National Biodiesel Board Guidance, Issued November 30, 2005

Use of Biodiesel Blends above 20% Biodiesel

Background: Due to the renewable, domestic, and clean burning attributes of biodiesel there is interest by some individual users and fleets that use diesel fuel to utilize blends of biodiesel above 20 percent by volume (B20), up to and including pure biodiesel (B100). The recent rise in petrodiesel prices has resulted in some situations where the price of biodiesel is lower than that of petrodiesel, and this has provided an additional incentive for the use of blends higher than B20.

Current Situation: The American Society of Testing and Materials (ASTM) has approved a standard for pure biodiesel when used in blends at 20% by volume (B20) or lower: ASTM D6751 Standard Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels. This is a consensus standard, developed in cooperation with vehicle, engine, and fuel injection equipment companies; petrodiesel and biodiesel producers and distributors; and state and federal regulators and third parties through the ASTM standard development process.

Due to concerns of the US engine and fuel injection equipment manufacturers regarding influence of biodiesel fuels on cold flow properties, material compatibility, maintenance intervals, fuel stability, biological growth, energy content, and emissions influence with higher concentration blends, the ASTM standard has only been approved for blends of biodiesel of B20 and lower. D6751 states the following:

"A considerable amount of experience exists in the U.S. with a 20 % blend of biodiesel, primarily produced from soybean oil, with 80 % diesel fuel (B20). Experience with biodiesel produced from animal fat and other oils is similar. Although biodiesel (B100) can be used, blends of over 20 % biodiesel with diesel fuel (B20) should be evaluated on a case by case basis until further experience is available."

B20 has been used in vehicles that have been driven over 50 million miles, and has proven to be a practical fuel that can be used in any diesel engine with few precautions or changes compared to the use of petrodiesel. The National Biodiesel Board and the diesel engine, fuel injection, and vehicle companies have formed the B20 Fleet Evaluation Team (B20 FET) to develop an informed, fact-based position on the use of B20. Based on the available field experience the B20 FET has developed a set of recommendations for users of B20 titled, **"Technical Recommendations for B20 Fleet Use Based on Existing Data",** which describes specific advice for users of B20. The recommendations can be downloaded at: (http://www.biodiesel.org/buyingbiodiesel/guide/B20_Fleet_Recommendations.pdf).

Most auto, engine, and fuel injection equipment companies doing business in the US strongly discourage the use of blends over B20 due to the impacts of higher blends on equipment and fuel systems which have not been thoroughly tested with these high blends, and the higher likelihood of known problems or issues with high blends that are not present or are of lesser importance when using B20 or lower blends. Blends higher than B20 can not be considered a direct replacement for petroleum diesel fuel and may require significant additional precautions, handling, and maintenance considerations as well as potential fuel system and engine modification. Problems specifically caused by any fuel, including biodiesel or biodiesel blends, are not considered manufacturing defects and generally will not be covered by any engine or fuel injection equipment manufacturer's warranty.

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The following is a summary of the known concerns and issues with blends over B20:

1. The ASTM specification for pure biodiesel was approved only for blends up to B20, not for higher blends. There may need to be additional specifications, or different values of existing specifications, that are necessary if blends higher than B20 are used to assure satisfactory long term engine performance.

2. Cold flow properties: When biodiesel made from soybean oil is blended at 2% by volume with average No. 2 petrodiesel, the cold flow properties of the finished B2 blend are similar to those of the petrodiesel alone. With B20, the cold flow properties of the blend can be 3-10 degrees F higher than average No. 2. There can be more biodiesel impact when using biodiesel from different feedstocks or with lower gelling diesel fuel. In some cases, the increased gel temperature of B20 is within the variability seen with petrodiesel from supplier to supplier and no further precautions are needed in cold weather but it is always good to measure the cold flow properties of a biodiesel blend to insure it will perform adequately for the geography and climate the fuel will be used in. As biodiesel components greater than B20 are added, the cold flow properties become more like the B100. B100 made from soybean oil typically starts to gel around 32 degrees Fahrenheit or higher, with high biodiesel blends being more similar to B100 than the petrodiesel. Great care must be taken to be sure the blend will not gel and clog fuel filters in cold conditions (climate or altitude). This is especially a concern for someone who may be using a high blend of biodiesel in the warm conditions and precautions are not taken before colder conditions are encountered. See the appendix in the ASTM standard for diesel fuel, ASTM D 975, for useful guidelines on cold flow temperatures for various parts of the USA by month.

3. Materials compatibility: B100 will soften and degrade certain types of elastomers and rubber compounds over time. Using high percent blends can impact fuel system components (primarily fuel hoses and fuel pump seals) that contain compounds incompatible with B100. Manufacturers recommend that natural or butyl rubbers not be allowed to come in contact with pure biodiesel or biodiesel blends higher than B20. Over the past 15 years of use, blends of B20 or lower have not exhibited problematic elastomer degradation and no changes are recommended. If a fuel system does contain these materials and users wish to fuel with blends over B20, replacement with compatible elastomers is needed. In many instances, especially with older equipment, the exact composition of elastomers can not be obtained and it is recommended they be replaced if using blends over B20.

4. Cleaning effect of B100 and high blends: In some cases the use of petrodiesel, especially #2 petrodiesel, leaves a deposit in the bottom of fuel lines, tanks, and delivery systems over years of time. Biodiesel acts as a cleaning agent and can dissolve these sediments and result in fuel filter becoming clogged and the need to change filters more frequently until the whole system has been cleaned of the sediments left by the petrodiesel. This phenomenon has not been observed with B5 and lower blends, and occurs when first using B20 in about 2% of the cases, requiring 2 or 3 additional filter changes when first using the fuel. The cleaning effect of B20 and lower blends appears to increase the need for filter changes only with systems that have significant amounts of sediment.

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Although experience is limited, with higher blend levels than B20 if any sediment is present it is brought up quickly and clogs filters immediately. The engine may be starved for fuel and stall. If the filter ruptures, this can cause a significant amount of debris and sediment to move into fuel lines, pumps and injectors resulting in an expensive repair that is not covered by warranty as the problem is not caused by an equipment defect but a ruptured fuel filter.

5. Fuel stability: Industry experts recommend that biodiesel be used within six months of manufacture to ensure that the quality of the fuel is maintained. Fuel degradation pathways for biodiesel are more likely with higher concentration blends due the higher presence of the biodiesel, so stability concerns and issues (fuel system deposits, clogged filters, etc.) are likely to be higher and may occur faster as the blend level is increased. There have been very few field reports of stability related problems with B20 and lower blends in the US when the biodiesel meets D6751 prior to blending and the fuel is used within six months.

6. Energy Content: B100 on average has 7-9% lower energy content (BTU per gallon) than average #2 diesel fuel. Conventional diesel engines convert the energy in biodiesel into work with the same efficiency as petrodiesel, so impacts on fuel economy, peak horsepower and peak torque are all directly related to the energy content of biodiesel. The energy content of conventional diesel fuel can vary over 15% from supplier to supplier or from summer to winter. On average, B20 will decrease BTU content 1-2% vs. petrodiesel, and BTU changes with B2 are imperceptible. While BTU changes of 1-2% can be picked up in lab tests for horsepower, torque, and fuel economy normal variability in the field make it very difficult to detect any impact with B20 and lower blends for these parameters. Some fleets have even shown fuel economy increases with B20, although this is unexpected based on the BTU content. With blends higher than B20, the impact on power or fuel economy may be great enough it will become noticeable by the user and the penalty in fuel economy may offset any fuel cost reduction.

7. Engine Oil Dilution: Blends higher than B20 may cause a larger amount of unburned fuel to make its way past the piston rings and into the oil pan. This is due to the slightly higher viscosity and the slightly higher density of biodiesel vs. petrodiesel. High levels of biodiesel present in the engine oil may polymerize over time and cause serious engine oil sludge problems. Engine oil change intervals may need to be shortened significantly if using high blends of biodiesel. The viscosity and density of B20 and lower blends are very similar to that of the pure petrodiesel, and this phenomenon has not been problematic with blends of B20 or lower so no changes in engine oil intervals are needed with B20 or lower.

If users take into account all the precautions and conditions mentioned above, then it may be possible to run blends higher than B20 in existing diesel engines and have a successful experience. Blends higher than B20 do require these precautions, however, and should not be considered a ‘drop in’ substitute for petrodiesel without taking them into account.

More information can be found at website for the National Biodiesel Board (http://www.biodiesel.org/), and in “2004 Biodiesel Handling and Use Guidelines,” available at http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/tp36182.pdf.