# BIODIESEL: FUEL QUALITY BEST MANAGEMENT PRACTICES

Biodiesel Preparedness, Biodiesel Blending Practices, Cold Weather Handling, ASTM, BQ9000, and Administrative To-Do's for Biodiesel Distributors, Marketers and Users

Clean Cities Virginia

**Virginia Clean Cities**

**June 2007**

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This guide was compiled by Virginia Clean Cities with support from the Virginia Department of Mines, Mineral and Energy. Much of the content was adapted from the National Biodiesel Board, the National Renewable Energy Laboratory, the National Oilheat Research Alliance, Virginia regulatory agencies with jurisdiction over biodiesel use, distribution and production, and opinions of Virginia biodiesel producers, distributors, marketers and users.

## NOTICE



*Clean Cities is a government-industry partnership designed to reduce petroleum consumption in the transportation sector by advancing the use of alternative fuels and vehicles, idle reduction technologies, hybrid electric vehicles, fuel blends, and fuel economy.*

*Virginia Clean Cities is one of almost 90 coalitions across the U.S. that help meet the objectives of improving air quality, developing regional economic opportunities, and reducing the use of imported petroleum. Virginia Clean Cities was incorporated in November 2001 as a 501 (c) (3) non-profit corporation*

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# BIODIESEL PREPAREDNESS

Some of the information in this section of the manual was extracted from the National Oilheat Research Alliance Fuel Quality Manual, the National Biodiesel Board and United Soybean Board Fuel Quality and Performance Guide, and the National Biodiesel Board Quality Assurance video. Additional information, including website links, from these sources and additional sources are included in the "Resource" section of this manual.

## Getting Ready

To make the transition to biodiesel a smooth one, follow Ric Hiller's (Arlington County) recommendations:

- Clean fuel storage tanks thoroughly before filling them with biodiesel. Due to biodiesel's solvent effect, it will scrub off any deposits in the tank and carry them straight through to the pump and into your trucks' fuel tanks. *For a list of companies that specialize in tank cleaning in preparation for biodiesel, see the tank cleaning directory*.
- Use 10-micron filters on fuel dispensers to catch tank deposits before they reach vehicle tanks.
- Stock plenty of primary and secondary fuel filters for any equipment that will use biodiesel. The cleansing property of biodiesel means filters will become clogged more quickly (during the initial stages of transition) if the equipment's fuel tank and system contain sludge and sediment from years of diesel buildup.
- Educate drivers, equipment operators and technicians. Make sure they understand that if they notice any degradation in vehicle power, rough engine idling, etc., they should bring the vehicle into the shop immediately to replace the fuel filters. That will solve the problem 99.9% of the time. Expect employees to blame everything on the biodiesel – even a blown headlight.

Arlington County's transition to biodiesel was documented by an independent consultant hired by Virginia Clean Cities, and can be accessed at http://www.hrccc.org/biofuels/ArlingtonB20Study.pdf.

## Purchasing Fuel

When purchasing fuel, ask for the fuel specifications and verify the fuel properties are suitable for the intended use. When buying fuel in the winter, ensure the cold weather characteristics are suitable for local climate conditions. Additionally, always request a certificate of analysis from your supplier to guarantee ASTM benchmarked fuels. Another way to ensure you are starting with a quality product is to obtain your biodiesel from BQ-9000 accredited producers or certified fuel marketers.

Once quality fuel is obtained, it's important to keep the fuel "on-spec." Ensuring fuel storage tanks are free of contamination (especially water) is critical. A good way to inspect incoming fuel is to check for cleanliness and haze, which sometimes indicates the presence of water or wax. Below is the protocol for the distillate fuel haze rating standard using the ASTM clear and bright test. This test is covered in the NBB Quality Assurance video.[1]

## Simple Tests to Quickly Evaluate Fuel[2]

*Clear and Bright Test (ASTM Method D 4176)*

This is a quick and easy test that allows you to visually inspect the fuel supply you are buying in the field. You can determine if there is suspended free water (haze) and contamination with solid particles.

You need: 1-quart clear glass jar, 4—0z. Bottles
Bar chart and haze rating photos (see examples below, can purchase from NORA)

Method:

- Take sample of fuel from tank or truck and fill about 90% of jar
- Place bar chart behind jar. Compare the appearance of bar chart through the sample with the standard photos (photos are in NORA Fuel Quality Manual – see resource section). Look at the comparison of the lines and how they fade gradually. Ignore the color differences. However, if the fuel is too heavily dyed or the fuel is too dark to allow you to see through the jar, pour a smaller amount of fuel into the 4—0z. bottle.
- Compare what you see to determine which of the example photos from the NORA Fuel Quality Manual your sample resembles most.
- Hold the sample up to the light and check for haze or clarity. Swirl the sample to produce a vortex and examine the bottom of the vortex for particles.
- Record the following observations:
    - Was it clear and bright? Or not?
    - Were there particles?
- Record the outdoor temperature or the fuel sample temperature if different.
- Record your observations if the fuel appears darker than usual.

The fuel should have no water or particles, and this is considered "clean and bright." When compared to your observations of typical fuels, the haze rating could give you an indication of an unusual batch with contamination or off-specification fuel.

If a sample is taken when the outdoor temperature is cold, small amounts of wax particles may settle out and cloud the fuel; this should not be confused with a water haze. These wax crystals will clog filter systems in your fuel delivery

[1] *NBB Fuel Quality and Performance Guide, p. 3*
[2] Source: The NORA Fuel Quality Manual, pg. 31.

system. Check for the Cloud Point (ASTM D 2500) and Pour Point (ASTM D97) temperature of the fuel. The fuels you store and use should have cloud and pour points well below the outdoor temperature in your geographic region. If they are not, you can expect cold-weather operability problems.


*Source: NBB Fuel Quality and Performance Guide*
*http://www.biodiesel.org/pdf_files/FuelQualityandPerformanceGuide.pdf*

## Fuel Sampling

Proper fuel sampling techniques are demonstrated in the NBB Fuel Quality Assurance video[3] (*we strongly encouraging watching this short video prior to receiving your first biodiesel load*).

The best method is to obtain a sample or mixture of several samples that represent the material in a truck or storage tank. Depending on where you are sampling from and for what purpose, there are several different types of devices that can be used to collect a fuel sample.

### Sampling Tips[4]

- Use clean sampling devices and containers.
- Always retrieve a minimum of one-quart sample of fuel and a backup sample to be kept and retained for your own testing should it be necessary.
- Fill sample containers to a safe level, normally 80% of capacity, which allows for expansion during transport to laboratories.
- Use the appropriate device for pulling bottom samples.
- Bulk samples are best rated when a top, middle and bottom sample (known as a tank composite) is evaluated.
- Line samples are an option in bulk plants when tank samples are inaccessible.

[3] "Biodiesel Quality Assurance." National Biodiesel Board. Multimedia download, available: http://www.biodiesel.org/multimedia/audiovideo/
[4] NBB Fuel Quality and Performance Guide, p. 4. Available online: http://www.biodiesel.org/resources/fuelqualityguide/viewstate.aspx?state=Virginia

- Dispenser and above ground storage tank samples are retrievable through the top of the tank or at the fuel dispenser nozzle.
- Samples can be taken from the fuel delivery truck which represents what was retrieved from the fuel terminal or manufacturing plant.
- An appropriate sample must be contained in a clean quality plastic container (preferably fluorinated type container, available through ASTM testing laboratories). All filled containers should have a tightly sealed cap, be inserted into a plastic bag sealed with a conventional bag seal, then enclosed in corrugated box for shipping to a lab of your choice.

## Bottom Sample for Water and Sediment[5]

Check tank bottoms for settled water, sludge or microbes (bacteria, yeast, fungi) by taking a sample with a Fuel Thief, or Bacon Bomb sampler. Only a small sample size is required. This consists of a stainless steel cylinder tapered at both ends and fitted with an internal, plunger type valve. The valve opens automatically when the sampler strikes the bottom of a tank and closes when lifted.

This is preferable to using the water indicating paste on a stick, as a sample can more easily be inspected visually. Unless there is more than about 1/2-1" depth of water, it is hard to detect it on the stick. An emulsion at the bottom (water and sludge mixture) can also displace the water from the paste, which may appear as spots on the paste. This doesn't mean there is an insignificant amount of water, as it doesn't take much to cause corrosion or support bacterial and fungal growth. A sample may give evidence of rust flakes or a slimy type of microbial growth.

Bacon Bomb with extension rods to sample from tank bottoms. The (4 oz.) 1" diameter one is also referred to as the Pencil Bomb. *Source: NBB*

## How to Sample Home Tanks[6]

Sampling from small residential tanks requires an accessible bung with an opening of 2" diameter minimum. A bottom sample is most useful to assess the cleanliness of the tank. Repeat calls or reports of issues may indicate problems with heavy sludge accumulating at the bottom of the tank. Take a sample with a fuel thief or a hand pump to look at the condition of the tank bottom. This will tell you how much water, sediment, or rust there is.

[5] The NORA Fuel Quality Manual, p. 40
[6] The NORA Fuel Quality Manual, pps. 40-41

*Source: NBB Fuel Quality and Performance Guide*
*http://www.biodiesel.org/pdf_files/FuelQualityandPerformanceGuide.pdf*

Check the level and pitch of the tank. Pull a bottom sample from the low end of the tank if possible. You may wish to take additional samples near the fuel supply line or from the fill-pipe. Tanks are sometimes installed with a slight tilt to allow water to collect in one end. Take note that when a sample is drawn from a port not located at the low end of the tank, sludge or water may not be detected. For large tanks it is recommended that samples be taken from more than one location to ensure that water and any contaminants are detected.

**Assessing "Problem" Home Tanks**[7]

Many "problem" tanks share common causes, which greatly affect fuel quality.

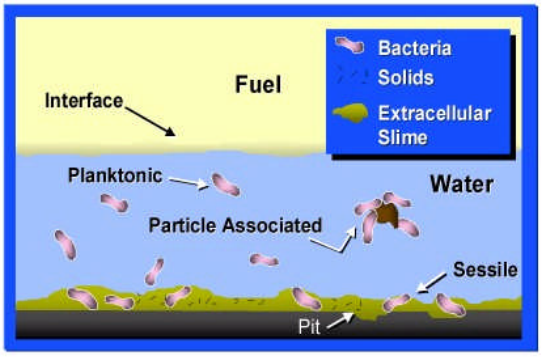
**Water and Sludge Accumulation in Tanks**

- Condensation of hot, humid, air in the tanks can slowly add to the water collecting at the bottom of the tank. This occurs as a tank "breathes" through the vent during the filling operation, drawing of fuel from the tank, and temperature changes experienced in outdoor tanks. Without periodic water removal, the amount of water that could accumulate after many years could be appreciable. Using a long measuring stick and water-indicating paste will help you monitor the tank for water.
- Be aware that water can be introduced into tanks from other ways; water can be delivered along with the fuel if it was already contaminated. Periodically check for water and cleanliness of the fuels received from your supplier. Sample to check that your tanker truck and/or bulk storage tanks are clean and dry.
- Sludge is a mixture of water, gum formed from the aging of fuels, rust, and microbes (bacteria and fungus). Repeat service calls due to sludge build-up

[7] The NORA Fuel Quality Manual, p 45-47.

require special attention. Sampling the tank bottom using fuel thief allows you to assess its condition and how much build-up there is.

- Collect the bottom sample in a clear, glass jar and take note of what it looks like.
- With many years of accumulation, the only effective means of removing sludge is through mechanical cleaning.
- Physical cleaning or replacement of heavily contaminated tanks, and replacement of clogged fuel supply lines, are the only effective means to solve these types of service problems.
- A floating suction device used on the fuel supply line may help to reduce the amount of sediment that gets picked up into the fuel delivery system. When a floating suction is used it is essential to monitor and remove the water as it accumulates. This should be done to prevent internal corrosion of steel tanks and to minimize microbial growth.




## Fuels Degrading in Storage

- The most important factors affecting storage stability of the fuel are the condition of the tank, the amount of existing sludge, water or microbial growth.
- Most of the incoming heating fuels from major suppliers appear to have acceptable stability. Pipeline sources of fuel tend to be more stable; barged fuels tend to be slightly less stable possibly due to the added handling and transport, longer storage times, and potential contamination.
- Generally, older tanks that have more overall accumulation of sludge show an increased likelihood of service problems. When replacing a tank, do not transfer old fuel into the new tank.
- Newer tanks with little water or sludge have fewer problems with microbial growth and provided better fuel storage stability.
- High sludge content (measured as Bottoms Sediment and Water or BS&W, of 10% more) results in more clogging problems of the fuel line and filter. You can detect large amounts of contamination at the tank bottom simply by sticking the tank and using water-indicator paste. If the paste color appears spotty, you likely have a mixture of water and heavy components of fuel (an emulsion).
- Tanks with existing sludge problems do not improve with fuel stabilizing additives. Stabilizers are typically designed for use with freshly refined, clean fuels to slow down oxidation and natural aging of fuels.
- Some dispersant-type fuel additives show reduced sludge on filters and may help to maintain cleaner fuel delivery system (supply line, filter, nozzle).
- To minimize fuel degradation during storage, keep outdoor tanks away from direct sun; high temperatures during the summer can accelerate the fuel aging process. Where possible install tanks in shaded areas, or on the north side of homes.

## Storing Fuels[8]

### Tank Considerations

- An accessible port should be at the top of the tank to allow for periodic inspection for water and sludge. Accumulated tank sedimentation and or water should be removed on a routine basis so that it does not clog strainers, lines, filters or nozzles and injectors.
- Locate outdoor tanks (AST) in cool, shaded areas if possible to minimize exposure of the fuel to high temperatures from direct sun.
- Petcocks normally located on the bottom of both truck saddle tanks and bulk storage tanks enable you to remove any bottom water and sediment that accumulate during seasonal temperature swings.

### Piping Considerations

- Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene, Teflon and most fiberglass. Materials such as brass, bronze, copper, lead, tin and zinc may accelerate the oxidation of your fuels and should be avoided.

### About Additives

- B100 (neat biodiesel) cannot presently be treated successfully with conventional winter fuel additives.
- Biodiesel blends can be adjusted with a combination of kerosene and cold flow improvers designed for petroleum fuel.
- If storage of neat biodiesel or blended fuels is intended beyond six months it is recommended that you add a fuel stabilizer. Biodiesel requires a specific stabilizer which can be obtained through a reputable fuel additive supplier.

### Storage Tank Maintenance

Fuels need to be protected in order for product quality to be maintained. This can be accomplished by following some basic, but critical, fuel quality strategies.

- Keep tanks topped off whenever possible.
- Know the operability values of these fuels (cloud, pour, cold filter plugging point).
- Monitor and eliminate water when it is present.
- Source an analytical lab for future fuel testing.
- Do not add additives to previously treated fuel (using more additives is not helpful).
- Additives should not be used once a fuel meets or falls below its posted cloud point.

[8] NBB Fuel Quality and Performance Guide, p 6-9

- Ask for fuel specifications. For larger bulk tanks, at the very least have a top, middle and bottom sampling performed to determine if the fuel maintains specifications.
- Inspect fill and vapor caps for damage and missing gaskets, replacing if necessary. Consider a desiccant dryer on vent pipes to limit moisture contamination.
- It is a good idea to have a lab run a microbiological evaluation of your fuel at least once per year to ensure that no contamination exists in your tanks.
- If storage of higher blends (more than B20) is intended beyond six months, it is recommended that you add a fuel stabilizer. Biodiesel requires a specific stabilizer that can be obtained through a reputable, experienced fuel additive supplier.
- Have the tank periodically cleaned by qualified professional contractors as an added safety measure (see biodiesel contractor directory).
- All biodiesel tanks exposed to cold outdoor conditions should be equipped with heating elements, insulation and tank mixers for satisfactory cold weather storage and distribution.
- A floating suction at the fuel intake may help reduce the amount of sediment drawn into the supply line.


By the sample drawn above, this tank has a problem with excessive water accumulation. You can also detect this much water with water-indicating paste on a stick.


This sample contains heavy amounts of degraded fuel products and water.

**B100 Bulk Storage Considerations**

Keep at 40-45F
Underground tanks reduce cold weather handling issues

Consider cloud point and cold filter plug point for biodiesel and petroleum diesel when blending

Might be less costly to winterize petroleum

Some additives don't work in biodiesel

## Cold Temperature Operations and Biodiesel[9]

Biodiesel requires close attention when storing, blending and distributing in cold weather markets.

Identify cold flow properties of the fuel you are buying. If you are dependent on someone to blend your diesel fuels, make them accountable for winter operability specification. You must advise that individual or company what temperatures you wish the fuel to function to and depend on them to make it happen. Their options will be to use kerosene, additives specific to the generic fuel, and control of biodiesel blends to achieve your desired goals.

To successfully blend biodiesel, follow the tips below:

- Identify the cold flow protection anticipated by the customer.
- Obtain a generic fuel with the lowest "temperature operability value" possible (cloud, cold filter plugging point and pour point).
- Use a proven additive, or kerosene to reduce the generic fuels operability value to levels low enough to accommodate the percent of biodiesel desired by the end user. Remember that a 20% biodiesel blend produced from soy methyl ester will reduce your cold flow values by 10°F in some cases. Lower blends reduce this value to a lesser degree.
- Blend biodiesel into diesel fuel and test the product for operability values.
- When splash blending is your only option, the hotter the biodiesel the more likely you will have a successful blending experience. To eliminate the possibility of the biodiesel flash freezing when introduced into a cold aluminum tank truck, successful blenders have heated the fuel to temperatures in excess of 100°F.

[9] NBB Fuel Quality and Performance Guide, p 10-13

- In-line or injection blending requires that the biodiesel be kept at a minimum of 10F higher than the cold operability properties of the biodiesel feedstock to ensure successful blending into diesel or heating oil.
- Dilution blending with kerosene is also an option for biodiesel blends.
- Once you have blended biodiesel into the diesel fuel or heating oil following the above general blending principals the fuels will stay blended.

### Identifying Engine Shutdown and Tank Issues

Engine failures due to fuel starvation provide convincing evidence of how important it is to manage your fuel systems and fuel quality. There is truth to the statement, "you can pay me now, or you can pay me later."

## Addressing Diesel Equipment Breakdowns

- Drop bottom of tank contents through petcock relief. Bleed bottoms to review tank bottom sedimentation and water.
- Verify that the fuel transfer pump is operating.
- Replace all in-line filters; normally two primaries and a secondary swap out will be necessary.
- Take the questionable filter and turn it upside down, pouring out any remaining liquids to determine if the problem revolves around waxing or icing.
- If waxing is the primary issue, it might be necessary to heat the fuel or add kerosene to regain operation. You must make provisions to allow the wax to melt, which can be accomplished by indirectly heating the fuel. The safest way to accomplish that is by garaging the vehicle in a heated space. Do not use cold flow additives at this point because the fuel has reached its cloud point and the performance of additives will be questionable at best.
- Moisture in fuel can stop fuel flow even before temperatures drop to the fuel's cold filter plug point.. If you find icing is blocking fuel flow, your only recourse is to thaw out fuel or utilize emergency anti-icing additives that contain alcohols and solvents which will immediately melt away the ice. These additives should only be used in emergency situations and must be used judiciously. Overdosing additives can cause fuel pump failure over the long term by drying out elastomers that are used as sealing devices in the pump.
- There are approximately six feet of quarter inch fuel lines that travel from saddle tank to the point of combustion. Along with this narrow piping, a minimum of four 90◦ brass fittings which carry the fuel may also become restricted – affecting fuel flow. The only recourse you would have with plugged lines in this case is to warm them up.
- Once up and running, you should package a quart of fuel retrieved from the saddle tank and one from the bulk storage tank from which the truck was fueled. Send it to a local laboratory to determine the cold flow properties, cloud, pour, and cold filter plugging point. If you visually observed any black slimy substance on the fuel filter media, ask them to have a microbiological

evaluation done on the fuel as well. You can also bundle up a fuel filter for lab reference on specific contamination found on the filter media.

## B100 Stability[10]

Few users have reported stability problems with B20 or B100 in the United States, but stability is a major issue for engine and fuel system manufacturers. Stability is a broad term, but really refers to two issues for fuels: long-term storage stability or aging and stability at elevated temperatures and/or pressures as the fuel is recirculated through an engine's fuel system. In the diesel fuel arena, long-term storage stability is commonly referred to as oxidative stability and thermal stability is the common term for the stability of fuels at elevated fuel system temperatures. At this time there are no ASTM specifications for the stability of either diesel or biodiesel (as of September 2006).

In biodiesel, fuel aging and oxidation can lead to high acid numbers, high viscosity, and the formation of gums and sediments that clog filters. If the acid number, viscosity, or sediment measurements exceed the limits in ASTM D6751, the B100 is degraded to the point where it is out of specification and should not be used. Biodiesel with high oxidation stability will take longer to reach an out of specification condition, while biodiesel with low oxidation stability will take less time in storage to reach an out of specification condition. Monitoring the acid number and viscosity of B100 over time can provide some idea about whether the fuel is oxidizing, with sampling at the receipt of the B100 and periodically during storage providing the most useful data.

In some cases, deposits from the cleaning effect or solvency of B100 have been confused with gums and sediments that could form over time in storage as the fuel ages. While sediment can clog a filter in either case, care should be taken to make sure the reason for the clogging is properly identified. For example, if the acid number of the fuel is within specification, then sediment formation is most likely due to the cleaning affect and not to fuel aging or oxidation.

## Ultra Low Sulfur Diesel Warning

How can ULSD cause fuel pump failure?

Both biodiesel and most petroleum highway diesel sold before the fall of 2006 cause pump seals to swell, but ULSD, which was introduced in most US markets around October 2006 causes the seals to shrink. If the seals shrink enough, the fuel pump will leak fuel and/or suck in air. The symptom of pump failure in Turbo Diesel Injection (TDI) engines has been difficult or unable to start because of air that entered fuel lines through the leaky seals. Chevron acknowledges that ULSD can cause seals to fail:
http://www.chevron.com/products/prodserv/fuels/diesel/ulsd.shtml#A14

[10] Biodiesel Handling and Use Guidelines. March 2006. US DOE. p 21

## BIODIESEL BLENDING PRACTICES & COLD WEATHER HANDLING

### Basic Properties and Blending Considerations for B100[11]

The considerations for storing, handling, blending and using B100 are very different than for B20 or lower biodiesel blends. If you are interested in using or handling finished B20 or lower biodiesel blends, you may want to skip the B100 section and go directly to the B20 section.

1. B100 is a good solvent. It may loosen and/or dissolve sediments in fuel tanks and fueling systems left by conventional diesel over time. If your system contains sediments, you should clean your existing tanks and fuel system before handling or using B100.
2. B100 freezes at higher temperatures than most conventional diesel fuel. Most soy-based B100 starts to cloud at around 35°F, so heated fuel lines and tanks may be needed even in Virginia's moderate climate. As B100 begins to gel, the viscosity also begins to rise, and it rises to levels much higher than most diesel fuel, which can cause increased stress on fuel pumps and fuel injection systems. Improved cold weather properties are a major reason many people use biodiesel blends instead of B100.
3. B100 is not compatible with some hoses and gaskets. B100 may soften and degrade certain types of rubber compounds found in hoses and gaskets (i.e. buna N, nitrile, natural rubber) and may cause them to leak and become degraded to the point they crumble and become useless. This could cause a fuel spill on a hot engine, could ruin a fuel pump, or could result in filter clogging as the hose material gradually wears away. If using B100, extreme care should be taken to ensure that any part of the fuel system that touches the fuel is compatible with B100. Some systems already have biodiesel resistant materials (i.e. Viton™) but many do not because these materials are usually slightly more expensive (*typically vehicles manufactured after 1994 are safe*).
4. B100 is not compatible with some metals and plastics. Biodiesel will form high sediment levels if contacted for long periods of time with copper or copper containing metals (brass, bronze) or with lead, tin, or zinc (i.e. galvanized surfaces). These high sediment levels may cause filter clogging. Diesel systems are not supposed to contain these metals, but sometimes they can occur anyway. In addition, B100 may permeate some typical types of plastics (polyethylene, polypropylene) over time and they should not be used for storing B100.

### Blending Biodiesel to Make B20 or Lower Blends[12]

If you are planning to blend your own fuel, if you are a distributor planning to blend fuels for your customers, or if you are just interested in more details, the

[11] Biodiesel Handling and Use Guidelines. March 2006. US DOE. p 8.
[12] Biodiesel Handling and Use Guidelines. March 2006. US DOE. p 37-42; Biodiesel Blending Options. PowerPoint Presentation. Virginia Clean Cities, February 1, 2007.

section below will go over the options and considerations for blending biodiesel into petrodiesel.

Biodiesel blending depends on a variety of factors, including the volume of B100 required to make the blend, the finished blend level, the volume of blended products being sold, tankage and space availability, equipment and operational costs, and customer requirements for blends, both now and in the future. **It should be noted that biodiesel is a fuel for diesel applications only and biodiesel is not to be blended with gasoline.**

At the time of the writing of this document, biodiesel is blended into diesel fuel via three primary means:

1. B100 splash blended with diesel fuel by the distributor at the time the delivery truck is loaded. Blending only at the end-users tank is not recommended unless thorough precautions are taken to ensure adequate mixing.
2. Pre-blended (via a variety of means) by a jobber or distribution company in bulk storage tanks and offered for sale as a finished blend, often B20 or B2.
3. Blended at a petroleum terminal with automated equipment. This method, though not yet offered in very many locations (One terminal in Virginia has announced plans to offer rack injection blending as of June 2007), ensures complete blending and reduces handling costs for distributors.

The chemical nature of biodiesel allows it to be blended with any kind of distillate, or diesel fuel. This includes light fuels such as jet fuel, kerosene, No.1 diesel, or military fuels (JP8, JP5), as well as normal diesel fuel like No. 2 diesel for diesel engines or gas turbines, and heating oil for boilers or home heating. Once biodiesel is blended thoroughly with diesel fuel, it stays together as one fuel and does not separate over time (assuming the fuel is maintained at temperatures above its cloud point). Once blended, B20 and lower blends should be treated exactly like conventional petrodiesel.

In the early days of biodiesel blend use, volumes were not high enough for the conventional petroleum infrastructure to carry and handle the fuel economically. Most of the B20 used in these early days was splash blended by the user after receiving B100 from a biodiesel supplier. As volumes increased, customers began to request B20 pre-blended from their existing supplier of petrodiesel. These petrodiesel suppliers would then receive and store the B100 and would blend the biodiesel with petrodiesel and supply a finished blend to the customer. In some cases, the petrodiesel supplier might carry B100 and petrodiesel in separate compartments in one truck and blend the two on the customer's site as the truck is unloaded. This is not a recommended blend practice and can result in improperly blended fuel, especially in cold weather conditions.

More recently, as demand increases, petroleum terminals are installing biodiesel blending capability so that jobbers and distributors can receive a biodiesel blend directly at the rack and store and distribute only the blended biodiesel. This

finished blend can then be sold to fleet or other applications that have on-site storage. Even more recently, there are an increasing number of public pumps and unattended refueling sites that are carrying biodiesel blends for individual users or fleets who do not have their own on-site storage capability.

There are many blending options available to the user or distributor depending on your area. As the market matures and volumes continue to increase, it is highly likely that the actual point of blending will occur further and further upstream in the distribution system where it is most efficient and economical. This is likely to be especially true with lower blends of biodiesel, such as B2. Most users find blending their own fuel to be time consuming and sometimes messy, so there are an increasing number of users who are requesting that their petroleum supplier make finished blends available. As noted, in the marketplace today, there are three avenues to blend biodiesel into petrodiesel. They are described in general terms below. Any of these options can be used to blend biodiesel into diesel fuel. All three options are commonly used in practice today.

## Splash Blending

An operation where the biodiesel and diesel fuel are loaded into a common vessel from the same or separate sources, with some mixing occurring as the fuels are pumped into a common tank. The vessel is usually an individual fuel tank on a fuel delivery truck (or a drum or tote). Once the fuels are splash-blended onto a delivery truck, additional mixing occurs as the truck travels to customers. This approach can be successful if agitation is adequate, but is not recommended practice, especially in cold weather. Little or no mixing can occur if biodiesel is loaded first into an empty delivery truck tank on a very cold day.

*In-Tank Blending*

In-tank blending is often just another form of splash blending. In-tank blending is where the biodiesel and diesel fuel are loaded separately, or, in some cases at the same time through different incoming sources, but at a high enough fill rate that the fuels are sufficiently mixed without the need for additional mixing, recirculation, or agitation. In some cases this is similar to splash blending but without the need to drive up and down the road. In other cases, the blended fuel in the tank may need to be recirculated or further mixed in order to get the two fuels thoroughly blended.

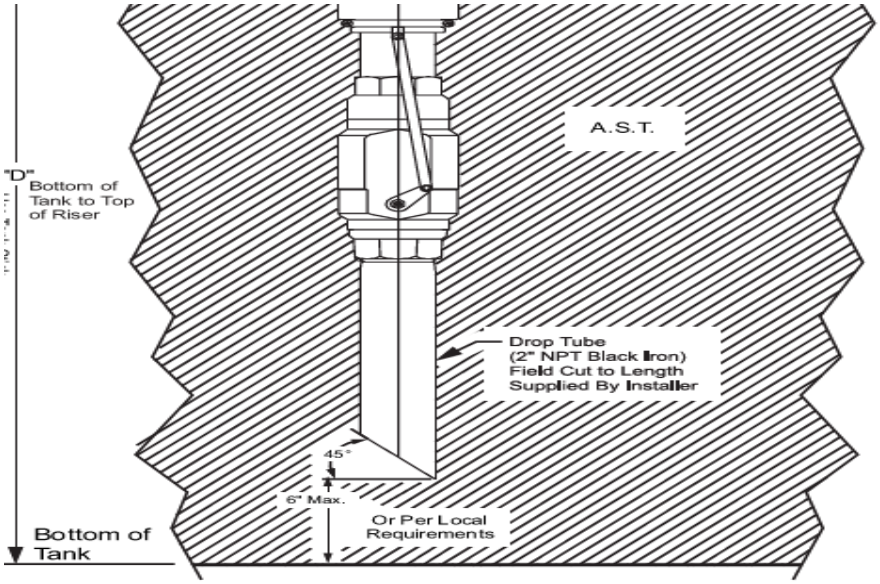
**Blending in Customer's Tank**

Prohibited by military and others

More flexible for small quantity deliveries

Follow same protocol as blending in truck tank

More risky in extreme cold



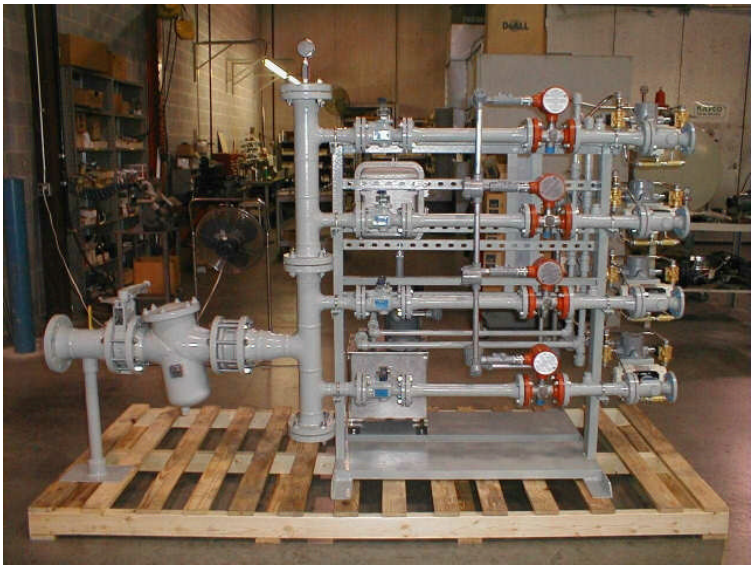

## Pre Blending

The biodiesel and diesel fuel are blended by the distributor and bulk-stored in that blended form before loading onto a delivery truck.

## In-Line (Injection) Blending

The biodiesel is added to a stream of diesel fuel as it travels through a pipe or hose in such a way that the biodiesel and diesel fuel become thoroughly mixed by the turbulent movement through the pipe—and by the additional mixing that occurs as the fuels enter the receiving vessel. The biodiesel is added slowly and continuously into the moving stream of diesel fuel via a smaller line inserted or 'Y' in a larger pipe, or the biodiesel can be added in small slug or pulsed quantities spread evenly throughout the time the petrodiesel is being loaded. This is similar to the way most additives are blended into diesel fuel today and is most commonly used at pipeline terminals and racks. Some distributors carry B100

and petrodiesel in separate truck compartments and blend the two fuels with separate metered pumps operating simultaneously at high speeds. These methods offer superior consistency and lower operational costs.



**In general, blending biodiesel is not difficult if you keep a couple of basic facts in mind:**

- **The more mixing the better**
- **Biodiesel is slightly heavier than diesel fuel**

Biodiesel has a specific gravity of 0.88 compared to No. 2 diesel at 0.85 and No. 1 diesel at 0.80. So if you put the biodiesel in an empty tank and then pour diesel fuel slowly on top, it may not blend properly, if at all. Since the biodiesel is heavier, it may stay in the bottom of the tank in a layer of mostly biodiesel. Most pumps draw from the bottom of a fuel tank, and if not properly mixed this bottom layer can contain high concentrations of biodiesel. The problems generally manifest themselves in cold months, as the high concentration biodiesel fuel starts to freeze, plugging filters and forming a gel layer at the bottom of tanks. This concentration of near B100 in improperly blended fuel also can foster leaks from hoses and gaskets that are compatible with B20 but not with higher blends. Because the freezing problems may not manifest themselves in the summer and any adverse affects on hoses and gaskets associated with higher blends may take some time to develop, users may go for many months without a problem. But over a long enough period of time, or during cold weather, improperly mixed fuels are guaranteed to cause problems. One additional issue this can create is that a concentrated layer of biodiesel could also start to dissolve tank sediments, which might not be affected by B20, resulting in filter clogging.

There are two simple tests that can be performed to see if a tank has been thoroughly mixed.

1. A top, middle, and bottom sample of the tank (see ASTM D405712 for the proper way to take a representative sample of a tank) can be taken and analyzed for the percent biodiesel using infra-red spectroscopy or by measuring the specific gravity or density. This can be done with any of the conventional means of measuring density or specific gravity that are readily available (i.e. digital density meter, hydrometer). If the values do not vary by more than 0.006 specific gravity units from top to bottom, the mix is probably adequate. There are several instrument companies who are currently offering relatively inexpensive equipment to measure the percent biodiesel in the field, similar to that used for ethanol in gasoline. See the National Biodiesel Board at www.biodiesel.org for further details.

2. Put the samples from the three layers in a freezer with a thermometer and check every 5 minutes until the fuel in one of the samples begins to crystallize. Record that temperature. Then, check every couple of minutes or so until all three samples show crystallization. Compare the crystallization temperatures on all three samples, they should be within 5-6°F (3°C). If not, the fuel will require agitation to mix thoroughly.

So what is the best option for blending biodiesel and diesel fuel? It depends on your volume, your investment, and your needs.

- Drums and totes are typically mixed by splash or in-tank blending or by adding B100 on top of diesel fuel in a storage tank. Disperse the biodiesel as much as possible with this approach by spreading it evenly over the diesel fuel surface. If an even distribution of the biodiesel over the surface of the diesel fuel cannot be obtained, or the addition of the biodiesel is not sufficient to get it thoroughly mixed, further agitation or recirculation may be needed.
- B20 is frequently blended in bottom-loading tank trucks. The biodiesel is loaded into the tank truck first, followed by the diesel fuel and some mixing occurs. The fuels continue mixing as the truck moves to the delivery point, so long as the roads are not straight and level and the route is not too short. When the fuels are pumped from the truck into the B20 storage tank at the point of use, a final mixing occurs. This is generally enough mixing except in cold weather. Putting B100 into a cold empty tank truck can cause the B100 to gel. Then the two fuels mix poorly or not at all. In cold weather, it is better to load half of the diesel, then the biodiesel is loaded, followed by the rest of the diesel fuel. This will help prevent the biodiesel from freezing to the internal parts of the tank truck. The gel point of the B100 and the ambient temperatures will tell you if this practice is necessary and there is additional research planned to further understand this phenomenon.

In-line blending uses two metered pumps and a dual fuel injection system, but requires an investment in equipment. This approach is the most accurate and reliable for guaranteeing a specific fuel blend.
Regardless of your blend technology, blenders need to answer the following questions to figure out their blending strategy:

- How is the B100 arriving, particularly in the winter months (B100, B50 or B20)? Can your supplier handle all or just some of those options? Are summer deliveries different, and if so, how? How does that affect your blending and storage system?
- What products are you making, B20 only or B20, B2, and B100?
- How much tankage do you have or can you afford? How much space? Is it worth the space or tankage for small volume blends?
- How much do you want to spend on equipment, heat, pumping, labor, training, problem solving?
- Do your customers have requirements? Customers will test to determine whether or not the specified blend level is being delivered. Can your blending strategy meet that standard time after time, with personnel turnover?

Cold weather blending is a concern in climates where the diesel fuel temperature falls below the cloud point of the B100 you are blending with. The first thing to keep in mind is that there should not be a problem if the diesel fuel temperature is above the cloud point of the final blend. If crystals do form during blending, they should go back into solution so long as the temperature of the blended fuel is above the cloud point of the blend. This process can be assisted by blending equipment that agitates the two fuels during blending. That agitation helps disperse the fuels and crystals more uniformly and can provide some energy to help the crystals dissolve. Additional work in this area is planned also.

It is best to store the B100 as B20 or some kind of blend as soon as possible regardless of the season. B100 does not store as long as blends and there are always cold weather factors to consider. If you have just a few B100 customers, you might consider setting aside a tote of B100 indoors or storing some underground or in heated tanks, depending on your climate.

It is always a good idea to retain a sample (one gallon) of the diesel and the B100 before blending the fuels (see BQ-9000). Once the customers have run through the current batch of fuel with no problems, you can dispose of these samples by mixing them into the new batch of fuel. If any problems arise, these samples will help you determine whether they were caused by the fuel or by something else.

### B100 Cold Flow Properties[13]

The cold flow properties of biodiesel and conventional petrodiesel are extremely important. Unlike gasoline, petrodiesel and biodiesel can both start to freeze or gel as the temperature gets colder. If the fuel begins to gel, it can clog filters or can eventually become too thick to pump from the fuel tank to the engine. There are three tests used to measure the cold flow properties of fuels for diesel

[13] Biodiesel Handling and Use Guidelines. March 2006. US DOE. p 16-20

engines: cloud point, cold filter plug point, and pour point. They are described in more details below.

**Cloud Point:** The temperature at which small solid crystals are first visually observed as the fuel is cooled. This is the most conservative measurement of cold flow properties, and most fuel can be used without problems below the cloud point but above the cold filter plug point.

**Cold Filter Plug Point (CFPP):** The temperature at which fuel crystals have agglomerated in sufficient amounts to cause a test filter to plug. The CFPP is less conservative than the cloud point, and considered by some to be a better indication of low temperature operability.

**Pour Point:** The temperature at which the fuel contains so many agglomerated crystals it is essentially a gel and will no longer flow. This measurement is of little practical value to users, since the fuel has clogged the filter long before reaching its pour point. Distributors and blenders, however, use pour point as an indicator of whether the fuel can be pumped, even if it would not be suitable for use without heating or taking other steps.

Neither ASTM D975 nor ASTM D6751 has a specific requirement for the maximum cloud point, but the cloud point should be provided to the customer. This can be confusing to someone new to using diesel fuel or biodiesel. How can something be in the specification but not have an exact required value? The answer is that the cold flow properties needed for the fuel depend on where it is being used (i.e. Michigan or Texas) and what time of year the fuel is being used (i.e. January or July). A petrodiesel or biodiesel fuel with a cloud point of 20°F may be just fine for a Texas summer, but would not be fine for a North Dakota winter.

There is a set of maps in the back of ASTM D975 that identify the 10$^{th}$ percentile minimum temperature for the central and northern tier states for the various months of the winter. These maps can be used as a guide for the user or distributor. The 10$^{th}$ percentile temperature is that temperature at which only 10% of the days got colder during that month on average over the last 50 years or so. Some users and distributors use the 10$^{th}$ percentile as the target for their cold flow properties, some use 10 degrees higher than that as their target, while some use cloud point as their measurement and some use CFPP. Still other users do not monitor cold flow properties at all, and rely on their distributor to make sure the cold flow properties are managed.

These guidelines should be followed for storing biodiesel (B100) in winter:

- B100 should be stored at temperatures at least 5°F to 10°F higher than the cloud point of the fuel. A storage temperature of 40°F to 45°F is fine for most B100, although some B100 fuels may require higher storage temperatures.
- B100 can be stored underground in most cold climates without additional considerations because underground storage temperatures are normally

above 45°F. Above ground fuel systems should be protected with insulation, agitation, heating systems, or other measures if temperatures regularly fall below the cloud point of the fuel. This precaution includes piping, tanks, pumping equipment, and the vehicles. Many small-scale B2 blenders store B100 in drums or totes indoors during winter months.

The cloud point of B100 starts at 30°F to 32°F for most of the vegetable oils that are made up primarily of mono- or poly-unsaturated fatty acid chains and can go as high as 80°F or higher for animal fats or frying oils that are highly saturated. Some examples of the cloud, pour, and cold filter plug point of B100 made from various sources can be found in Table 4. It should be noted that the pour point of B100 is usually only a few degrees lower than the cloud point, so once biodiesel "begins to freeze," gelling can proceed rapidly if the temperature drops only a few degrees further.

| Test Method | Cloud Point ASTM D2500 | | Pour Point ASTM D97 | | Cold Filter Plug Point IP 309 | |
|---|---|---|---|---|---|---|
| **B100 Fuel** | **°F** | **°C** | **°F** | **°C** | **°F** | **°C** |
| Soy Methyl Ester | 38 | 3 | 25 | -4 | 28 | -2 |
| Canola Methyl Ester | 26 | -3 | 25 | -4 | 24 | -4 |
| Lard Methyl Ester | 56 | 13 | 55 | 13 | 52 | 11 |
| Edible Tallow Methyl Ester | 66 | 19 | 60 | 16 | 58 | 14 |
| Inedible Tallow Methyl Ester | 61 | 16 | 59 | 15 | 50 | 10 |
| Yellow Grease 1 Methyl Ester | -- | -- | 48 | 9 | 52 | 11 |
| Yellow Grease 2 Methyl Ester | 46 | 8 | 43 | 6 | 34 | 1 |

*Source: Biodiesel Handling and Use Guidelines. March 2006. p 18.*

B100 tanks and fuel lines should be designed for the cold flow properties of the biodiesel being used and the climate they will see. Make sure that fuel pumps, lines, and dispensers are protected from cold and wind chill with properly approved heating and/or insulating equipment. Fuel in above ground tanks should be heated in a range that fluctuates between 5°F to 10°F above the fuel cloud point.

Once crystals begin to form, they should go back into solution as the fuel warms up. However, that process could be slow if the fuel warms only marginally or very slowly. Crystals formed in biodiesel or diesel fuel can drift to the bottom of the tank and begin to build up a gel layer. Slow agitation can prevent crystals from building up on the tank bottom or, once present in the fuel, agitation can help to dissolve crystals back into solution. If B100 has gelled completely, it may be wise to bring the B100 temperature up to 100°F to 110°F to melt the most highly saturated biodiesel components if the fuel needs to be used right away. Lower temperatures can be used if enough time is provided for the mixture to come to its equilibrium cloud point. Further work is occurring in this arena.

Some additive manufacturers have data that show their cold flow additives can reduce the pour point of a B100 by as much as 12°C (30°F), but the treat rate is in excess of 10,000 ppm. At more typical treat rates (1000 ppm), benefits were about 3°C, which are within the variation in the test method.

B100 found in the United States cannot be effectively managed with current cold flow additives like some petrodiesel or European rapeseed oil based biodiesel. The U.S. oils and fats contain too high a level of saturated compounds for most additives to be effective. Cold flow additive effectiveness can also change dramatically depending on the exact type of biodiesel and the processing it has undergone; much like the situation found with diesel fuel. Cold flow additives have been used much more successfully with biodiesel blends. Contact the major additive manufacturers and work directly with them on this issue.

There are efforts underway to design new additives specific for U.S.-based B100, and there are processes which serve to winterize biodiesel by removing some of the saturated compounds. At present the cost of these approaches makes them undesirable. As time goes on, and biodiesel volumes increase, expect to see more progress in this area.

### B20 Cold Flow[14]

This is probably the largest concern for blenders and users alike. Blending biodiesel with petroleum diesel moderates cold flow problems by dilution. The blend also makes the use of cold flow additives practical, since these are effective in the petroleum portion of the blend. When biodiesel is blended with diesel fuel, the key variables are the cold flow properties of the diesel fuel you blend with, the properties of the biodiesel, the blend level, and the effectiveness of cold flow additives.

B100 cold flow properties depend on composition, which affects the cold flow properties of blends (See Biodiesel Use and Handling Guide for data). The same is true of diesel fuel. No. 2 diesel fuel may have cloud points that range from –10°F to 10°F on average (some fuels can be higher or lower than these figures). No 1 diesel, jet A, or kerosene may have cloud points that range between –40°F to –60°F.

Blends of No. 1 and No. 2 diesel fuel are frequently used to meet customer cold flow specifications (Figure 16). Adjusting the blend of kerosene (or No. 1 diesel) in the diesel fuel alone or with additives can modify the cloud and pour point temperatures of B20. An accurate estimate of how B20 will perform in the winter months will require mixing the biodiesel with the winter diesel typically delivered in your area and testing the mixture. Your petroleum distributor or refinery may already be blending No. 1 and No. 2 diesels in the winter, using cold flow

[14] Biodiesel Handling and Use Guidelines. March 2006. US DOE. p 31, 37

additives, or both. So ask your diesel distributor to provide some samples of winter diesel.

The University of Minnesota Center for Diesel Research tested soy B20 made with various diesel fuels available in their region. The database of biodiesel blends (0%, 2%, 5%, 10%, 20%, 100%) shows how different diesel fuels and soy biodiesel blends alter cold flow properties (cloud, pour, and CFPP). Some of the data are shown on the following page (Figure 17, all in °F)

No. 1 diesel fuel typically costs more than No. 2, so blenders may prefer to use additives depending upon their particular situation. Many cold flow additives are available for diesel fuel. Most reduce the size of crystals or inhibit crystal formation in some way. Most have a limited effectiveness on B100, but work with varying degrees of effectiveness with B20.

Additive manufacturers have struggled to develop cold flow additives for biodiesel. They have observed that some additives may work quite well with European rapeseed biodiesel but not with soy biodiesel. They have also observed that some additives have performed differently among the same kinds of biodiesel (from one type of rapeseed biodiesel to another). They theorize that the way some oils are produced can change how the additives perform. Oils are typically either crude or have undergone some kind of pretreatment before they are converted into biodiesel. Pretreating oils removes minor compounds that may affect the performance of cold flow additives. Because of these factors, there is no better way to test additive packages than to use your B100, your winter diesel, and a selection of possible additives.

Laboratory testing should be done on the winter fuel, biodiesel, and the additive at realistic temperatures before starting a fleet wide program with biodiesel and additives. In other words, experiment with the additive with *cold* diesel fuel (in the range you would expect diesel to be on a cold winter day), biodiesel, and the additive. Remember, even the truck or tank you mix the fuels in may be cold. We've seen additives freeze in fuel tanks before the fuels could be blended in. We've also seen biodiesel gel in very cold truck tanks if it goes in first.

Some people have specified feedstocks in their purchasing contracts, such as soy biodiesel. This may lock you into a certain price range for your biodiesel but can also assure biodiesel with specific cold weather characteristics. You might consider the cost trade-offs of using less expensive biodiesel that might be higher in saturates with extra No. 1 diesel or additives versus soy biodiesel and No. 2 diesel.

Your current supplier may be willing to switch from higher saturated feedstocks in the summer to a more unsaturated feedstock in the winter. If cold flow problems occur, you could use 10% biodiesel in the winter and 30% biodiesel in the summer. If you are using biodiesel to meet EPAct requirements, this approach may not work because EPAct requires users to use B20 or higher blend

levels. Examine your reporting requirements to see if this might work for you. As a last resort, you could limit your biodiesel use to the warmer months.

B20 users are generally pushing all these issues onto the fuel distributor and blender's shoulders with contractual language. Users may simply specify that they need a fuel to remain crystal free at temperatures down to -14°F for December, January, and February. Then the blender will work with the biodiesel and diesel suppliers and the additive firms to address these issues independently of the user.

# ASTM & BQ9000

## Quality Specifications[15]

The American Society for Testing and Materials International (ASTM) specification for biodiesel (B100) is ASTM D6751-03. It is summarized in the table below. This specification is intended to insure the quality of biodiesel to be used as a blend stock at 20% and lower blend levels. Any biodiesel used in the United States for blending, should meet ASTM D6751 prior to blending. ASTM is a consensus based standards group comprised of engine and fuel injection equipment companies, fuel producers, and fuel users whose standards are recognized in the United States by EPA and most government entities, included states with the responsibility of insuring fuel quality.

For a description of the intent of each fuel quality requirement in the table below and further discussion on ASTM, please visit the Biodiesel Handling and Use Guidelines: http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/40555.pdf.

| Property | ASTM Method | Limits | Units |
|---|---|---|---|
| Flash Point | D93 | 130.0 min | °C |
| Water and Sediment | D2709 | 0.050 max. | %vol. |
| Kinematic Viscosity 40°C | D445 | 1.9 - 6.0 | $mm^2/s$ |
| Sulfated Ash | D874 | 0.020 max. | % mass |
| Sulfur* | D5453 | 0.0015 max (S15)<br>0.05 max (S500) | % mass |
| Copper Strip Corrosion | D130 | No. 3 max | |
| Cetane Number | D613 | 47 min. | |
| Cloud Point | D2500 | Report to Customer | °C |
| Carbon Residue** | D4530 | 0.050 max. | % mass |
| Acid Number | D664 | 0.80 max. | Mg KOH/g |
| Free Glycerin | D6584 | 0.020 max. | % mass. |
| Total Glycerin | D6584 | 0.240 max. | % mass. |
| Phosphorus Content | D4951 | 0.001 max. | % max. |
| Distillation Temperature, 90% Recovered (T90)*** | D1160 | 360 max. | °C |

*Sulfur content of on-road diesel fuel to be lowered to 15 ppm in 2006
**Carbon residue shall be run on the 100% sample
***Atmospheric equivalent temperature

[15] Biodiesel Handling and Use Guidelines. March 2006. US DOE. p 10

## National Biodiesel Board BQ-9000 Quality Management Program[16]


The National Biodiesel Accreditation Program is a cooperative and voluntary program for the accreditation of producers and marketers of biodiesel fuel called BQ-9000. The program is a combination of the ASTM standard for biodiesel (ASTM D 6751) and a quality systems program that includes storage, sampling, testing, blending, shipping, distribution, and fuel management practices.

BQ-9000 is open to any biodiesel manufacturer, marketer or distributor of biodiesel and biodiesel blends in the United States and Canada.

### Program Accreditation

Accreditation under the Program is open to all companies actively producing, distributing or marketing, or planning to produce, distribute or market, biodiesel fuel either in its neat form or for use in blending with a petroleum diesel fuel (or similar fuel). Accreditation is held for a period of two years, at which time, a company would need to undergo a recertification audit for another two year accreditation term.

Accreditation is awarded following a successful formal review and audit of the capacity and commitment of the applicant to produce or market biodiesel fuel that meets the ASTM D-6751 Specification for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels. The accreditation process is comprehensive and includes a detailed review of the applicant's Quality System documentation, followed by a formal audit of the applicant's conformance to its System.

Accredited Producer


This category is for companies that produce biodiesel fuel to the ASTM D 6751 standard. The program ensures a production company is using a system for monitoring the quality of their biodiesel, including:

- Sampling
- Testing
- Storage
- Retain samples
- Shipping

[16] BQ-9000 Quality Management Program. "Program Description." http://www.bq9000.org/description/

Certified Marketer

This category is for distribution companies who sell biodiesel and biodiesel blends. This is an important designation, because proper handling of biodiesel is as critical to fuel quality as proper production.

Visit the BQ-9000 website for more information:
http://www.bq-9000.org/

## ADMINISTRATIVE TO-DO'S FOR BIODIESEL DISTRIBUTORS, MARKETERS, AND/OR USERS

### Fuel Quality Registration

Issues that need to be addressed when looking at producing biodiesel for commercial sale in the US:

Registration with EPA as a biodiesel fuel producer: In the US, EPA governs fuel and fuel additive registration and anyone selling biodiesel must first be registered with them.

In most cases, each fuel supplier must first be registered in the state in which the fuel is being sold and suppliers must be properly licensed, bonded, and insured. Contacting your local Department of Revenue is a good starting point.

Incorporated fuel quality assurance procedures to guarantee the fuel meets ASTM D6751 specifications. The full specification has to be ordered through ASTM, www.astm.org.

Along with the ASTM standard for biodiesel, the industry also has in place a quality assurance program called BQ-9000. The program is a unique combination of the ASTM standard for biodiesel, ASTM D 6751, and a quality systems program that includes storage, sampling, testing, blending, shipping, distribution, and fuel management practices. There are two classes of accreditation in the BQ-9000 program, Accredited Producers and Certified Marketers. Accredited Producers are business units that commercially produce biodiesel. Certified Marketers are business units that undertake to commercially sell or resell biodiesel or biodiesel blends. For more information, http://www.bq-9000.org/.

### IRS and State Blender's Permitting/Registration Requirements

The following information was extracted from the National Biodiesel Board's Issue Brief: Biodiesel Tax Credit Implementation: http://www.biodiesel.org/news/taxincentive/Biodiesel%20Tax%20Credit%20NBB%20Issue%20Breif.pdf

### Biodiesel Producer, Importer, and Blender Registration

Biodiesel producers or importers of biodiesel must register with the IRS and have their application approved by the IRS prior to commencing production. The application and approval process may be a lengthy process.

Application for registration is to be done via IRS Form 637. The Service has updated its Form 637 and has developed two (2) new Activity Letters under

which a producer/importer will register as either one or both depending on whether they produce "biodiesel" or agri-biodiesel." The updated Form 637 is available on the Forms and Publications page of the IRS website: www.irs.gov.

Companies who are both biodiesel producers and blenders of biodiesel/agri-biodiesel into diesel fuel will have a combination of Activity Letters on their Form 637 registration that denotes production and blending.

*Blenders* must receive a 637 M designation from the IRS by applying for it on Form 637.

## Certificate For Biodiesel

The JOBS Act states that a biodiesel mixture credit is not allowed unless the producer of the mixture (i.e. blender) obtains a certificate from the biodiesel producer that identifies the product as "biodiesel" or "agri-biodiesel", that it is properly registered as a fuel with the EPA and that it meets the requirements of ASTM D 6751.

For more information and guidance on all the various distribution and inventory storage scenarios, visit http://www.biodiesel.org/news/taxincentive/ and download "Blender Tax Credit—General Overview."

## Claiming Credits & Receiving Payment for Excess Credits

IRS Notice 2005-62 clarified that a "biodiesel mixture" is a mixture of biodiesel and diesel fuel containing t least .1 percent (by volume) of diesel fuel. Thus, for example, a mixture of 999 gallons of biodiesel and 1 gallon of diesel fuel is a biodiesel mixture.

Eligible entities are currently able to file claims with the Service for credits and/or payments. Climants must follow the procedures outlined in Notice 2005-04 and Notice 2004-62 which include the following mandatory steps:

1. Blenders must use Form 720, Quarterly Federal Excise Tax Form; and Form 8849 to claim their credit(s) and payment for the excess sum of their credit(s) above their excise tax liability.
2. Blenders must use for 4136, Credit for Federal Tax Paid on Fuels; or Form 8846 Biodiesel Fuels Credit when claiming an income tax credit.

## Other Items of Understanding

IRS Notice 2005-62 provided further clarification regarding the definition of "agribiodiesel" to state the list of eligible feedstocks in the JOBS Act is not an exclusive list and that for example biodiesel derived solely from virgin oils includes esters derived from palm oil and fish oils.

Heating Oil. Heating oil is considered a taxable fuel that is exempt from taxation. Because of this, blending biodiesel and agri-biodiesel into heating oil would be considered as an eligible activity upon which the blender could make a Biodiesel Mixture Credit claim.

B100 used as a fuel. The IRS Notice 2005-04 addresses this in section 2 (e) on page 4. The guidance states that use of unblended B100 as a fuel qualifies for the income tax credit but not the excise tax credit. Entities should refer to Rev. Rul. 2002-76 for additional information regarding taxation of biodiesel. As is noted in that ruling, biodiesel is not included in the definition of a taxable diesel fuel (because it contains less than 4% normal paraffins). Tax is imposed on biodiesel when it is either a) blended into non-exempt taxable diesel fuel, or b) when B100 is delivered as fuel directly into the tank of a diesel-powered highway vehicle or a diesel-powered train. An entity that delivers B100 as a fuel directly into the tank of a vehicle may claim a nonrefundable income tax credit.

It is important to note that entities that blend biodiesel into undyed diesel fuel MUST report and remit the 24.4 cent per gallon tax on Form 720. As mentioned previously, the claimant may claim the applicable credit against their tax liability. Failure to report and remit taxes could result in substantial penalties including fines and imprisonment.

**Application of These "Understandings" to a Practical Scenario**

When a blender reports a tax liability (ie. blending into undyed diesel), it would utilize Form 720 reporting the gallons of biodiesel/agri-biodiesel blended, calculate the total tax, and claim the value of their Biodiesel Mixture Credits to offset their tax liability.

Claims requesting a refund of the excess value of Biodiesel Mixture Credits above a blender's excise tax credit should be able to be made prior to the end of the quarter utilizing Form 8849.

When a blender has no tax liability to report (ie. blending only into dyed diesel), it would utilize Form 8849 to make a claim for their excess biodiesel mixture credits.

IMPORTANT - Blending undyed biodiesel/agri-biodiesel into dyed diesel fuel: Blenders must take necessary action to ensure the finished blend meets required federal dye concentration specifications. If not, the blended fuel would be subject to taxation.

New fuel fraud provisions in Section 854(c) of the JOBS Act require that all dye added to diesel fuel must be added by tamper-proof, mechanical injection. This provision becomes effective 180 days after the final regulations are issued. Final and temporary regulations were issued on April 26, 2005 and become effective on October 24, 2005. The new regulations are clearly susceptible of an

interpretation that they require the mechanical injection of dye only in cases of removals of diesel and kerosene from terminal racks and bulk transfer facilities. However in conversations with IRS Office of Chief Counsel, the regulations were not intended to be interpreted as applying only to dyeing at terminal racks or bulk transfer facilities. The IRS may well answer questions regarding whether, and under what circumstances, the mechanical dyeing requirements apply below the rack. Therefore to date, the applicability of this requirement below the rack remains an open question.

## Complying with IRS Federal Fuel Excise Tax Regulations and any Applicable State Taxes

Contact the excise tax division of your state department of revenue for more specific information on any requirements they may have.

Contact Tammy West, Virginia Department of Motor Vehicles, to ensure you are meeting state registration and fuel tax requirements: dmvtpw@dmv.state.va.us.

Additional contacts at the Virginia Division of Motor Vehicles for questions about taxes:
(804) 367-2657 Candy Williams
(804) 367-4328 Jackie Dunn

## Biodiesel Training Checklist for New Biodiesel Marketers and Distributors

### In House Training

New biodiesel distributors and marketers should provide some in-house training prior to beginning a new biodiesel program. Here is a simple checklist of staff which should be provided with basic training to ensure a seamless integration of biodiesel into your product line.

*Sales Force*: Ensure your sales force knows biodiesel. Conduct a short workshop which covers the basics of biodiesel, including technical information regarding storage, blending and cold weather operability. Contact Virginia Clean Cities if you are unsure what kind of information should be included in this training.

*Office Staff*: Your office staff should be knowledgeable enough to field questions from customers. Provide your staff with quick guides or an FAQ manual which can be accessed easily. Keep track of customer inquiries and investigate thoroughly to ensure accurate information is being disseminated.

*Accounting*: There are several biofuels credits available to biodiesel blenders and distributors. Educate your accounting staff on biodiesel tax incentives and credits, as well as all applicable state and federal taxes.

Drivers: Drivers are an important piece of the seamless transition to biodiesel. As of this writing, many of the problems associated with biodiesel experienced by fleets in Virginia have been associated with improper biodiesel handling & blending practices (especially cold weather blending). Provide drivers with a short tutorial on proper handling and blending practices, and resources they can keep on hand if questions arise. Contact Virginia Clean Cities if you are unsure what kind of information you should provide drivers with.

**Customers**

Customers can make or break your new biodiesel program. An outreach and education campaign should be initiated prior to biodiesel roll-out. Educate customers on the benefits of biodiesel, and why you have begun to carry it. Be careful as to what information you provide customers with. If they receive a long list of problems to anticipate, chances are they will refuse to try the new product.

## RESOURCES

*National Oilheat Research Alliance Fuel Quality Manual*
Order online: https://www.norastore.org/online_shop.cfm#c20 (Item # NORA-FQM)

*Fuel Quality and Performance Guide (2006)*
National Biodiesel Board and United Soybean Board
http://www.biodiesel.org/pdf_files/FuelQualityandPerformanceGuide.pdf

*Quality Assurance video (May 2006)*
The National Biodiesel Board
http://www.biodiesel.org/multimedia/audiovideo/
*This video is an excellent resource, and can be used as an employee educational tool.*

*Biodiesel Handling and Use Guidelines (September 2006)*
National Renewable Energy Laboratory
http://www.nrel.gov/vehiclesandfuels/npbf/pdfs/40555.pdf

*Business Management for Biodiesel Producers (July 2004)*
National Renewable Energy Laboratory, Jon Van Gerpen
http://www.nrel.gov/docs/fy04osti/36242.pdf

*National Biodiesel Board Fuel Quality Policy*
http://www.biodiesel.org/pdf_files/fuelfactsheets/20060621_TAB_11_Fuel_Quality_Policy.pdf

*Virginia Department of Motor Vehicles: Licensing and Fuel Taxes*
http://www.dmv.virginia.gov/webdoc/commercial/taxact/license.asp - Who must be licensed

http://www.dmv.state.va.us/webdoc/pdf/ft213.pdf - Application

http://www.dmv.virginia.gov/webdoc/commercial/taxact/payments.asp - Paying fuel taxes

Contact Tammy West, Va DMV, to ensure you are meeting state registration and fuel tax requirements: dmvtpw@dmv.state.va.us (804) 367-0883

All producers & blenders must register with the IRS under Form 637

*Biodiesel Testing Labs*
http://www.biodiesel.org/resources/fuelqualityguide/testinglabs.shtm

## TANK CLEANING DIRECTORY

Virginia Clean Cities highly recommends hiring a professional tank cleaning service to handle preparing your current infrastructure for biodiesel delivery. Older tanks tend to accumulate sediment and sludge from years of diesel storage. Furthermore, the solvent properties of biodiesel will likely dissolve and loosen the sediment causing a variety of problems downstream.

The following tank cleaning services are located in Virginia, and have been used by one or more Virginia Clean Cities' stakeholders prior to their biodiesel transition and first delivery

Reco Biotechnology
710 Hospital Street, Richmond, VA
http://www.recobio.com/
Contact: Charles Firth
(804) 644-2800

Oil Equipment Sales & Service Co Inc
4331 Bainbridge Boulevard, Chesapeake, VA
www.oessco.com
Contact: Meg Laning
(757) 543-3596

Gec Environmental
13880 Berlin Turnpike, Lovettsville, VA (Northern Virginia)
(540) 882-4669