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May 31, 2006

Test Specifications for Biodiesel Fuel

These specifications for biodiesel were developed by EMA to identify a standard biodiesel blend fuel with consistent properties suitable to be used for testing and evaluation. The development and release of the specification does not imply or constitute any endorsement for use of B20 blends by EMA or its member companies. The specification is not an approved national fuel standard, and it should not be used as such. There are no quality or approval claims associated with any biodiesel blend fuel, including those that meet the test specification requirements identified by EMA.

In order to design and maintain their engines properly, EMA members and their customers require fuels having consistent properties. Thus, it is critical that fuel derived from a blend of petroleum diesel and biodiesel meet certain defined specifications when it is dispensed at the pump. In addition, such fuels should be monitored for changes in acid level, formation of solids, and microbial growth so that the extent, if any, to which the fuel blend has degraded during storage can be determined.

Engine manufacturers have limited data regarding the use of biodiesel with current engine technologies. Therefore, for the sole purpose of evaluating the performance of biodiesel fuels in compression ignition engines, EMA and its members have established specifications for the development of biodiesel blends, of up to 20% by volume (B20), which are made with biodiesel meeting either ASTM D6751 or EN 14214, and which also meet the requirements in Table 1 below. Fuel users are encouraged to require that biodiesel be obtained from sources known to produce quality fuels that meet those specifications. Petroleum diesel utilized in these biodiesel blends is generally expected to meet ASTM D975 standards. There may be exceptions, however, for sulfur and lubricity; provided those characteristics meet the specifications in the finished blend.

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A blend of petroleum diesel fuel meeting ASTM D975 and 100%(neat) biodiesel fuel meeting either ASTM 6751 or EN 14214, where the biodiesel content of the blended fuel is no more than 20% biodiesel by volume (B20), shall meet the requirements identified in Table 1 at the point of delivery of the fuel to the end user.

Table 1 Final Blend Fuel Requirements (at point of delivery)

Item	Performance Characteristics	Requirements		Test Procedure
		D1 Blends	D2 Blends	
1	Flash Point, °C, min.	38	52	ASTM D93
2	Water and sediment, vol %, max.	0.05	0.05	ASTM D2709 or D1796
3	Physical Distillation, T90, °C, max.	343	343	ASTM D86
4	Kinematic Viscosity, cSt@40C	1.3~ 4.1	1.9~4.1	ASTM D445
5	Ash, mass%, max.	0.01	0.01	ASTM D482
6	Sulfur, wt%, max.	Per regulation	Per regulation	
7	Copper strip corrosion rating, max.	No. 3	No. 3	ASTM D130
8	Cetane Number, min.	43	43	ASTM D613
9	Cloud point [1]	Per footnote	Per footnote	ASTM D2500
10	Ramsbottom carbon residue on 10% distillation residue, wt%, max.	0.15	0.35	ASTM D524
11	Lubricity, HFRR@60C, micron, max.	460	460	ASTM D 6079
12	Acid number, mg KOH/g, max.	0.3	0.3	ASTM D664
13	Phosphorus, wt%, max.	0.001	0.001	ASTM D4951
14	Total Glycerin	------	-----	N/A
15	Alkali metals (Na+K),ppm, max.	Nd	Nd	EN14108
16	Alkaline metals (Mg+Ca), ppm max.	Nd	Nd	EN14108
17	Blend fraction, vol. %[2]	+/- 2%	+/- 2%	EN14078
18	Thermo-oxidative Stability, insolubles, mg/100 mL, max.	10	10	Modified ASTM D2274[3]
19	Oxidation Stability, Induction time, hours, minimum	6	6	EN14112 (Rancimat)

[1] The maximum cloud point temperature shall be equal to or lower than the tenth percentile minimum ambient temperature in the geographical area and seasonal timeframe as defined by ASTM D975.

[2] Blend fraction refers to the variation in volume percent of B100 in diesel fuel claimed

[3] Use glass fiber filter

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Technical Justifications

D1 and D2 Blends – Both Number 1 and Number 2 petroleum diesel fuel ("D1" and "D2") may be blended with biodiesel for a variety of reasons, including the need for lower temperature operation. D1 and D2 may be blended with biodiesel independently or by using a previously blended D1/D2 petroleum fuel blend.

Flash Point – The flash point temperature is the minimum temperature at which the fuel will ignite (flash) on application of an ignition source under specified conditions. Flash point varies inversely with the fuel's volatility. Flash point minimum temperatures are required for proper safety and handling of fuels. Note that the biodiesel component must meet a flash point criteria, prior to blending, for the purpose of assuring that the biodiesel component does not contain methanol. It is not possible, however, to rely on the flash point of the blend for the same purpose inasmuch as the flash point of the petroleum component is much lower.

Water and Sediment – Fuel should be clear in appearance and free of water and sediment. The presence of these materials generally indicates poor fuel handling practices. Water and sediment can shorten filter life or plug fuel filters, which can lead to engine fuel starvation. In addition, water can promote fuel corrosion and microbial growth. The level of water specified is within the solubility level of water in fuel and, as such, does not represent free water. Limits are established to allow measured results to be compared to a maximum level acceptable for proper engine operation.

Physical Distillation – Distillation provides a measure of the temperature range over which a fuel volatizes or turns to a vapor. D1 typically has a greater volatility than D2; however, the inclusion of biodiesel at B20 blend levels results in comparable T90 temperature characteristics. Volatility directly affects the engine's ability to operate as intended. Biodiesel does not have a traditional petroleum distillation characteristic; however, the addition of biodiesel to petroleum diesel in a blend can result in an increase in T90 distillation temperature. Higher volatility, as represented by a lower T90 temperature, generally provides better engine performance, while lower volatility generally provides better fuel economy. The T90 temperature specified has been evaluated for engine performance with biodiesel blends, up to B20, where the petroleum diesel fuel utilized in the blend met the requirements of ASTM D975.

Kinematic Viscosity – Kinematic viscosity affects injector lubrication and fuel atomization. Biodiesel fuel blends generally have improved lubricity; however, their higher viscosity levels tend to form larger droplets on injection which, can cause poor combustion and increased exhaust smoke. The limits established provide an acceptable level of fuel system performance for D1 and D2 fuel blends.

Ash – Ash is a measure of the amount of metals contained in the fuel. Ash forming materials may be present in three forms: (i) abrasive solids, (ii) soluble metallic soaps, and (iii) residual biodiesel catalyst. Abrasive solids and biodiesel catalyst materials result in wear of fuel system and internal engine components exposed to fuel after injection. Metallic soaps can contribute to deposits in the fuel system. All ash forming compounds can contribute to the accumulation of materials on diesel particulate filters, requiring filter maintenance. The levels specified are

considered acceptable for engine performance; however, more stringent requirements may be necessary for optimal particulate filter maintenance intervals.

Sulfur – Sulfur levels in fuel are regulated by various governmental agencies to assure compatibility with emission standard requirements. In the United States there are currently three sulfur grades: S5000, S500, and S15, for both D1 and D2 petroleum diesel fuel. Biodiesel blends may not exceed the applicable maximum sulfur levels as defined for petroleum diesel.

Copper Strip Corrosion – The copper strip corrosion test indicates potential compatibility problems with fuel system components made of copper alloys such as brass and bronze. The limit specified is the same as that for petroleum diesel fuel.

Cetane Number – Cetane number is a measure of the fuel's ignition and combustion quality characteristics. Biodiesel blend stock typically has a higher minimum cetane level than that of petroleum diesel. Fuels with low cetane numbers will cause hard starting, rough operation, noise and increased smoke opacity. The level specified is consistent with EMA's requested increase in the minimum cetane number for petroleum diesel fuel.

Cloud Point – Cloud point is a test used to characterize the low temperature operability of diesel fuel. It defines the temperature at which a cloud or haze appears in the fuel under prescribed test conditions. The cloud point for biodiesel blends is generally higher than it is for petroleum diesel fuel. To avoid component precipitation in vehicle fuel tanks and blockage of fuel filters, the traditional blending practices for D1 and D2 for a given ambient temperature should be modified prior to blending with biodiesel. Alternative low temperature operability test methods such as Cold Filter Plugging Point (CFPP) and Low Temperature Flow Test may be agreed to between the supplier and the purchaser of the fuel.

Ramsbottom Carbon Residue – The Ramsbottom Carbon residue test is intended to provide some indication of the extent of carbon residue that results from the combustion of a fuel. The limit specified is the same as that for petroleum diesel fuel.

Lubricity – Lubricity is a measure of the fuel's ability to provide adequate lubrication of the components of the fuel system, including fuel pumps and injectors. The precision required in the manufacturing of these components and the significant influence of abnormal wear require that they be adequately protected from scuffing, scratching, wearing, etc. that may affect their fuel delivery characteristics. The level specified is consistent with that recommended by suppliers of fuel injection equipment for modern diesel engines.

Acid Number – Acid number is a measure of acids in the fuel. These acids emanate from two sources: (i) acids utilized in the production of the biodiesel that are not completely removed in the production process; and (ii) degradation by oxidation. For biodiesel blends the acid number will change as a result of the normal oxidation process over time. Once purchased, biodiesel fuel blends that will not be utilized immediately should be monitored for changes in acid number as an indicator of fuel degradation.

Phosphorus – Phosphorus has been shown to damage the ability of aftertreatment systems to reduce exhaust emissions as intended. The influence of phosphorus is cumulative; therefore, very low levels of contamination over the significant amount of fuel consumed by an engine may lead to unexpected deterioration of the aftertreatment system.

Total Glycerin – Glycerin is a byproduct of the production of biodiesel. If glycerin remains in the finished biodiesel, or biodiesel fuel blend, it can result in fuel separation, material incompatibility, engine deposits and engine durability concerns. In finished fuel blends, the ability to directly measure glycerin is compromised by interference with naturally occurring petroleum diesel fuel components. When an acceptable test method for Glycerin in a fuel blend is available, a limit value will be established.

Alkali Metals – Sodium and potassium are "alkali metals" utilized as catalysts in the production of biodiesel and should be removed through the biodiesel production process. Residual Alkali metals can form deposits in fuel injection system components and poison emission control aftertreatment systems.

Alkaline Metals – Magnesium and calcium are "alkaline metals" utilized as absorbents in the production of biodiesel and should be removed through the biodiesel production process. Residual Alkaline metals can form deposits in fuel injection system components and poison emission control aftertreatment systems.

Blend Fraction – It is important that the amount of biodiesel utilized in a given fuel blend be identified and uniform throughout the blend.

Stability:

From the time of production, biodiesel fuels are unstable due to the natural oxidation process. The process involves a free radical chain reaction that continues until the reactive molecular links or available oxygen are depleted. Peroxides (hydroperoxides) are reactive oxidizing agents formed during the first steps of fuel oxidation. At high concentration, peroxides or the free radicals formed can damage or degrade certain plastics and elastomers, particularly at higher temperatures. Subsequent steps in the oxidation process produce acids, gums, polymers, and other insoluables.

Thermo-oxidative Stability, Insolubles – Polymers and other insoluble materials that are formed during oxidation result in fuel filter blockage. Fuel that meets the specified limit at the time of retail sale is expected to provide six months of storage capability, depending on storage conditions, before degradation occurs. Fuel should be monitored to determine if degradation has taken place and necessary steps taken to avoid the use of degraded fuel. It is important to note that the test method utilized must be modified to use glass fiber filters to prevent degradation of the filter media by the biodiesel.

Oxidation Stability, Induction time – Historically, petroleum diesel fuels have exhibited extremely long storage stability periods. In some cases, the processing required to produce very low sulfur level petroleum diesel fuels has significantly reduced the stability of the petroleum fuel component in biodiesel blends. The test method utilized predicts the amount

of time that fuel can be stored before the production of acids indicates that the fuel is becoming unstable. Fuel that meets the specified limit at the time of retail sale is expected to provide six months of storage capability, depending on the storage conditions, before degradation occurs. Fuel should be monitored to determine if degradation has taken place and necessary steps taken to avoid the use of degraded fuel.

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