Director's Digest
FATS AND PROTEINS RESEARCH FOUNDATION, INC.

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Biodiesel Cold Flow Characteristics

Biodiesel has been criticized for having cold flow properties that are a deterrent to its use in cold climates. Feedstock sources containing a higher content of saturated fatty acids i.e. tallow has particularly been incriminated. Though cold flow properties are a concern, in reality it has been a concern for the years that diesel has been used as a fuel. Conventional diesel is typically produced through a refining and distillation process from crude petroleum oils. Crude oil contains the entire range of fuel components from methane and propane, to gasoline, to diesel fuel, to asphalt and other heavier components. The refining process separates the crude oil into components and mixtures of these components primarily on the basis of volatility. Diesel fuels are on the heavy end of a barrel of crude oil. This gives diesel its high BTU content and power but also gives it the property of gelling or becoming more viscous in cold weather. Even though biodiesel critics are always ready to point out this property it has always been a property and a problem with conventional diesel and diesel vehicle operation. In general No. 2 diesel fuel will develop low temperature problems sooner than No. 1 fuel. This is not an issue with gasoline.

As a result of this property and concern the oil industry has invested a tremendous amount of effort to understand and solve cold flow properties and low temperature operability. Testing procedures to characterize fuels have been developed. Most commonly cloud point, cold filter plugging point or the low temperature filterability test are used. Cloud point is the temperature at which small solid crystals are first visually observed as the fuel is cooled. Cold filter plugging point (CFPP) or low temperature filterability test (LTFT) are the temperatures at which a fuel will cause a fuel filter to plug due to fuel components which have begun to crystallize or gel. The CFPP is less conservative than cloud point and is most often considered to be a better, truer indicator of low temperature operability.

The petroleum industry and engine manufacturers have several recommendations for cold weather operability when using conventional diesel. The most common being the use of additives and the utilization of fuel tank, fuel filter and fuel line heaters. Suffice it to say that

these recommendations are also applicable to biodiesel. There have been similar research and demonstration attention given to cold flow properties of biodiesel. A rather extensive study conducted by the Institute of Gas Technology was previously reported in FPRF Directors Digest #295. The study involved a number of feedstock fuels and blends. A brief summary is as follows using only the certified petroleum diesel fuel (CPDF), soy oil (SME), inedible tallow (ITME), and high free fatty acid yellow grease (HYGME) as reference fuels made from the respective feedstocks.

	CTDF(#1)	SME	ITME	HYGME
Viscosity 100% biodiesel or Diesel	2.453	4.546	4.93	4.66
Viscosity 20% biodiesel blend	-	2.966	2.930	2.876
Viscosity 5% biodiesel blend	-	2.418	2.444	2.435
Viscosity 1% biodiesel blend	-	2.461	2.476	2.490
Pour Point °C 100% biodiesel or Diesel	-27	-4	15	-3
Pour Point °C 20% biodiesel blend	-	-18	9	-12
Pour Point °C 5% biodiesel blend	-	-21	-15	-18
Pour Point °C 1% biodiesel blend	-	-24	-24	-24
Cloud Point °C 100% biodiesel or Diesel	-18	3	16	8
Cloud Point °C 20% biodiesel blend	-	-17	-11	-14
Cloud Point °C 5% biodiesel blend	-	-19	-18	-20
Cloud Point °C 1% biodiesel blend	-	-21	-20	-21
Cold Filter Plugging 100%biodiesel or Diesel	-20	-2	10	1
Cold Filter Plugging 20% biodiesel blend	-	-17	-11	-14
Cold Filter Plugging 5% biodiesel blend	-	-19	-18	-19
Cold Filter Plugging 1% biodiesel blend	-	-21	-20	-20

Conclusions:

(1) The above test methods have end point temperatures recorded as °C. The methods have inherent variability of 2 to 4°C in their accuracy.

(2) The results indicate that biodiesel from all feedstocks used as a neat fuel have higher values than the control diesel used in this study. However #2 diesel would be expected to have values higher than the petroleum diesel tested.

(3) Biodiesel blends of 20% of soy oil and yellow grease sources are very comparable to that of the petroleum diesel for all properties.

(4) Biodiesel blends of 1 and 5% produced from all feedstocks have comparable temperature values and those values are equal or lower than that of the petroleum diesel for all properties.

(5) Though tallow sourced biodiesel have values higher than that obtained from other feedstocks, the low blend usage has minimal effects in the final fuel. Thus contrary to several inferences quality biodiesel can be produced from tallow as its primary feedstock.

Minnesota Test*

During the winter of 2001, a comparison was made from fuels supplied to Minnesota terminals to that of either 2% or 5% blends of biodiesel produced from either soy oil or yellow grease. The blends were obtained using both #1 and #2 low sulfur diesel fuel. The results are as follows:

	Low S Diesel #1	Low S Diesel #2	100% Soy	100% YG
Cloud Point °F	-54	4	32	48
Pour Point °F	-70	-30	25	45
Cold Filter Plugging Point °F	<-30	1	22	48

Blends in Low Sulfur Diesel #1

	2% Soy	2% YG	5% Soy	5% YG
Cloud Point °F	-45	-38	-32	-19
Pour Point °F	-60	-60	-55	-60
Cold Filter Plugging Point °F	<-30	<-30	<-30	-26

Blends in Low Sulfur Diesel #2

Cloud Point °F	6	6	8	9
Pour Point °F	-25	-25	-20	-20
Cold Filter Plugging Point °F	1	0	-1	1

Conclusions:

(1) The ASTM test methods used to develop the cold flow properties of the fuels and fuel blends are reported in °F. The repeatability is stated as 0.9°F for Cloud Point, 6.1 °F for Pour Point and 3.1°F for Cold Filter Plugging Point.

(2) The neat fuel comparisons (unblended) indicate improved low cold temperature tolerance for both the #1 and #2 diesel fuels compared to biodiesel from either feedstock. Soy based biodiesel showed greater tolerance in the neat form when compared to yellow grease. Neither feedstock was characterized as per their proximate analyses or fatty acid composition with in the report. Additives were not tested as being a part of diesel fuel.

(3) When used as 2% or 5% blends there were little differences detected within feedstock sources and no significant differences in pour point or cold filter plugging point values. *Conducted by Williams Laboratory Services, Kansas City, Missouri.