BCTransit

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biodiesel

BLENDING GUIDE

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B100 Procurement

Biodiesel used in BC Transit vehicles must be produced by a BQ-9000 accredited manufacturer.

BQ-9000 is a quality standards organization which certifies producers and marketers are adhering to specified quality assurance standards and procedures.

The biodiesel product must meet all the criteria of the latest version of ASTM D6751, Standard Specification for Biodiesel Fuel Blend Stock (B100) for Distillate Fuels. This standard identifies the parameters the pure biodiesel (B100) must meet before being blended with petroleum diesel. When blending pure biodiesel with pure petroleum diesel the terminology "neat" may be used. The term "neat" refers to the pure fuel. When purchasing biodiesel, the term "B99" may be used. This is more correctly a B99.9 biodiesel blend whereby a small amount of diesel has been added to the biodiesel in order to capture the Blender's Credit in the USA.

The user should acquire and become familiar with the complete D 6751 standard. It can be purchased from the ASTM Web site: www.astm.org.

Each shipment of B100 should be delivered with a Certificate of Analysis (COA) and a current Material Safety Data Sheet (MSDS). In most cases, the carrier will already have an MSDS. In the event the carrier does not, the fuel producer must provide one. Actual test results (as opposed to typical values) should be requested for the COA accompanying each shipment. If the suppliers do not guarantee that the values are "actuals" it is recommended to not purchase from them and only purchase from those which do furnish actual results for the COA shipment being purchased.

A purchaser should retain a sample of biodiesel from the shipment in the event a dispute concerning product quality arises.

This protocol is covered in the BQ-9000 Quality Assurance Accreditation Program. Refer to: **www.BQ-9000.org** for further details. It should be noted however, that BQ-9000 does allow for decreased testing frequency for metals (calcium + magnesium and sodium + potassium).

It is recommended that you request the metals analysis on every COA. In addition, it is strongly suggested that the Cold Soak Filtration test is on all COAs on every batch as well. The Cold

Soak Filtration test will be in the next revision of D6751 which is anticipated in late 2008. The impurities which result in failures in the Cold Soak Filtration test are known to potentially plug filters and result in operability issues.

Biodiesel Blending

This section outlines best practices to ensure biodiesel blends meet operational requirements. Factors to be considered include the cloud point of both the biodiesel and petroleum diesel and the method used to blend the fuels: either in-line blending or splash blending.

Cloud Point and Biodiesel Blending

Cold weather operability is one of the biggest concerns in Canada when considering B20 blends. Blends below B20 are less of a concern, although the cloud-point of the blended fuel should still be verified that it meets the Canadian General Standards Board (CGSB) percentile temperature for the season and region of use.

Blending biodiesel with petroleum diesel may lower the low temperature operability of the fuel. Thus, the petroleum diesel used in the blend may need to be produced with a slightly lower (colder) cloud point to accommodate the biodiesel blend.

When biodiesel is blended with petroleum diesel, the cloud point of the diesel fuel, and the cloud point of the biodiesel are the two most important properties. The blended fuel must still meet the CGSB seasonal temperatures for cloud point for the region the fuel is being used.

If blending is done into seasonal diesel it must be done such that the seasonal cloud point temperatures are maintained. Therefore the cloud point of the biodiesel and the cloud point of the petroleum diesel must be known. This may in some cases, govern the blend level of the biodiesel blend.

Operators who blend even low percentages of biodiesel with seasonal diesel in the winter or shoulder seasons, risk having operational issues due to the raised cloud point. Therefore, it is important to know the cloud point of the diesel used for blending, the biodiesel intended for blending and the regional seasonal cloud point for the biodiesel blend.

Blending of biodiesel blends without knowing the cloud points of the fuels being blended is not recommended.

The spreadsheet "BC Estimated Cloud Point Warming for Biodiesel Blends" available to BC Transit operators will provide guidance. The temperatures for the various regions in BC for each month are taken from the "Canadian Monthly Design Temperature maps (2.5% Low End)" temperature maps. However, periodic verification through cloud point testing should be done to verify this as it is a guide only.

The "Canadian Monthly Design Temperature maps (2.5% Low End)" prepared for the CGSB by Environment Canada is intended to provide guidance, based on historical temperature data for various regions in Canada, for operability and storage of petroleum fuels. This also applies to biodiesel blends.

B100 and In-line Blending

In-Line Blending consists of two storage tanks, one with petroleum diesel and the other with biodiesel. The delivery hose or pipe contains a mixing valve which is preset to dynamically mix the two fuels at a specified ratio. This is the best way to mix petroleum diesel and biodiesel.

To determine in-line blending temperatures, a *Biodiesel Cold Weather Blending Study* was undertaken. Biodiesel derived from various feedstocks; (soy, yellow grease and tallow) was tested with #1 and seasonal diesel. The cloud points of the biodiesel fuels were 0C, 6C, and 14C respectively. The blending temperatures were conducted at -12C, -18C and -23C. The purpose of the study was to come up with in-line blending temperature recommendations.

The *Biodiesel Cold Weather Blending Study* Internet link is: **http://www.biodiesel.org/resources/reportsdatabase/reports/gen/20050728_gen-354.pdf**

There were soy derived, canola derived and tallow derived biodiesel fuels included in this study. To avoid shock crystallization, it was determined that the recommended temperature for the biodiesel to be blended with cold diesel is a minimum of 10 F (6C) above the actual cloud point of the biodiesel being used for in-line blending.

Since Soy based methyl esters (ME), Yellow Grease based methyl esters (ME) and Tallow based methyl esters (ME) each have different cloud points, the target temperature will need to be determined on an individual basis. It will be important for blenders to request the cloud point (CP) from suppliers for cold weather considerations. It should be noted that even with in-line blending it is recommended that the B100 storage be 16 – 18 C in temperatures when the diesel is at 8 C or colder.

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B100 and Splash Blending

Splash Blending occurs when biodiesel is pumped into a delivery truck already containing petroleum diesel. The process of loading, travel and unloading into the customer's fuel storage tank is the blending mechanism.

Fueling a bus with biodiesel.

B100 and Blending for Splash Blending

Splash Blending happens when biodiesel is pumped into a delivery truck already containing petroleum diesel. The process of loading, travel and unloading into the customer's fuel storage tank is the blending mechanism.

For splash blending the rule of thumb for B100 storage and blending temperature is 18-20 C when the diesel (or ambient temperature) is 8 C or colder. This is because there is more surface contact with the colder petroleum diesel relative to the smaller point of contact with in-line blending.

There has not been a study to determine the optimum temperature for B100 storage and for splash blending. It is important to keep storage of the B100 at an optimum storage temperature for handling without heating unnecessarily in order to effectively manage utility costs.

It is also important to know the optimum temperature or temperature differential between the petroleum diesel and the biodiesel in order to ensure effective mixing in splash blending. This will be dependent upon the cloud point temperatures of the two fuels and also on the blend level of the biodiesel blend. When the biodiesel being blended is tallow derived with a cloud point of 15 C or warmer, a B100 temperature prior to blending of 20 – 22 C is recommended.

For high blends of biodiesel such as B20, bottom loading is recommended.

The reason is that the biodiesel is dispersed into the petroleum diesel and dispersed upwards and the chances of the biodiesel making contact with the cold steel of the tank are minimized. If the splash blending is done via top loading at blends as high as B20 during the winter months, the risk of monoglycerides coming out of solution is increased. If top loading splash blending is done for smaller blends B5 – B10 the biodiesel may blend properly with the petroleum diesel if the loading arm is positioned properly. However, in large blends such as B20 this will not be likely to occur.

Effective Splash Blending at levels above B10 is a challenge at the best of times. For top loading splash blending the contact of biodiesel into the petroleum diesel from the top loading arm is not achievable in blends higher than B10 unless a dip tube is employed.

The temperature of the petroleum diesel is not the key critical parameter when blending biodiesel. The key is that the biodiesel must be heated per the guidance above and blended in such a way as to facilitate rapid mixing.

For example, in the case of a B20 blend if blended with cold petroleum diesel, the velocity of the mixing and contact of the fuel in the blending process must be done such that the fuels are mixed when the biodiesel is added. If the warmed biodiesel is simply added on to of the cold petroleum diesel and not added with sufficient velocity to contact and properly mix with the petroleum diesel, proper blending will not occur.

Intermediate Blends

The practice of making "intermediate blends" is discouraged. In this case, the B100 biodiesel is blended with kerosene or diesel to make a B70 blend and then used as blend stock and blended down to the desired blend amount (i.e. B5, B10, etc.) the problem with this technique is primarily that if the 'intermediate blend" is done with cold biodiesel and cold diesel, any trace impurities in the biodiesel although within D 6751 specification, may come out of solution, which could lead to filter plugging. The secondary issue with this practice is if the diesel or kerosene is sufficiently different than the diesel that is used to make the final biodiesel blend, the aforementioned issues could arise, although for a different reason.

Shown here is a Nanaimo Regional Transit ad from 2007 promoting the use of biodiesel in their bus fleet.

Cold Flow Additives

Most reduce the crystal size or shape, or inhibit the agglomeration of crystals. As such, they tend to affect the pour point—ability of the fuel to flow—but have little effect on the cloud point, which is critical to most diesel engine operations. Most cold-flow additives for B100 that have been developed to date have had limited success, but work is ongoing. However, it must be emphasized that even if cold flow improvers have been used to facilitate handling, it is not a replacement for heating the B100 prior to blending.

It is not sufficient to just have the biodiesel be able to flow. It is critical that the biodiesel with a warmer cloud point relative to the biodiesel, be warmed sufficiently that when it is blended with the colder diesel that there is no shock crystallization, which otherwise may occur if the B100 is not heated.

Distribution Filters

The purpose of dispensing filters at filling stations in the past has been to catch particulates which are often in the form of rust from the distribution of the fuel through the pipeline of from the storage tank. The purpose of distribution filters should not be to catch fuel which is problematic. Some dispensing filters are 25 micron and others are 10 micron. As fuel filters in trucks range between 7 or 8 micron to as low as 2 micron it is suggested that 10 micron filters at the dispensing pump would be preferred. However, plugging of the 10 micron filters can become a high maintenance item. The filters should be analyzed and the reason for the pluggage of the filters determined. Moisture can often be the problem with pluggage of the smaller 10 micron filters. In this case, the cause of the moisture should be determined. A 25 micron filter can also be considered.

Storage Tank Maintenance

The desiccant filters on breathing vents should be checked monthly.

Tanks should be checked for water level using sticking paste monthly.

Excess water should be drained as required.

Storage Tank Considerations

Solvency/Cleaning Effect

Biodiesel is comprised of methyl esters. Methyl esters are mild solvents and have been used as low volatile organic-compound cleaners for years. Therefore, higher biodiesel blends may dissolve or dislodge the accumulated sediments in diesel storage tanks, pipes, fueling systems and engine fuel tanks. Dissolved or dislodged sediments can plug fuel filters and cause fuel injector failure. Existing tanks and transfer systems should be cleaned, dried, and inspected prior to introducing higher biodiesel blend into the tank. This solvency cleaning affect if it occurs should only occur when higher biodiesel blend is introduced into a storage tank which had previously been used for another service.

When changing service from a petroleum diesel tank service to a biodiesel blend for the first time, more frequent change of dispensing filters will likely occur.

If a tank has already been in service for biodiesel blends, but the percentage of biodiesel is being increased, this should not result in any change in dispensing filter change frequency.

Excess Air

As a fuel tank is emptied, air will enter through the vent pipes to displace the fuel in the tank. The excess air in the tank may lead to increased oxidation, particulate contamination, and increased water levels. These contaminants affect both the stability and quality of the fuel. In order to limit the effects of air in the tanks, it is recommended that fuel handlers do not store fuels for longer than six months in partially empty tanks without stabilizers. Additionally, desiccant filters on vents to reduce moisture and particulate contamination (dirt) are recommended.

Water Contamination

Biodiesel is slightly more susceptible to water-related problems than is conventional petroleum diesel, depending on the blend level. Desiccant filters on breathing vents will greatly reduce condensation in the tank and are highly recommended. Sump drains are recommended where practical. Both free and entrained water accelerate corrosion and fuel degradation. Free water may enter bulk fuel tanks via condensation, carry-over from the fuel distribution system or leakage through the fill cap, spill containment valve or piping. In addition to accelerated breakdown of the fuel product, water also creates a fertile growing environment for microbial contamination. Microbial activity, surfactants, alcohols, particulates, and poorly designed additives may be the cause of entrained water problems.

Poor tank design can make complete removal of water nearly impossible, and therefore, it is important to take steps to prevent water entrance. If you believe that your storage systems fall into this category contact a mechanical engineering company to determine a strategy that will optimize your storage tank.

Microbial Contamination

Biocides are recommended for conventional and biodiesel fuels wherever biological growth in the fuel has been a problem. If biological contamination is a problem, water and sediment contamination must be controlled. The preferred approach, however, is simply a good tank cleanliness program—keep the fuel clean and dry.

If regular maintenance to minimize water in the tank is practiced, microbial contamination should not be an issue. If black film is seen, or if when draining the tank an interface of black material is seen in the water or interface layer it should be analyzed for the possible presence of microbial contamination.

Tank Cleaning and Testing

Fuel tanks need to be thoroughly cleaned and tested on a scheduled basis. A full cleaning is recommended to establish a starting point. This involves the tank being emptied, cleaned of all sediment and inspected. If a full cleaning has occurred within two to three years, annual testing by a qualified fuel tank cleaning service is sufficient. In addition, regular monthly testing for water is necessary. If water is detected, it should be reported to the tank cleaning service and appropriate action taken.

Summary of Key Points for Biodiesel Receipts

1. **Insist the biodiesel be produced by a BQ-9000 accredited manufacturer.**
2. **Insist on a COA for all shipments received and request that all results are actual results from that tank or batch and are not "typicals".** If the suppliers do not guarantee that the values are "actuals" it is recommended to not purchase from them and only purchase from those which do furnish actual results for the COA shipment being purchased.
3. **Insist on the Cold Soak Filtration test in addition to the D 6751 full test results.**
4. **Know the cloud point of the B100 biodiesel received.**
5. **Know the cloud point of the diesel which will be used to make the biodiesel blend.**
6. **Know the seasonal cloud point for the region for the biodiesel blend being used during the time period.**
7. **Be sure that the cloud point of the biodiesel blend will meet the Can/CGSB-3.520 cloud point specifications for the region and period of use.**
8. **Be sure that the oxidation stability by Rancimat is 3 hours or greater at the time of blending.** If the COA has a result of 3 hours at time of production, there is little chance that it will be 3 hours at the time of blending. The minimum limit in D 6751 is 3 hours. However, D 6751 is a blend stock specification, and the limits are intended for at the time of blending.
9. **Know the acid number level of your biodiesel.** In general, the lower the level of saturation—less compounds containing double bonds—the more likely the fuel will oxidize. Tallow-derived biodiesel has the least number of double bonds, followed by soy- and then canola-derived biodiesel fuels. However, that the saturation level of the biodiesel is not the only indicator of acid number or oxidation stability. That is why acid number is important. The acid number and specification is on the COA.
10. **Do not store B100 in clear or translucent plastic totes in the summer.** Heat and sunlight accelerate the oxidation process.
11. **Do not store B100 for long periods in systems containing reactive metals.** Certain metals such as copper, brass, bronze, lead, tin, and zinc will accelerate the degradation process and form even higher levels of sediment than would be formed otherwise. Metal chelating additives may reduce the negative impact of the presence of these metals.
12. **Keep oxygen away from fuel.** By limiting the fuel's exposure to oxygen, the risk of fuel oxidation is greatly reduced or eliminated. This increases the storage life of the biodiesel.
13. **Keep moisture away from the fuel.**

Summary of Key Points for Blending

1. **Biodiesel is heavier than diesel fuel.** Biodiesel has a density of 0.88 compared to seasonal diesel at 0.85 and No. 1 diesel at 0.82. Therefore, it is recommended that the generic distillate fuel—diesel fuel, kerosene or heating oil—be in the tank prior to introducing the biodiesel portion. When splash blending, biodiesel should be blended into the petroleum diesel. This is critical in winter months. If the biodiesel is added first to a cold vessel it will result in formation of solid at worst and poor mixing at best.

2. **Biodiesel has a higher cloud point—relative to petroleum diesels.** Depending on the outside temperature, to ensure flow, it may be necessary to heat the biodiesel prior to the introduction to the generic distillate portion of the blend. For up to B5 blends the biodiesel temperature of 16 – 18 C has been found to be satisfactory for in-line blending, 18 – 20 C for splash blending, and 20 – 22 C for tallow based biodiesel. Splash blending at levels above B5 into cold petroleum diesel can be problematic unless thorough blending is initially achieved.

3. **Blends will not separate in the presence of water.** However, execute proactive tank management to prevent other problems caused by free water.

4. **Only use fuels that meet CGSB specifications, CAN/CGSB-3.520 Biodiesel B1-B5 Standard for Biodiesel and CAN/CGSB 3.517 for Automotive Low Sulphur Diesel Fuel for generic diesel.** Specifications for B6 and above are under development at CGSB and have recently passed at ASTM.

5. **Know absolutely the cloud point of your generic diesel fuel product prior to blending it into the biodiesel.** This will tell you what the inclusion of your specified blend of biodiesel will do to these key winter operability characteristics post-blending. If you start with the wrong fuel for the seasonal low temperature operability weather specifications, you will end up with an inferior biodiesel blended fuel, and increase the risk of filter plugging. The cloud point of the petroleum diesel and the B100 must be known prior to the biodiesel blending. It is important that the blended fuel still meet the CGSB cloud point specifications for that seasonal temperature for that time of year and for that region. The only way to ensure that the blended fuel meets this is to have some frequency of testing for cloud point of the biodiesel blend.

Summary of Key Points for Blending

6. **Seek blending speeds either through gravity distribution or mechanical agitation at least 273 LPM/75 GPM to full rack velocity, which can be as high as 2364 LPM/650 GPM.** Hand mixing—basic pouring of one fuel into another—is not recommended at any time. The reason is that without proper agitation there is no way to ensure that the blend is homogeneous. An alternative approach to blending would be product mixing during delivery, which is known as Splash Blending. Once the truck has been loaded at a bulk terminal, your products are mixed en route to its final destination. Once at the destination, pumps or gravity, drop the mixed products into the end user's fuel storage tanks. Success has been achieved using this blend strategy.

7. **Neat biodiesel should not be kept on a truck or railcar overnight prior to delivery, when the outdoor temperature reaches lows less than 10 degrees C abouve the B100's cloud point, unless the truck or railcar has heating coils.**

8. **Many fuel users and distributors currently use cold winter diesel fuel additives to improve winter handling characteristics of diesel fuel.** To date, no commercial diesel fuel additive has been found to be effective in modifying the cloud point of biodiesel.

9. **Become acquainted with a local fuel testing laboratory in your region before you have a problem.**

10. **Test for water in all tanks storing biodiesel, conventional diesel fuel, and blends of both fuels by using the tried and true method of a gauge stick and water-finding paste, (available at petroleum supply houses).**

11. **Fuel Dispenser Filter - industry recommendations suggest that 25-micron filters be used on filters utilized for fuel pumping islands.** Winter conditions frequently cause fuel to haze when fuels reach posted cloud points because well-entrained moisture tends to freeze causing premature filter plugging.

12. **Water-fuel separators on vehicles need to be checked and be serviced as often as necessary.**