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Biodiesel: Advantages and Potential Problems

The energy picture in the United States and worldwide is changing. Higher oil prices and environmental concerns are causing consumers to consider alternative sources of fuel. As they do this, biodiesel is gaining increasing prominence in the nations energy usage landscape. The name "biodiesel" refers to a ratio of treated vegetable oil or animal fat to diesel or heating fuel. For the purposes of this article, it will be referred to as vegetable oil. Soybean oil and rapeseed oil are the most common vegetable oils used to produce biodiesel.

Advantages

The major advantages of biodiesel are that the vegetable oil portion is a renewable energy source, that use of biodiesel will reduce dependence on foreign oil sources and, most importantly, will reduce emissions. EPA testing confirms that, depending on the percentage of vegetable oil in the fuel blend, biodiesel lowers carbon monoxide emissions by up to 48% and particulate matter emissions by up to 47%. In addition, sulfate emissions (from which sulfur dioxide and sulfuric acid can result) can be reduced by up to 100% from regular diesel fuel.

The rapid rise in biodiesel use can't help but be noticed – domestic biodiesel production in 2006 was estimated at between 200 and 250 million gallons, up from 75 million gallons just one year earlier. Major reasons for the increasing popularity of biodiesel include the implementation of a federal tax credit for fuel consumers using renewable fuels like biodiesel, and movement on the state level to use renewable fuels which reduce emissions and improve the air quality of urban areas within states that are in regular violation of the EPA's air quality standards (such as many areas of Texas). In a possible reflection of future trends, in late 2005, the State of Minnesota enacted a law that all diesel fuel sold in the state would be required to contain no less than 2% soy or vegetable oil (commonly known as a B2 blend.) If more states follow Minnesota's lead, the use of biodiesel will surely continue to expand.

Biodiesel Blends

The most common blends of biodiesel are B2, B5 and B20, which correspond to 2%, 5% and 20% vegetable oil concentration respectively. The vegetable oil for use in biodiesel is produced by a process called esterification through a batch to batch process, and each batch can vary in terms of quality. The oil from crushed soy beans is filtered and then reacted with sodium hydroxide (common lye). The product is then rinsed with alcohol and a finished product is produced which can be blended with #2 diesel fuel to produce biodiesel.

Nearly every Original Equipment Manufacturer (OEM) approves the use of up to B5, provided it meets the ASTM D6751 specification. In most cases, the industry believes that blends up to 20% (B20) will have no negative effects on performance. Most equipment manufacturers discourage the use of blends above 20% as the possible impacts on equipment and fuel systems has not to this point been fully evaluated.

Common Problems with Biodiesel

In spite of the higher price for biodiesel, almost everyone is touting its use. However, it is wise to consider that there are many documented problems with the use of biodiesel that you should be aware of. We will summarize the most common issues from this point on.

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Energy Value and Water Problems

Most concerning for the consumer concerned about fuel costs is that biodiesel, specifically B20, has only 117,000 BTUs of heat energy per gallon of fuel compared to 131,000 BTU per gallon of #2 diesel fuel. This is due to the fact that biodiesel is about 11 percent oxygen by weight, which does not contribute to the energy value of the fuel. Less energy value in the fuel means less mileage per gallon and less power - in over the road operation there can be both a loss of power (meaning the driver has to shift more often) and a decrease in miles per gallon of between 0.5 to 1.0 mile per gallon. For a truck which might only get 7-8 miles per gallon on #2 diesel fuel, this loss of mileage is significant.

Water contamination is also a significant problem for biodiesel users. Biodiesel fuel absorbs water and holds on to it, either in free form or in the form of a milky emulsion. In cold weather this water can form ice and cause operating problems. In emulsion form, the water can negatively affect the auto-ignition properties of the diesel fuel. In either form, it can promote the growth of bacteria and microbes. The bio-(vegetable oil) portion of the fuel is an excellent nutrient for slime and bacterial growths. Bacterial growths in biodiesel blossom very quickly and, if not controlled, can cause massive filter plugging. The microbial organisms also produce substances in the course of reproduction and respiration which can accelerate the decomposition of an already-fragile biodiesel blends.

Cold Flow Problems

The most common form of biodiesel, B20, does not flow very well in cold weather; at temperatures between 30 and 50 degrees F, it can form a thick and cloudy bio-mass. According to the National Biodiesel Board, B20 blends can raise the cold filter plug point value of the fuel by 10 degrees F. Due to this, some biodiesel suppliers do not recommend the fuels use during the winter months.

To compound the problem, biodiesel fuels seem to be more problematic for cold flow products than conventional diesel fuels. Due to the variance in specifications among biodiesel batches in the marketplace, cold flow improver effectiveness can vary. The type of feedstock which produced the biodiesel also impacts the cold flow properties of the fuel. Substances called monoglycerides can significantly raise the Cloud Point and Cold Filter Plug Point of a biodiesel. This is important because different feedstocks (soybean oil or palm oil or tallow, for example) produce differing amounts of different kinds of monoglycerides (saturated or unsaturated), which causes the biodiesel produced from them to respond differently to cold flow products. The monoglycerides produced from soybean and canola oils are less saturated and tend to have less of a negative effect on cold flow properties than those from palm oil or tallow (animal fats).

Most traditional cold flow and anti-gel additives do not improve the flow of B20 very well because they are designed to act upon paraffin wax crystals which exist naturally in petroleum; they are not designed to be effective on the components within the vegetable oil phase which cause gelling.

At Bell Performance, a dual-action cold flow improvement product for biodiesel called **Bio Dee-Zol Plus** has been developed to address biodiesel gelling problems. This product contains a constituent which controls wax formation from the diesel portion of the fuel and a viscosity modifier that improves the flow of the vegetable oil portion of biodiesel at low temperatures.

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Biodiesel Effects on Engine Lubricants

Biodiesel is less volatile than traditional petroleum diesel fuel. Due to the nature of the diesel combustion process (which relies on precise specifications for fuel volatility causing the fuel to combust at exactly the right time in the piston cycle), this means there is a greater chance for incomplete combustion of the fuel to occur. The non-combusted fuel can get past the engine piston rings and accumulate on the sides of the piston. This is then scraped down the side of the piston and accumulates in the crankcase oil sump, diluting the engine oil. This dilution increases the potential for serious problems developing with the crankcase oil in the form of adverse impacts on the oil's properties for preventing wear (due to changes in oil viscosity from dilution resulting in changed oil film thickness), corrosion (due to oxidative products being added to the oil from the biodiesel), oil degradation and engine deposits. Engine deposits and sludge can be increased by biodiesel oil dilution because the esters present in biodiesel can undergo reactions to polymerize (come together to form long molecules) and form sludge-like deposits in the oil. This can be especially problematic if this deposit-forming reaction occurs within the upper cylinder area, as this can lead to piston ring sticking, increasing the more serious problem of soot blow-by further contaminating the crankcase oil.

Quality Control Issues

Ease of manufacture has been both a blessing and a curse for the biodiesel industry. Almost anyone with the proper equipment can manufacture the fuel, but not everyone can or is willing to monitor their processes closely enough to ensure that the fuel produced meets specifications. As a result, there have been problems with out-of-spec biodiesel fuels reaching the market. A 2006 survey by the National Biodiesel Board of 200 different fuel batches found that 50% of them did not meet minimum specifications for quality. This minimum specification, ASTM D-6571, gives guidelines for biodiesel fuel parameters such as alcohol content and glycerin content, both of which can be met with proper quality controls in the manufacturing process. It is important to have fuel which meets these particular specifications in order to eliminate potential fuel-related issues. Contamination of the finished product with ingredients from the manufacturing process (such as methanol, glycerol or metallic soaps) can cause serious fuel system and injector problems. It is not uncommon to see cloudy product and oil which drops out of the biodiesel mixture (doesn't stay blended); when this happens, the oil will only re-dissolve when heated above 100 degrees (how will you do that?). Excessive alcohol content (from the methanol wash) is another common problem in out-of-spec biodiesel; excessive alcohol affects the auto-ignition temperature of the fuel and causes rough running in diesel engines. As a biodiesel user, it is important to ensure that the fuel you use is certified to meet the ASTM specification for biodiesel fuel.

Specifications for Biodiesel – ASTM D6751

Biodiesel is easier to manufacturer and produce than traditional fuels. While the advantage of this is obvious, the disadvantage is the danger of non-spec fuels reaching the marketplace. When this happens, large-scale problems are seen, such as the case in Minnesota in 2006, where the state temporarily rescinded its B2 mandate due to statewide incidences of engine problems caused by out-of-spec biodiesel fuel.

The official specification for biodiesel is ASTM D6751; this specification gives parameters and limits for important properties of the biodiesel which, if met, help ensure that the biodiesel may be used as a fuel without causing harm. It is important to distinguish that the D6751 standard specification applies to the vegetable oil portion of the fuel; if the vegetable oil to be blended meets the D6751 standard, then it is

assumed that blending it into diesel fuel will produce a biodiesel fuel which meets the separate D975 standard for diesel fuel.

As a user of biodiesel, it is important to understand the characteristics of biodiesel fuel and what they mean with respect of potential problems if the fuel does not meet a given specification in some way. Important characteristics of biodiesel which are covered by the D6751 standard include the following characteristics which are most closely influenced by a quality manufacturing process:

Acid Number

Acid number is an indicator of the acidic impurities and degradation of the fuel. Improper processing of the feedstock can lead to an elevated acid number, which can lead to accelerated oxidation and breakdown of the fuel.

Free and Total Glycerin

Glycerin is a by-product of the biodiesel production process and is related to amounts of unconverted or partially-converted fats and oils left over from the manufacturing process. If the Glycerin value is too high, it can lead to storage tank and fuel system filter plugging.

Oxidative Stability

Oxidative stability of the fuel is related partly to the Acid Number and is related to the presence of organic acids and polymers produced by the decomposition or oxidation of the fuel. The Oxidation Stability test is an accelerated test used to predict the fuel stability in long-term storage of up to six months. Fuels with lower Oxidative Stability numbers will decompose and oxidize to a greater extent over time.

Bell Performance would recommend that any customer purchasing biodiesel fuel obtain Specification certificates for the biodiesel certifying that the fuel meets the entire D6751 standard. Biodiesel producers who are BQ-9000 certified are most likely to consistently meet this standard. A list of BQ-9000 fuel producers can be obtained from the National Biodiesel Board by going to their web site at www.nbb.org.

Materials Compatibility

The compatibility of biodiesel with various seal and hose materials is another issue of concern. Some o-rings, seals and gasket materials can be negatively affected by biodiesel, while various hose materials used to dispense biodiesel are sometimes softened and have failed when in contact with the fuels. Natural or nitrile rubber compounds, polypropylene, polyvinyl and Tygon materials are particularly vulnerable. On the bright side, many elastomers produced after 1993, including Teflon, Viton and Nylon, have very little reaction to biodiesel. Biodiesel is also incompatible with certain metals like copper, lead, bronze, tin and zinc but works well with aluminum, steel and most types of fiberglass.

Other Problems

Biodiesel is known to act as a detergent when first introduced into existing storage tanks. It will disperse any old sludge that has settled to the bottom of the tank leading to massive filter plugging problems if the user is unprepared. This problem occurs during the first few loads of switching to biodiesel. Therefore it is advisable to have extra filters on hand during the initial introduction of biodiesel to a new system.

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Biodiesel degrades about four times faster than diesel fuel or heating oil. In the presence of even small amounts of water, pure biodiesel degrades 80-85% faster than pure diesel fuel alone. Blending biodiesel with other fuels accelerates its bio-degradability; blending 20% oil with 80% diesel or home heating fuel creates a blend which breaks down twice as fast as #2 diesel alone. This aging can be predicted by having an ASTM aging test performed on the fuel. Destabilized biodiesel fuel turns thick, darkens in color and plugs fuel filters. Having seen this problem repeatedly, Bell Performance has developed a Fuel Storage Stabilizer that greatly reduces the aging of biofuels and biodiesel.

Finally, many Biodiesel users have problems when they do their own blending of vegetable oil and diesel fuel. Users have found that the bio- portion they are adding to a tank of #2 diesel or home heating oil must be added on top of the regular fuel to assure good mixing. This type of "splash blending" takes advantage of the difference in the weight per gallon, as vegetable oil is heavier than diesel fuel.

As with anything new, we tend to hear all of the good things about a newer product – why it is good for the economy, the environmental benefits, etc. We at Bell Performance feel that if we take the experience of our customers and combine them with laboratory and field experiences to make you aware of potential problems, everyone can be better prepared.

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