is produced by catalytic hydro processing of the same triglyceride feedstocks used to produce biodiesel. In this process, an alcohol is not required, the products are hydrocarbons rather than fatty acid alkyl esters, and no glycerol byproduct is formed. The general term “biodistillate” is used to refer to both biodiesel and renewable diesel. Terminology regarding “1st Generation” and “2nd Generation” biofuels are in popular usage, but have no legal or regulatory meaning. the term “1st Generation” refers to biofuels produced from commonly available, edible feedstocks using well established conversion technologies. Most biofuels in use today are classified as 1st Generation. This includes ethanol produced via fermentation of sugars (from corn, sugar cane, sorghum, etc.) and biodiesel produced via transesterification of triglycerides (from vegetable oils and animal fats). The term “2nd Generation” can refer to biofuels produced from either advanced, non-food feedstocks, or produced via advanced processing technology (or both). Examples of advanced feedstocks include lignocellulose and nonedible triglycerides (such as jatropha and algae). Examples of advanced processing technology include catalytic hydroprocessing of triglycerides to produce renewable diesel, and thermal conversion (gasification and pyrolysis) of lignocellulose. Because of their imprecise and variable meanings, this paper avoids use of the terms 1st Generation and 2nd Generation (and related terms) (Broch A, Hoekman SK.,2009).

2. Biodiesel composition

Biodiesel fuel can be produced by transesterification of virtually any triglyceride feedstock. This includes oil-bearing crops, animal fats, and algal lipids. The literature contains hundreds of references of biodiesel production from a wide variety of feedstocks. At present, however, the dominant feedstocks are soybean oil, rapeseed oil, and palm oil. Animal fats (especially beef tallow) and used cooking oil (also called yellow grease) represent significant niche markets for biodiesel in many locations. Other vegetable oils having real or potential commercial interest as biodiesel feedstocks include camelina, canola, coconut, corn, jatropha, safflower, and sunflower. In addition, there is great interest in developing and utilizing algal lipids as biodiesel feedstocks. Of all photosynthetic organisms, microalgae are the most productive users of CO_2, and can fix larger amounts of CO_2 per land area than other plants. While many of these values are rather speculative, it appears that algae have the potential to produce significantly larger annual volumes of biodiesel per acre as compared to other sources. Although biodiesel fuel produced from transesterification of triglycerides contains numerous individual FAME species, a particular fuel is generally dominated by only a few species. This convention consists of two numbers, separated by a colon symbol. The first number refers to the number of carbon atoms in the FA chain; the second number refers to the number of carbons–carbon bonds in the FA chain. composition of FAME derived from vegetable oils and animal fats: palmitic acid (16:0), stearic acid (18:0), oleic acid (18:1), linoleic acid (18:2), and linolenic acid (18:3). Some algal-derived lipids are dominated by these same fatty acid groups, while other algae are more diverse in their composition, containing significant amounts of several other FA groups. Biodiesel (FAME) produced from transesterification of triglycerides, regardless of their source, is composed nearly exclusively of even-numbered FA chains. In contrast, renewable diesel produced from the same feedstocks contains substantial amounts of odd-numbered FA chains, since one carbon is removed during the hydro processing step used to manufacture renewable diesel.

3. Biodiesel properties

The physical and chemical properties of biodiesel are determined by the compositional profiles described above. Biodiesel properties can vary substantially from one feedstock to the next. Specific variations with feedstock are discussed below in greater. However, it is also useful to briefly compare a few critical properties of biodiesel fuels as a class, with the properties of petroleum diesel, for completeness, typical properties of renewable diesel are also included. (A thorough comparison of biodiesel and renewable diesel with respect to production, properties, and impacts has recently been published. Because of its considerable oxygen content (typically 11%), biodiesel has lower carbon and hydrogen contents compared to diesel fuel, resulting in about a 10% lower mass energy content. However, due to biodiesel's higher fuel density, its volumetric energy content is only about 5–6% lower than petroleum diesel. Typically, biodiesel has somewhat higher molecular weight than petroleum diesel, which is reflected in slightly higher distillation temperatures (as measured by T90). Consisting mainly of straight chain esters, most biodiesel fuels have excellent cetane numbers – typically higher than No. 2 diesel fuel. The viscosity of most biodiesel fuels is significantly higher than petroleum diesel, often Renewable diesel consists mainly of paraffinic hydrocarbons, usually dominated by odd carbon numbers. Depending upon process variables, even carbon number hydrocarbons can also be produced.) While some renewable diesel fuels contain primarily straight-chain, normal paraffins, others contain appreciable amounts of branched paraffins. As a consequence of their high paraffinic content, renewable diesel fuels typically have cetane numbers much higher than biodiesel. On a mass basis, the energy content of renewable diesel is higher than biodiesel (similar to petroleum diesel); on a volumetric basis, the energy contents of Biodiesel and renewable diesel are very similar. When reviewing the properties of biodiesel prepared from different feedstocks, it is useful to bear in mind the standard specifications that have been established by various fuel standard-setting.

4. Flash point

The flash point values for 11 of the 12 biodiesel types are well above the minimum specifications in the U.S. (93 ◦C) and European (101 ◦C) standards. Coconut-derived biodiesel has a significantly lower flash point, although it is still just within the standard specifications. The main purpose of the flash point specification is to ensure that the manufactured FAME has been sufficiently purified by removal of excess methanol. Even small amounts of residual methanol in FAME will cause a significantly depressed flash point.

5. Cetane number

Cetane number values for all 12 biodiesel types easily surpass the ASTM minimum specification of 47, with the highest cetane values being observed for palm-, coconut-, and tallow-derived FAME. The European specification is more stringent, requiring a minimum cetane number of 51. On this basis, biodiesel produced from camelina, safflower, soy, and sunflower are all borderline, and specific batches may have difficulty in meeting the specification.

6. Properties of biodiesel from algal lipids

Despite the current emphasis on use of algal lipids as biodiesel feedstocks, there are very few literature reports of actual biodiesel samples produced from algae, and even fewer reports of relevant fuel properties from such algal-derived materials. Miao et al. reported the production of biodiesel from Chlorella prototheorids, and showed that it satisfied several of the ASTM specifications for biodiesel. Considering the high degree of unsaturation of many algal FA profiles are surprising that these biodiesels would meet the European IV specification. It is also expected that such highly unsaturated materials would have difficulty in meeting the oxidation stability requirements within either the U.S. or European biodiesel standards. Assessing the suitability of algal-derived FAME as a biodiesel fuel is clearly an area requiring further study.

7. Heating value

Neither the U.S. nor European biodiesel standards include a specification for heating value. Due to its substantial oxygen content, it is generally accepted that biodiesel from all sources has about 10% lower mass energy content (MJ/kg) than petroleum diesel. However, there are some differences in heating value among the 12 biodiesel types investigated here. Camelina was reported to have the highest HHV at 45.2 MJ/kg (based upon a single report), followed by corn and safflower at 43.1 and 42.2 MJ/kg, respectively. FAME produced from soy, sunflower, tallow, and yellow grease are all just below 40 MJ/kg, while FAME from coconut is much lower at 38.1 MJ/kg. It should be emphasized that with several biodiesel types, the data reported for heating values is very sparse. In addition, confusion between LHV and HHV is likely in several literature reports.

8. Flash point

Flash point is inversely related to fuel volatility. The biofuel specifications for flash point are meant to guard against contamination by highly volatile impurities – principally excess methanol remaining after product stripping processes. Of the 12 biodiesel materials investigated in this study, coconut-derived FAME showed the lowest inherent flash point, as expected, since its composition includes more light constituents (≤C12) than the other 11 FAMEs. Overall, our dataset does not indicate a high degree of correlation between flash point and any other property.

9. Conclusions

The heat in biofuel reduces compare using diesel fuel dependent of fuel constant and properties.

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