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Use of Raw Vegetable/Plant Oil or Animal Fats in Compression-Ignition Engines

In recent years, engine manufacturers have experienced an increasing number of owners and operators substituting raw or straight vegetable/plant oils, used cooking oil, and animal fats for "processed" biodiesel meeting established specifications in compression-ignition engines.[1] The U.S. Department of Energy (DOE) has stated that, "Raw or refined plant oil, or recycled greases that have not been processed into biodiesel, are not biodiesel and should be avoided."[2] Such unprocessed vegetable/plant oils, recycled greases, or animal fats – regardless of blend level – can have significant adverse effects when used in compression-ignition engines and should not be used to fuel them.

Raw, refined, and recycled vegetable/plant oils, greases, and animal fats have significantly different and widely varying properties that make them unacceptable for use in modern compression-ignition engines. The composition and characteristics of these oils, greases, and fats adversely affect the fuel delivery, combustion process and resulting engine performance and emissions levels. Incomplete combustion and excessive fuel condensation increase fuel dilution of engine lubricating oil, which can lead to sludge formation and diminished lubricating oil performance. The higher viscosity and chemical composition of unprocessed oils, greases, and fats also have been shown to cause a number of problems, including: (i) piston ring sticking; (ii) injector and combustion chamber deposits; (iii) fuel system deposits; (iv) reduced power; (v) reduced fuel economy; (vi) increased exhaust emissions; and (vii) reduced aftertreatment system performance and/or increased maintenance costs. The significantly higher viscosity of raw vegetable/plant oils (27-54 mm^2/s) compared to petroleum diesel fuel (1.3-4.1 mm^2/s) adds stress on fuel injection systems, particularly modern common rail systems that operate at significantly higher pressures.

In addition, unprocessed oils, greases, and fats experience significant degradation due to oxidation if stored for a period of more than approximately three to six months. Specifically, oxidation reactions in the storage or vehicle fuel tank lead to fuel system component degradation and sludge formation, which, in turn, can plug fuel filters and prevent fuel delivery to the engine's combustion chamber. This oxidation reaction is accelerated by exposure to heat, which can be due to high ambient temperature or fuel recirculation in the engine's fuel delivery system.

Use of unprocessed oils, greases, or fats may result in reduced engine life, increased maintenance costs, or catastrophic engine failure. The potential adverse effects of these oils, greases, and fats increase as fuel injection system pressure increases and sophisticated injection strategies become more prevalent. Moreover, the problems associated with their use, regardless of blend level, may not become evident until a significant amount of damage has occurred over an extended period.

In every case, owners and operators of compression ignition engines should refer to their engine manufacturer's fuel recommendations prior to making any decisions regarding use of an alternative fuel.

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[1] Biodiesel, or B100, is a term defined by the United States Department of Energy (DOE) as, "A biodegradable transportation fuel for use in diesel engines that is produced through the transesterfication of organically-derived oils or fats." ASTM International has adopted a "Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels" (D6751). Similarly, European Committee for Standards (CEN) has adopted "Automotive Fuels. Fatty Acid Methyl Esters (FAME). Requirements and Test Methods," EN 14214.

[2] Biodiesel Handling and Use Guide, (Fourth Edition). U.S. Department of Energy (Revised December 2009).