Renewable Lubricants, Inc.
Distributed By: DM's Bio-Based Fluid Supply Inc.
10 McEwan Dr. W, Unit 4B
Bolton, ON, Canada L7E 1H1
Voice: 905.951.1100 Fax: 905.951.2100
www.dmsbiobased.ca

Bio-Power™ Soy-Based Summer and Winter Diesel Fuel Conditioners and Biodiesel The Good, The Bad and The Additives

What is Biodiesel?

Biodiesel is a renewable fuel and is defined as 'fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats'. Generally, a fat or oil is reacted with an alcohol (typically methanol or ethanol) in the presence of a catalyst to produce the co-products glycerol and fatty acid (methyl or ethyl) esters. These esters are known as biodiesel.

The physical and chemical properties of biodiesel as related to the operation of compression ignition (diesel) engines are similar to petroleum based diesel fuels. Therefore, it can be used in diesel vehicles without expensive alterations to the engine or fuel infrastructure. In addition to being biodegradable and nontoxic, biodiesel is virtually sulfur and aromatics free and has a high cetane number. The lubricity of low sulfur and ultra-low sulfur fuels can be improved by adding as little as 0.25% biodiesel. Biodiesel also improves the conductivity of diesel fuels. With the introduction of ultra low sulfur fuels, which typically have conductivity readings below the recommended 50 picosiemens per meter, biodiesel could alleviate a potential safety issue by reducing the buildup of a static electrical charge.

The use of biodiesel is growing rapidly throughout the world, in part due to its positive environmental benefits and the opportunity to reduce dependence on oil. Legislation is pending in many countries to provide tax incentives for biodiesel production and its use.

B100 refers to the pure biodiesel. Although it contains no petroleum, biodiesel can be easily blended with petroleum fuels to create biodiesel blends. These blends are designated as Bxx, where 'xx' is the percentage of biodiesel in the blend. For example, a B20 blend is 20% biodiesel and 80% diesel fuel.

The ASTM specification for fuel grade biodiesel B100 to be used for blended fuels is ASTM D 6751. At this time, no specification exists in the United States for blends of biodiesel, although the ASTM Biodiesel Task Force is in the process of developing

a specification for biodiesel blends greater than B5. In the European Union, Standard prEN 14214 (Standard Specification for Biodiesel Fuel B100 or as Blend Stock for Distillate Fuels) is being developed. Specifications are also under review in Canada, Australia, India, and Brazil, as well as other countries. Biodiesels that have not been esterified may not meet these specifications.

Engines run with biodiesel and biodiesel blends emit substantially lower emissions than engines run with conventional diesel fuels. The reduced emissions include lower levels of hydrocarbons, particulate matter, soot, carbon monoxide and carbon dioxide. There is the potential for slightly

increased levels of nitrogen oxides (NOx), but the amount of increase is related to the engine design, duty cycle of the engine and the feedstock of the biodiesel.

Biodiesel is an alternative fuel that has fully completed the health effects testing requirements of the 1990 Clean Air Act Amendments. These testing protocols include the most stringent testing for environmental and human health effects ever required for certification of fuels and fuel additives in the United States. Due to its alternative fuel status, regulated fleets in the United States can earn Energy Policy Act (EPact) credits by operating on B20 blends.

Biodiesel Feedstocks

The most common feedstocks for biodiesel are soybeans (in the US, Canada and Brazil) and rapeseed or canola (in Europe and Canada). However, biodiesel can be made from a wide variety of seeds and animal fats. Palm and coconut oils are common feedstocks of choice in the Far East and jatropha seed is used in India. The use of recycled cooking oils from restaurants is growing rapidly due to the environmental benefit and the potentially lower cost.

The oils used to manufacture biodiesel are comprised of saturated, monounsaturated and polyunsaturated fats. The chemical makeup of the various oils affects the performance of the biodiesel. For example, biodiesels that contain high levels of saturates are poorer for cold weather operability, have higher cetane numbers, lower NO_x emissions and better oxidative or storage stability. Base biodiesels containing higher amounts of polyunsaturates have better low temperature operability, lower cetane numbers, higher NO_x emissions and reduced oxidative stability. Figure 1 summarizes the characteristics of the fats in biodiesel that can affect the engine's performance, long term storage stability of the fuel and cold weather operability.

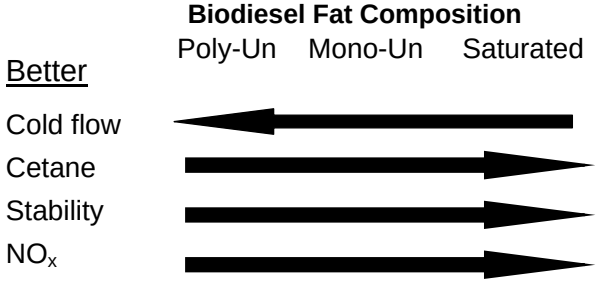

Figure 1. Feedstock Impacts Performance

Additives Improve Biodiesel

Despite the many positive aspects of biodiesel, there can be issues when the fuel is used. Fortunately, additives are available to overcome these obstacles. Bio-Power™ Summer and Winter are multifunctional diesel fuel conditioners that contain anticorrosion, antioxidants, lubricity and cleanliness additives. Bio-Power™ Winter contains additional cold weather performance additives.

Water Retention

Biodiesel and biodiesel blended fuels typically retain more water than diesel fuel. Excessive water can increase fuel degradation and cause corrosion in the fuel tanks and the engine fuel systems. The tendency for fuel filter plugging may increase. To separate water out of the fuel, Bio-Power™ Summer and Winter Diesel fuel conditioners can be added. Demulsifiers or dehazers contained in these additive packages are designed to separate out the water, thus reducing the potential for corrosion and fuel filter plugging.

Injector Deposits

Conflicting data exists in regards to whether or not injector deposits increase with the use of biodiesel and biodiesel blended fuels. Many fleets are running biodiesel and reporting no problems while other fleets may note increased injector deposits. The biodiesel feedstock, engine and engine duty cycle can all play a role in the amount of injector deposits formed.

Testing documented by the National Biodiesel Board on their website http://www.nbb.org showed injector deposits increased in testing done with SME (soy methyl ester) biodiesel in the Cummins L10 Injector Depositing Test (L10-IDT). Adding a multi-functional fuel additive reduced the amount of injector deposits to the base diesel fuel level.

Tests have been conducted in the Peugeot XUD-9 Deposit Tests with RME (rapeseed methyl ester) and SME biodiesels and biodiesel blends. All testing showed injector flow improvement when biodiesel or biodiesel blended fuels were run. The amount of improvement varied somewhat with the feedstock of the biodiesel and the amount of biodiesel in the blend. Adding Bio-Power™ to the fuels significantly improved the injector flow on straight #2 diesel, B100, and biodiesel blends. The testing run with RME is

summarized in Figure 2. A flow rating greater than 15% is required to meet a pass rating on this test.

For additional info on Bio-Power™ injector clean up and keep clean in Cummins L10 and Peugeot XUD-9, contact Renewable Lubricants, Inc. to request "World Class Performance with Bio-Power™ Multi-Functional Diesel Fuel Conditioner".

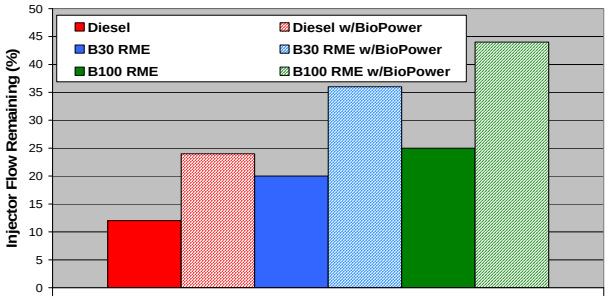

Figure 2. Peugeot XUD-9 Tests with RME

Cold Weather Performance

All biodiesels are not created equal in regards to cold weather operability. As with diesel fuels, biodiesel and biodiesel blends can gel as the ambient temperatures drop. The higher the percentage of biodiesel in the blend, the poorer the low temperature properties. Biodiesel blends of B5 or less typically exhibit similar cold weather performance to the base diesel fuel. Biodiesels with a higher saturated fatty ester content will exhibit wax crystal formation and begin to gel at significantly higher temperatures than those containing higher amounts of unsaturated fatty esters. Therefore, biodiesels made from rapeseed have better low temperature properties than those made from soy beans. Biodiesels made from palm and coconut oils have very poor cold weather operability.

Traditionally, kerosene or #1 diesel fuel has been used to lower the gelling point of diesel fuels. This approach is also effective with biodiesel blended fuels. Bio-Power™ Winter will improve the cold weather performance of biodiesel and its blends. The use of Bio-Power™ Winter can be more cost effective than blending with kerosene. Engine power losses and lubricity reduction associated with kerosene blending are also avoided.

Oxidative or Storage Stability

Biodiesel and its blends are very susceptible to oxidation. As the fuel ages, the biodiesel breaks down to release low molecular weight acids and peroxides. The extra water retained by biodiesel further accelerates the fuel degradation. Aged biodiesel can cause fuel filter plugging, deposit formation in the fuel system and engine, component corrosion and seal degradation. Biodiesels containing high levels of polyunsaturated fats tend to have poorer overall storage stability.

Much effort has been expended throughout the industry to develop a quick bench test that duplicates the storage stability issues of biodiesel and blends experienced in the field. In Europe, the Rancimat Test (ISO 6886 Oil Stability Index) is incorporated into the biodiesel specification. In the US, the ASTM Oxidative Stability Task Force is investigating a modified version of ASTM D2274 (Oxidation Stability of Distillate Fuel Oil) using glass fiber filters and testing for viscosity and acid number increases on the test drain. As biodiesel oxidizes, the viscosity and acid number will increase. Industry data is being gathered on both test methods to determine their applicability to the field.

The addition of Bio-Power™ to biodiesel and biodiesel blends can minimize the oxidation of these fuels. In both the Rancimat and the modified D2274 tests, adding Bio-Power™ significantly improved the oxidative stability of the biodiesel blends with a considerable reduction in insolubles. The data from the modified ASTM D2274 testing is summarized in Figure 3.

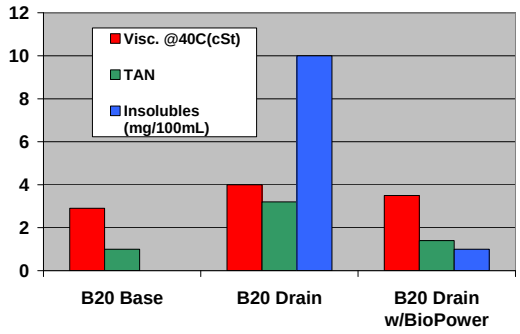

Figure 3. Reduced Insolubles, Viscosity and TAN from Modified D2274 Test

Conclusions-

The use of biodiesel to power diesel engines is growing rapidly throughout the world, due to its positive environmental benefits and the opportunity to reduce dependence on oil. Numerous countries are proposing legislation offering tax incentives for biodiesel production and use. Some legislation proposes mandatory levels of biodiesel in diesel fuels.

Biodiesel is manufactured from many feedstocks. The feedstock can affect the performance of the biodiesel in the engine, as well as the cold weather operability and the oxidative stability of the fuel. It is highly important to understand what feedstock is being used and that it meets ASTM Biofuel requirements. To help with any negative aspects associated with the use of biodiesel, use Bio-Power™ to significantly enhance the performance of biodiesel and biodiesel blended fuels.

Bio-Power™ has also shown proven performance in straight #1 and #2 diesel fuels.

Benefits of Bio-Power™:

- Provides superior rating level of injector cleanliness as shown by the Cummins L10 test
- Exceeds CSCA requirements for Peugeot XUD-9 injector cleanliness
- **Improves fuel economy (4.1% to 13.6%) and horsepower (up to 5.6%)**
- **Reduces exhaust emissions (up to 42% less black smoke) and reduces NO_x**
- Provides superior corrosion protection (Cummins N14 Corrosion/Erosion Test)
- Enhances fuel stability in storage and equipment
- Offers exceptional lubricity for reduced fuel system wear
- Reduces water entrainment & prevents varnish and sludge formation in fuel & fuel filter system
- Protects against low temperature gelling and icing (Bio-Power™ Winter)