

MINUTES OF THE SENATE AGRICULTURE

The meeting was called to order by Chairman Mark Taddiken at 8:30 a. m. on February 7, 2006 in Room 423-S of the Capitol.

All members were present.

Committee staff present:

Raney Gilliland, Kansas Legislative Research
Lisa Montgomery, Office of Revisor of Statutes
Judy Seitz, Committee Secretary

Conferees appearing before the Committee:

Kenlon Johannes, Kansas Soybean Association
Jere White, Kansas Grain Sorghum Producers Association/Kansas Corn Growers

Others attending:

See attached list.

Chairman Taddiken noted that some of the handouts were as a result of Committee members' request for information. A Biodiesel Handling and Use Guidelines and a Biodiesel Cold Weather Blending report were distributed from the Kansas Soybean Association (Attachments 1 and 2).

The minutes for the January 31 and February 1 meeting were distributed and will be acted on later in the meeting.

Chairman Taddiken introduced a resolution congratulating and commending the Kansas Pork Association on its 50th Anniversary. Chairman Taddiken made a motion to introduce the resolution, seconded by Senator Lee. Motion passed.

Hearings were opened on **SB 393-Tax exemptions and credits for production of biodiesel fuel.**

Brad Harrelson, Kansas Farm Bureau, had previously submitted written testimony in support of **SB 393** (Attachment 3).

Kenlon Johannes appeared in favor of **SB 393** (Attachment 4). He said the proposed tax incentives are needed so that Kansas may be competitive with surrounding states. The Kansas Soybean Association also supports the exemption of personal property tax for items used in the point of sale in the storage, blending, dispensing, or preparation for sale of biodiesel.

Mr. Johannes stood for questions.

Chairman Taddiken introduced Chris Courtwright, Legislative Research staff person for the Assessment and Taxation Committee. He answered some questions on this bill regarding taxes.

Mr. Gilliland said **SB 393** has three components: property tax, income tax and sales tax.

Mr. Courtwright stood for more questions.

The Chairman declared the hearings on **SB 393** closed. Hearings opened on **SB 390 –Biofuels railroad terminals, property tax exemption, issuance of bonds by Kansas Development Finance Authority (KDFA).**

Mr. Gilliland said **SB 390** is another bill which came from the Select Joint Committee on Energy. This bill deals with property used exclusively as a biofuels railroad terminal for the distribution and transportation of biofuels or ingredients used in production of biofuels. This would provide for a property tax exemption for twelve (12) years for facilities completed after December 31, 2005.

Mr. Gilliland stood for questions.

CONTINUATION SHEET

MINUTES OF THE Senate Agriculture at 8:30 a.m. on February 7, 2006 in Room 423-S of the Capitol.

Other questions were asked of Mr. Courtwright.

Kenlon Johannes spoke as a proponent for **SB 390** (Attachment 5). He said that farmers and other investors in biodiesel plants need the tax exemption in order to compete with nearby states.

Mr. Johannes stood for questions.

Jere White spoke in support of **SB 390** (Attachment 6) and suggested a change on page 1, beginning on line 19, that the words "and its co-products" be added following the word "biofuels."

Mr. White took questions from the Committee.

The Chairman handed out a drawing (Attachment 7) to illustrate the handling of trains in regards to loading cars.

Pat Hubbell, Kansas Railroads, stood for questions.

Chairman Taddiken closed the hearings on **SB 390**.

Chairman Taddiken began discussions on **SB 388 – Establishing the Kansas qualified biodiesel fuel producer incentive fund**. He made a motion to amend the bill to provide the incentive funds beginning the fourth quarter of 2007, page 1, line 20 and line 39. Senator Pine seconded the motion. There was discussion on the motion.

Motion by Senator Huelskamp to approve minutes of the February 1 and 2 Agriculture Committee meeting, seconded by Senator Schmidt. Motion passed.

The meeting adjourned at 9:28 a.m. The next meeting will be held on February 8.

SENATE AGRICULTURE COMMITTEE GUEST LIST

DATE: February 7, 2006

NAME	REPRESENTING
Mark Schreiber	Westar Energy
Matthew Todd	Senator Lee
David R. Corbin	KDOR
Ethan Erickson	KDOT
Anton Johannes	Kansas Soybean Association
Jerre White	KCCA-KCSPA
Duane Simpson	KAEP
Ernie Dominguez	KDOC
Ray Hammarlund	KDOC
Mandy Miller	Sen. Schmidt
Chris Wilson	KS Dairy Association
CV Cotsovalis	KDA
Estelle Montgomery	Hein Law Firm
John Donley	Ks. Livestock Assoc.
Patricia R. Hubbell	Ks. Railroads
Ken Selman	KS Petroleum Council
Tom Palace	PMCA of KS
Wayne Reed	PMCA of KS ^M
Judy Braden	Alliance of Auto Mfg

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2004

Biomass

BIODIESEL

Handling and Use Guidelines



DOE/GO-102004-1999
Revised November 2004



U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

*Senate Agriculture Committee
2-7-06
Attachment 1*

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Foreword

This is version two of the *Biodiesel Handling and Use Guidelines*. I want to thank the many users of version one that provided suggestions for improving these guidelines. I've updated it and incorporated suggestions and recommendations from many biodiesel users and technical experts in the biodiesel and petroleum diesel world. Version two contains more detail than version one because every time someone called with a question, I made a note to include the answers in version two.

I also want to thank the contributing authors and reviewers for their ideas that have enriched this document. It's been a pleasure working with you.

K. Shaine Tyson
National Renewable Energy Laboratory

Table of Contents

1.	Introduction.....	1
2.	Biodiesel Basics.....	2
	2.1 What is Biodiesel?	2
	2.2 Registration and Regulation.....	2
	2.3 Benefits of Biodiesel Use.....	4
	2.4 Drawbacks of Biodiesel Use.....	6
	2.5 Biodiesel in Non-Transportation Applications	7
3.	Biodiesel (B100).....	8
	3.1 Quality Specifications.....	10
	3.2 Variation in Biodiesel Properties	14
	3.3 B100 Energy Content.....	16
	3.4 B100 Cold Flow Properties.....	16
	3.5 B100 Cetane Number.....	20
	3.6 B100 Stability	21
	3.7 B100 Microbial Contamination	25
	3.8 B100 Cleaning Effect.....	25
	3.9 B100 Material Compatibility	26
	3.10 Suggestions for Transporting B100	27
	3.11 Suggestions for Using B100	27
	3.12 B100 and NO _x Emissions	28
4.	Using 20% Biodiesel Blends	31
	4.1 B20 Cold flow.....	31
	4.2 Blending Biodiesel to Make B20 or Lower Blends	37
	4.3 B20 and Emissions.....	43
	4.4 B20 Cleaning Effect.....	43
	4.5 B20 Material Compatibility	43
	4.6 Lubricity.....	44
	4.7 B20 Stability	44
5.	Warranty Issues.....	46
6.	Taxes and Incentives	47
7.	Safety, Health, and Environmental Issues	48
8.	Using Biodiesel Under the Energy Policy Act	49
9.	Frequently Asked Questions about Using Biodiesel	50
10.	Information Resources	54
11.	Glossary/definitions	55
12.	Sample Biodiesel Material Safety Data Sheet	58

List of Figures

Figure 1. Average emission impacts of biodiesel fuels in CI engines	6
Figure 2. Composition of various biodiesel feedstocks	15
Figure 3. Heating value of diesel and biodiesel (B100) fuels.....	16
Figure 4. Melting points of biodiesel components.....	19
Figure 5. Cetane number of fuels made from pure fatty acids.....	20
Figure 6. Cetane number of fatty acid methyl esters, petroleum diesel and various biodiesel fuels	21
Figure 7. ASTM D4625 (43°C) Long-term storage stability. B100 on left. B20 on Right. Some fuels contain natural antioxidants, some contain additions, some B100 distilled, some natural.	24
Figure 8. NOx emissions of B100 made from single types of fatty acids	29
Figure 9. Increase in NOx emissions from CI engines using various B100 fuels	29
Figure 10. Biodiesel/diesel blend cloud point test results.....	32
Figure 11. Biodiesel/diesel blend pour point test results	32
Figure 12. Biodiesel/diesel blend cloud point test results (0–10% biodiesel blend range)	33
Figure 13. Biodiesel/diesel blend pour point test results (0–10% biodiesel blend range)	33
Figure 14. Biodiesel/diesel blend cold filter plugging point test results.....	34
Figure 15. Biodiesel/diesel blend cold filter plugging point test results (0–10% biodiesel blend range)	34
Figure 16. Adjusting cloud points of B20 fuels with blends of No. 1 and No. 2 diesel ...	35
Figure 17. Cold flow properties of some soy biodiesel blends, °F	36
Figure 18. Scuffing Load Ball on Cylinder (SCBOCLE) lubricity data for various biodiesel fuels	44
Figure 19. Logo for a Certified B100 Distributor.....	51

List of Tables

Table 1. Selected Properties of Typical No. 2 Diesel and Biodiesel Fuels.	9
Table 2. Requirements for Biodiesel (B100) Blend Stock as Listed in ASTM D6751-0310	
Table 3. Fuel Properties as a Function of Fuel Composition in Diesel Engines	15
Table 4. Cold Flow Data for Various B100 Fuels	18

Abbreviations and Acronyms

AFV	alternative fuel vehicle
ASTM	American Society for Testing and Materials
B100	100% biodiesel
B20	20% biodiesel, 80% petroleum diesel
BTU	British Thermal Unit
CFPP	cold filter plug point
CI	compression ignition
CO	carbon monoxide
CO ₂	carbon dioxide
DOE	U.S. Department of Energy
ECRA	Energy Conservation Reauthorization Act of 1998
EPA	U.S. Environmental Protection Agency
EPAc	Energy Policy Act of 1992
FAME	fatty acid methyl esters
GVWR	gross vehicle weight rating
HC	hydrocarbon
HUMBUGS	hydrocarbon utilizing microorganisms
MSDA	material safety data sheet
MSHA	Department of Labor's Mining Safety Health Administration
NBB	National Biodiesel Board
NO _x	nitrogen oxide
NPAH	nitroated polyaromatic hydrocarbons
NREL	National Renewable Energy Laboratory
OEM	original equipment manufacturer
OSHA	Occupational Safety and Health Administration
PAH	polyaromatic hydrocarbons
PM	particulate matter
ppm	parts per million
SO ₂	sulfur dioxide
ULSD	ultra low sulfur diesel
VOC	volatile organic compound

1. INTRODUCTION

This document is a guide for those who blend, distribute, and use biodiesel and biodiesel blends. It is intended to help fleets and individual users, blenders, distributors, and those involved in related activities understand procedures for handling and using biodiesel fuels. We hope it will be a useful tool, both when planning biodiesel use and as an ongoing resource.

Biodiesel is a renewable fuel manufactured from vegetable oils, animal fats, and recycled cooking oils. Biodiesel offers many advantages:

- It is renewable.
- It is energy efficient.
- It displaces petroleum derived diesel fuel.
- It can be used in most diesel equipment with no or only minor modifications.
- It can reduce global warming gas emissions.
- It can reduce tailpipe emissions, including air toxics.
- It is nontoxic, biodegradable, and suitable for sensitive environments.
- It is made in the United States from either agricultural or recycled resources.
- It can be easy to use if you follow these guidelines.

Biodiesel can be used in several different ways. You can use 1% to 2% biodiesel as a lubricity additive, which could be especially important for ultra low sulfur diesel fuels (ULSD, less than 15 ppm sulfur), which may have poor lubricating properties. You can blend 20% biodiesel with 80% diesel fuel (B20) for use in most applications that use diesel fuel. You can even use it in its pure form (B100) if you take proper precautions. The word *biodiesel* in this report refers to the pure fuel—B100—that meets the specific biodiesel definition and standards approved by ASTM International. A number following the “B” indicates the percentage of biodiesel in a gallon of fuel, where the remainder of the gallon can be No. 1 or No. 2 diesel, kerosene, jet A, JP8, heating oil, or any other distillate fuel.¹

Today, B20 is the most common biodiesel blend in the United States because it balances property differences with conventional diesel, performance, emission benefits, and costs. B20 is also the minimum blend level allowed for Energy Policy Act of 1992 (EPAct) compliance. B20 can be used in equipment designed to use diesel fuel. Equipment that can use B20 includes compression-ignition (CI) engines, fuel oil and heating oil boilers, and turbines.

Higher blend levels, such as B50 or B100, require special handling and fuel management and may require equipment modifications such as the use of heaters or changing seals and gaskets that come in contact with the fuel to those compatible with high blends of biodiesel. The level of special care needed largely depends on the engine and vehicle manufacturer. High blend levels are not recommended for the first-time biodiesel consumer.

¹ The ASTM standard for B100 to be used as a blend stock is D6751. Diesel fuel is defined in ASTM D975. ASTM D396 defines heating oils. A-A-59693A defines B20 for military use.

2. BIODIESEL BASICS

This section provides a basic overview of biodiesel. This section, in addition to the Frequently Asked Questions (Chapter 9) will help you answer general questions from your management, customers, or reporters. Technical details are provided in Chapters 3-8.

2.1 What is Biodiesel?

Biodiesel is a diesel replacement fuel that is manufactured from vegetable oils, recycled cooking greases or oils, or animal fats. Because plants produce oils from sunlight and air, and can do so year after year on cropland, these oils are renewable. Animal fats are produced when the animal consumes plant oils and other fats, and they too are renewable. Used cooking oils are mostly made from vegetable oils, but may also contain animal fats. Used cooking oils are both recycled and renewable.

The biodiesel manufacturing process converts oils and fats into chemicals called long chain mono alkyl esters, or biodiesel. These chemicals are also referred to as fatty acid methyl esters or FAME. In the manufacturing process, 100 pounds of oils or fats are reacted with 10 pounds of a short chain alcohol (usually methanol) in the presence of a catalyst (usually sodium or potassium hydroxide) to form 100 pounds of biodiesel and 10 pounds of glycerine. Glycerine is a sugar, and is a co-product of the biodiesel process.

Raw or refined vegetable oil, or recycled greases that have not been processed into biodiesel, are not biodiesel and should be avoided. Research shows that vegetable oil or greases used in CI engines at levels as low as 10% to 20%, can cause long-term engine deposits, ring sticking, lube oil gelling, and other maintenance problems and can reduce engine life. These problems are caused mostly by the greater viscosity, or thickness, of the raw oils (around 40 mm²/s) compared to that of the diesel fuel for which the engines and injectors were designed (between 1.3 and 4.1 mm²/s). To avoid viscosity-related problems, vegetable oils and other feedstocks are converted into biodiesel. Through the process of converting vegetable oil or greases to biodiesel, we reduce viscosity of the fuel to values similar to conventional diesel fuel (biodiesel values are typically between 4 and 5 mm²/s).

2.2 Registration and Regulation

ASTM International 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 most government entities, including states with the responsibility of insuring fuel quality. The specification for biodiesel (B100) is ASTM D6751-03. 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 standards.

The definition of biodiesel within ASTM D6751 describes long chain fatty acid esters from vegetable or animal fats that contain only one alcohol molecule on one ester linkage. Raw or refined vegetable oils contain three ester linkages and are therefore not legally biodiesel. Biodiesel can be made from methyl, ethyl, isopropyl, and other

alcohols, but most biodiesel research focuses on methyl esters and virtually all commercial-production in the United States today uses methyl esters. Some research has occurred on ethyl esters (biodiesel produced with ethanol as the alcohol rather than methanol), however higher ethanol prices relative to methanol, lower ethyl ester conversions, and the difficulty of recycling excess ethanol internally in the process, have hampered ethyl ester production in the commercial marketplace. Therefore, in this document we will only consider methyl esters.

Biodiesel is a legally registered fuel and fuel additive with the U.S. Environmental Protection Agency (EPA). The EPA registration includes all biodiesel meeting the ASTM International biodiesel specification, ASTM D 6751, and is not dependent upon the oil or fat used to produce the biodiesel or the specific process employed.

Do not be fooled by other so-called "biofuel" products, many of which are being offered to consumers without the benefit of EPA registration or extensive testing and demonstrations. In fact, if you purchase methyl ester that does not meet ASTM biodiesel standards, it is not legally biodiesel and should not be used in diesel engines or other equipment designed to operate on diesel fuel. Methyl esters are used as an industrial lubricant and solvent in some applications so be sure to purchase only ASTM grade methyl esters (i.e. biodiesel).

Biodiesel is a recognized alternative fuel under the Energy Policy Act of 1992 (EPAct) as amended in 1996. EPAct requires that over 75% of new vehicle purchases by certain federal, state, and alternative fuel provider fleets be alternative fueled vehicles. As a recognized alternative fuel, any vehicle certified to run on B100 could qualify under the alternative fuel vehicle purchase provisions of EPAct, but it does not appear that any vehicles meeting this requirement are available today. B100 is more expensive than other alternative fuel options, and the original equipment manufacturer (OEM) community has had little interest in certifying vehicles on B100, so this vehicle credit has not created a market for biodiesel.

EPAct was amended in 1998 by the Energy Conservation and Reauthorization Act (ECRA). The amendment allowed qualified fleets to use B20 in existing vehicles to generate alternative fuel vehicle purchase credits, with some limitations. This has created significant B20 use by government and alternative fuel provider fleets. For more information on using biodiesel to fulfill EPAct requirements, see Chapter 8, Using Biodiesel Under the Energy Policy Act.

As biodiesel grows in popularity, some states are beginning to develop biodiesel incentive policies to promote biodiesel use and production. State policies can change rapidly, so please contact your state agencies or the National Biodiesel Board for more information.

2.3 Benefits of Biodiesel Use

Biodiesel Displaces Imported Petroleum

The fossil fuel energy required to produce biodiesel from soybean oil is only a fraction (31%) of the energy contained in one gallon of the fuel.² You get 3.2 units of fuel energy from biodiesel for every unit of fossil energy used to produce the fuel. That estimate includes the energy used in diesel farm equipment and transportation equipment (trucks, locomotives), fossil fuels used to produce fertilizers and pesticides, fossil fuels used to produce steam and electricity, and methanol used in the manufacturing process. Because biodiesel is an energy-efficient fuel, it can extend petroleum supplies and makes for sound state or federal energy policy.

Biodiesel Reduces Emissions

When biodiesel displaces petroleum, it reduces global warming gas emissions such as carbon dioxide (CO₂). When plants like soybeans grow they take CO₂ from the air to make the stems, roots, leaves, and seeds (soybeans). After the oil is extracted from the soybeans, it is converted into biodiesel and when burned produces CO₂ and other emissions, which return to the atmosphere. This cycle does not add to the net CO₂ concentration in the air because the next soybean crop will reuse the CO₂ in order to grow.

When fossil fuels are burned, however, 100% of the CO₂ released adds to the CO₂ concentration levels in the air. Because fossil fuels are used to produce biodiesel, the recycling of CO₂ with biodiesel is not 100%, but substituting biodiesel for petroleum diesel reduces life-cycle CO₂ emissions by 78%. B20 reduces CO₂ by 15.66%.³

Biodiesel reduces tailpipe particulate matter (PM), hydrocarbon (HC), and carbon monoxide (CO) emissions from most modern four-stroke CI engines. These benefits occur because the fuel (B100) contains 11% oxygen by weight. The presence of fuel oxygen allows the fuel to burn more completely, so fewer unburned fuel emissions result. This same phenomenon reduces air toxics, because the air toxics are associated with the unburned or partially burned HC and PM emissions. Testing has shown that PM, HC, and CO reductions are independent of the feedstock used to make biodiesel. The EPA reviewed 80 biodiesel emission tests on CI engines and has concluded that the benefits are real and predictable over a wide range of biodiesel blends (Figure 1, page 5).⁴

² Sheehan et al. May 1998. *A Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus*. NREL/SR-580-24089.

³ Some other life cycle studies show negative emission benefits for biodiesel. Those studies assume that oilseed crops are planted on native prairie. In the United States, oilseed crops such as soybean, sunflower and canola are planted on cropland that has been used to produce crops for more than 150 years. None of the life cycle studies take credit for the ability of soybean crops to sequester nitrogen in their root systems. This sequestering benefit reduces nitrogen fertilizer requirements for crops planted in the following year and saves emissions that result from the production of nitrogen fertilizer from natural gas.

⁴ 39 studies were ultimately used in the EPA analysis in Figure 1.

In older two-stroke engines, B20 can reduce CO, HC, and PM if the engines do not consume excessive amounts of lube oil. If lube oil consumption is high, PM benefits from B20 use may be less than shown in Figure 1.

In addition, one of the first benefits that people notice when using biodiesel or biodiesel blends is the smell. Using biodiesel can make diesel exhaust smell better; more like cooking odors.

Biodiesel and Human Health

Some PM and HC emissions from diesel fuel combustion are toxic or are suspected of causing cancer and other life threatening illnesses. Using B100 can eliminate as much as 90% of these “air toxics.” B20 reduces air toxics by 20% to 40%. The effects of biodiesel on air toxics are supported by numerous studies, starting with the former Bureau of Mines Center for Diesel Research at the University of Minnesota. The Department of Energy (DOE) conducted similar research through the University of Idaho, Southwest Research Institute, and the Montana Department of Environmental Quality. The National Biodiesel Board conducted Tier I and Tier II Health Effects Studies that also support these claims.

Recently, the Department of Labor’s Mining Safety Health Administration (MSHA) tested and approved the use of biodiesel in underground mining equipment where workers are exposed to high levels of diesel exhaust.⁵ Switching to biodiesel blends is believed to reduce the risk of illness and life-threatening diseases in miners.

Biodiesel Improves Lubricity

By 2006, all U.S. highway diesel will contain less than 15 ppm sulfur—ultra low sulfur diesel fuel (ULSD). Currently highway diesel contains 500 ppm sulfur (or less). Biodiesel typically contains less than 15 parts per million (ppm) sulfur (sometimes as low as zero). Some biodiesel produced today may exceed 15 ppm sulfur, and those producers will be required to reduce those levels by 2006 if the biodiesel is sold into on-road markets.

In the on-road market, low-level blends of biodiesel such as 1% or 2% can improve lubricity of diesel fuels and this may be particularly important for ULSD as these fuels can have poor lubricating properties. Engine manufacturers depend on lubricity to keep moving parts, especially fuel pumps, from wearing prematurely. Even 2% biodiesel can restore adequate lubricity to dry fuels such as kerosene or Fischer-Tropsch diesel.

Biodiesel is Easy to Use

And last, but maybe not least, the biggest benefit to using biodiesel is that it is easy. In blends of B20 or less, it is literally a “drop in” technology. No new equipment and no equipment modifications are necessary. B20 can be stored in diesel fuel tanks and pumped with diesel equipment. You can find many users to ask questions of and compare notes with. There are some caveats and precautions that must be followed to ensure a trouble free B20 experience and some mistakes to be avoided, as discussed in this guide.

⁵ Schultz, Mark and David Atchison. 2003. *Environmental Diesel Particulate Matter Investigation* PS&HTC-DD-03-808.

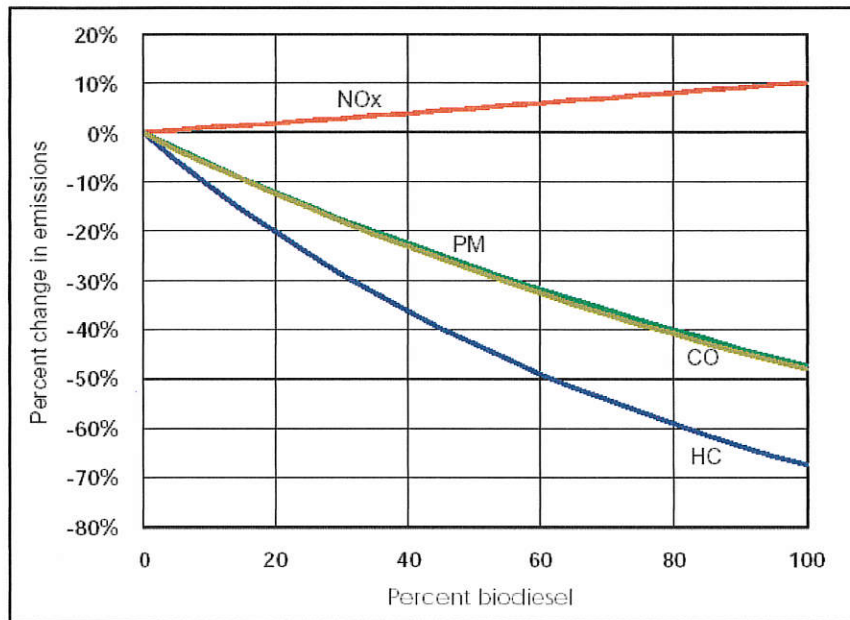


Figure 1. Average emission impacts of biodiesel fuels in CI engines⁶

2.4 Drawbacks of Biodiesel Use

Biodiesel contains 8% less energy per gallon than typical No. 2 diesel in the United States; 12.5% less energy per pound. The difference between these two measurements is caused by the fact that biodiesel is slightly more dense than diesel fuel, so there are slightly more pounds in a gallon of fuel. All biodiesel, regardless of its feedstock, provides about the same amount of energy.

	<u>Btu/lb</u>	<u>Btu/gal</u>
Typical Diesel No. 2	18,300	129,050
Biodiesel (B100)	16,000	118,170

The difference in energy content can be noticeable if you are using B100. If you are using B20, the difference in power, torque, and fuel economy should be between 1% and 2%, depending on the diesel with which you are blending. Most users report little difference between B20 and No. 2 diesel fuel. As the biodiesel blend level is lowered, any differences in energy content become diminished and blends of B5 or less do not cause noticeable differences in performance compared to diesel No. 2.

⁶ Environmental Protection Agency. October 2002 Draft Technical Report, *A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions*, (EPA420-P-02-001) (www.epa.gov/OMS/models/biodsl.htm).

A further drawback to biodiesel use is its less favorable cold flow properties compared to conventional diesel. 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 eventually it can become thick enough that it cannot even be pumped from the fuel tank to the engine.

Biodiesel has also been shown to increase nitrogen oxide (NO_x) emissions in many engines. Biodiesel does not contain nitrogen so the increasing NO_x phenomenon is not related to fuel nitrogen content. NO_x is created in the engine as the nitrogen in the intake air reacts at the high in-cylinder combustion temperatures. As with petroleum based diesel fuel, the exact composition of the biodiesel can also influence NO_x emissions. Data shows NO_x variability between the various biodiesel meeting ASTM D6751 of around 15%, with soybean oil based biodiesel producing the highest NO_x increase. This is similar to the variability observed for conventional diesel fuels spanning the range of the ASTM diesel fuel specifications (ASTM D975).

2.5 Biodiesel in Non-Transportation Applications

When biodiesel is used in CI engines, nitrogen oxide (NO_x) emissions tend to increase as shown above. But when biodiesel is used in boilers or home heating oil applications, NO_x tends to decrease. The fuel is burned in very different ways in these dramatically different applications (open flame for boilers, enclosed cylinder with high pressure spray combustion for engines) and results in different effects.

Heating oil boilers have been tested with blends as high as 20% biodiesel. At 20% biodiesel, NO_x emissions appear to be reduced 20% over the entire range of air settings, based on studies of several different boiler systems conducted by Brookhaven National Laboratory,⁷ the New England Fuel Institute, the Massachusetts Oil Heat Council, and the Northeast Oil Research Organization.⁸ Sulfur dioxide (SO₂) emissions were reduced when the two fuels were blended because biodiesel contains much less sulfur than typical heating oil. So a 20% blend of biodiesel in heating oil will reduce SO₂ by about 20%.

Heating oil and diesel fuel that is dyed red for off-road use (agriculture, power, boiler fuels, construction, forestry, mining, etc.) can contain as much as 5,000 ppm sulfur today. By blending biodiesel into off-road diesel fuel, large SO₂ reduction benefits can be generated. Even if off-road diesel sulfur content is reduced to 500 ppm in the future (under EPA consideration), biodiesel will still provide significant SO₂ benefits in these markets for a long time to come.

⁷ Krishna, C.R. October 2003. *Biodiesel Blends in Space Heating Equipment*, NREL/SR-510-33579.

⁸ Batey, John E. December 2002. Interim report of test results, Massachusetts Oilheat Council Biodiesel Project.

3. BIODIESEL (B100)

This section will describe the basic properties and blending considerations for B100 fuels. The considerations for storing, handling, blending and using B100 are *very different* than for B20 or lower biodiesel blends, but for some readers the B100 information may help you further understand B20 use. If you are only 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.

B100 has physical and chemical properties similar to petroleum based diesel (see Table 1) and can in some cases be used in existing diesel applications with little or no modification to the engine or fueling system. While B100 can be used as a pure fuel in diesel applications, there are important differences between B100 and conventional diesel fuels that must be taken into consideration when handling or using B100. Using B20 and lower blends significantly reduces or eliminates the issues described here (see the following section on using B20).

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 and this must be taken into account if handling or using B100. Most B100 starts to cloud at between 35°F and 60°F, so heated fuel lines and tanks may be needed even in moderate climates. 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. Cold weather properties are the biggest reason many people use biodiesel blends.
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.
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.

There are other physical or chemical properties where biodiesel is substantially different from petroleum diesel and where these differences provide significant benefits. Biodiesel has significantly lower sulfur than today's diesel fuel, while providing a significant increase in lubricity. Most B100 already meets the EPA's new rule requiring all on-road diesel fuel to contain less than 15 ppm sulfur in 2006. The future 15 ppm diesel—Ultra low sulfur diesel or ULSD—can create lubricity problems as the new refining processes tends to reduce the natural lubricity of diesel. Pure biodiesel, or biodiesel blended with ULSD restores fuel lubricity in levels as low as 1% or 2% biodiesel. Biodiesel also contains 11% oxygen by weight, as well as a slightly higher cetane number, which provides for more complete combustion and a reduction in most emissions.

Table 1. Selected Properties of Typical No. 2 Diesel and Biodiesel Fuels.

<u>Fuel Property</u>	<u>Diesel</u>	<u>Biodiesel</u>
Fuel Standard	ASTM D975	ASTM D6751
Lower Heating Value, Btu/gal	~129,050	~118,170
Kinematic Viscosity, @ 40°C	1.3-4.1	4.0-6.0
Specific Gravity kg/l @ 60°F	0.85	0.88
Density, lb/gal @ 15°C	7.079	7.328
Water and Sediment, vol%	0.05 max	0.05 max
Carbon, wt %	87	77
Hydrogen, wt %	13	12
Oxygen, by dif. Wt %	0	11
Sulfur, wt %*	0.05 max	0.0 to 0.0024
Boiling Point, °C	180 to 340	315 to 350
Flash Point, °C	60 to 80	100 to 170
Cloud Point, °C	-15 to 5	-3 to 12
Pour Point, °C	-35 to -15	-15 to 10
Cetane Number	40-55	48-65
Lubricity SLBOCLE, grams	2000-5000	>7,000
Lubricity HFRR, microns	300-600	<300

*Sulfur content for on-road fuel will be lowered to 15 ppm maximum in 2006.

3.1 Quality Specifications

The American Society for Testing and Materials International (ASTM) specification for biodiesel (B100) is ASTM D6751-03. It is summarized in Table 2 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, including states with the responsibility of insuring fuel quality.

As with other ASTM fuel standards, ASTM D6751 is based on the physical and chemical properties needed for safe and satisfactory diesel engine operation. It is not based on the specific raw materials or the manufacturing process used to produce the biodiesel. The finished blend stock must meet the properties specified in Table 2 below as well as the following definition:

Biodiesel, noun, a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100.

Table 2. Requirements for Biodiesel (B100) Blend Stock as Listed in ASTM D6751-03

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) 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

The definition of biodiesel contained in ASTM D 6751, along with the physical and chemical property limits, eliminates certain “biofuels” that have been incorrectly called biodiesel in the past. The raw vegetable oil or animal fat feedstock, partially reacted oils

or fats, coal slurries, or any other “biologically derived” fuels not meeting the definition and table above are not biodiesel and should not be confused with biodiesel.

The ASTM biodiesel standard began as a standard for B100 as a stand alone motor fuel. During the ASTM ballot process, lack of experience with blends over B20 did not allow ASTM to come to consensus on the properties needed for satisfactory B100 operation. The standard was re-named to reflect its formal approval by ASTM as applying to a blend stock but not to a neat motor fuel. While D6751 can be used as the standard for B100 as a neat motor fuel upon consultation with the equipment manufacturer, and is being used successfully for that purpose in the United States today, users and suppliers should recognize that D6751 does not have full ASTM consensus as a stand alone fuel specification and that B100 is only recognized by a select few equipment manufacturers (see warranty section).

Buyers and sellers are encouraged to use ASTM D6751 for the commercial trading of biodiesel (B100) whether the fuel is planned for B100 use or for blending. Other arrangements or specifications can be legally used provided both the buyer and seller agree upon them and so long as they meet pertinent local, state, and federal regulations (i.e. EPA sulfur limits, OSHA safety limits on flash point, etc.).

Some of the test methods listed in Table 2 perform more than one role to ensure that the fuel performs as intended in CI engines and as tests to ensure that the manufacturer produced a high-quality B100. The intent of each quality requirement in Table 2 is described below:

- A minimum **flash point** for diesel fuel is required for fire safety. B100’s flash point is typically much higher than diesel fuel’s (150° C compared to 70° C) to ensure that the manufacturer has removed excess methanol used in the manufacturing process. Residual methanol in the fuel is a safety issue because even very small amounts reduce the flash point. Residual methanol, which can be found in biodiesel with low, out-of-specification flash point, can also affect fuel pumps, seals and elastomers, and can result in poor combustion properties.
- **Water and sediment** refers to the presence of free water droplets and sediment particles. The allowable level for B100 is set at the same level allowed for conventional diesel fuel. Poor drying techniques during manufacturing or contact with excessive water during transport or storage can cause B100 to be out of specification for water content. Excess water can lead to corrosion and provides an environment for microorganisms. Fuel oxidation can also raise sediment levels, so this test can be used in conjunction with acid number and viscosity to determine if fuels have oxidized too much during storage.
- A minimum **viscosity** is required for some engines because of the potential for power loss caused by injection pump and injector leakage. This is not an issue for B100 and the minimum is set at the same level as for petroleum diesel. The maximum viscosity is limited by the design of engine fuel injection systems. Higher viscosity fuels can cause poor fuel combustion that leads to deposit formation as well as higher in-cylinder penetration of the fuel spray which can result in elevated engine oil dilution

with fuel. The maximum allowable viscosity in ASTM D975 for No. 2 diesel is 4.1 mm²/s at 40°C although most engines are designed to operate on fuels of higher viscosity than 4.1 mm²/s. ASTM D6751 allows for slightly higher viscosity than D975 primarily because that is where the normal viscosity of B100 lies. Consult your operational manual or your engine manufacturer if you intend to use a B100 in your engine that has a higher viscosity than what the engine or fuel system was designed for.

- The **sulfated ash** test measures the amount of residual alkali catalyst present in the biodiesel as well as any other ash forming compounds that could contribute to injector deposits or fuel system fouling.
- **Sulfur** is limited to reduce sulfate and sulfuric acid pollutant emissions and to protect exhaust catalyst systems when they are deployed on diesel engines in the future. Biodiesel generally contains less than 15 ppm sulfur. The test for low-sulfur fuel (ASTM D5453) should be used for accurate results instead of D2622, which will provide falsely high results due to test interference with the oxygen in the biodiesel.
- The **copper strip corrosion** test is used to indicate potential difficulties with copper and bronze fuel system components. The requirements for B100 and conventional diesel are identical, and biodiesel meeting other D6751 specifications always passes this test. While copper and bronze may not corrode in the presence of biodiesel fuel, prolonged contact with these catalysts can cause fuel degradation and sediment formation.
- An adequate **cetane number** is required for good engine performance. Conventional diesel must have a cetane number of at least 40 in the United States. Higher cetane numbers help ensure good cold start properties and minimize the formation of white smoke. The ASTM limit for B100 cetane number is set at 47 as this is the level identified for “Premium Diesel Fuel” by the National Conference of Weights and Measures, as well as the fact that 47 has been the lowest cetane number found in U.S. biodiesel fuels. The cetane index (ASTM D976) is not an accurate predictor of cetane number for biodiesel or biodiesel blends since it is based on a calculation using specific gravity and distillation curve, both of which are different for biodiesel than for petrodiesel.
- **Cloud point** is important for ensuring good performance in cold temperatures. B100 cloud point is typically higher than the cloud point of conventional diesel. Low temperature properties and strategies for ensuring good low-temperature performance of biodiesel blends are discussed in more detail in the following chapters.
- **Carbon residue** gives a measure of the carbon-depositing tendency of a fuel and is an approximation of the tendency for carbon deposits to form in an engine. For conventional diesel fuel the carbon residue is measured on the 10% distillation residue. Because B100 boils entirely in the high end of the diesel fuel range and at approximately the same temperature it is difficult to leave only a 10% residual when distilling biodiesel. So biodiesel carbon residue specifies that the entire biodiesel sample be used rather than the 10% distilled residue.
- **Acid number** for biodiesel is primarily an indicator of free fatty acids (natural degradation products of fats and oils) and can be elevated if a fuel is not properly manufactured or has undergone oxidative degradation. Acid numbers higher than 0.80

have been associated with fuel system deposits and reduced life of fuel pumps and filters.

- **Free and total glycerin** numbers measure the amount of unconverted or partially converted fats and by-product glycerin present in the fuel. Incomplete conversion of the fats and oils into biodiesel can lead to high total glycerin. Incomplete removal of glycerin can lead to high free glycerin and total glycerin. If these numbers are too high, storage tank, fuel system, and engine fouling can occur. Fuels that exceed these limits are highly likely to cause filter plugging and other problems.
- **Phosphorus** content is limited to 10 ppm maximum in biodiesel because phosphorus can damage catalytic converters and phosphorus above 10 ppm can be present in some vegetable oils. Biodiesel produced in the United States generally has low phosphorus levels, on the order of 1 ppm.
- The **T90 distillation** specification was incorporated to ensure that fuels have not been contaminated with high boiling materials such as used motor oil. B100 exhibits a boiling point rather than a distillation curve. The fatty acids from which biodiesel is produced are mainly straight chain hydrocarbons with 16 to 18 carbons that have close boiling temperatures. The atmospheric boiling point of biodiesel generally ranges from 330°C to 357°C.

The D6751 specification also includes the following workmanship statement: “The biodiesel fuel shall be visually free of undissolved water, sediment, and suspended matter.” B100 should be clear, although it may come in a variety of colors. Biodiesel color does not predict fuel quality.

Currently there are ASTM specifications for B100 (D6751) and for petrodiesel (D975), but there is not a separate approved specification for biodiesel blends. Current practice to insure the quality of biodiesel blends is to use petrodiesel (No. 1 or No. 2) meeting D975 and biodiesel meeting D6751 prior to blending. Once blended, it is very difficult to determine the quality of the B100 used to make the blend. ASTM specifications for finished biodiesel blends up to B20 are under development, so please check with ASTM or the National Biodiesel Board (NBB) for updated information.

B5 and lower blends generally meet the properties listed in ASTM D975, which defines the properties of conventional diesel fuel. B20 or higher blends can also meet the properties listed in ASTM D975 with the possible exception of viscosity and distillation, depending mostly on the diesel fuel with which it is blended. The engine community has generally agreed that a slightly higher distillation with biodiesel blends will not cause the technical problems associated with high boiling petrodiesel fuel—provided the increase is due to biodiesel meeting D6751. They have also stated that a higher viscosity than allowed by D975 may cause added stress on the fuel system and inadequate fuel atomization that can result in poor engine performance and injector coking. Biodiesel blends that meet ASTM D975 can generally be used interchangeably with diesel fuel for normal usage, as long as the biodiesel meets the requirements of ASTM D6751 and the cold flow properties of the blend are adequate for the geography and time of year the fuel will be used.

3.2 Variation in Biodiesel Properties

As with petroleum-based fuels, the ASTM specifications for biodiesel allow for a variety of feedstocks and processes to be used to produce biodiesel. The specifications prescribe the amount of acceptable variability in the finished product. This variability is a compromise between maximizing the amount of fuel available for use and minimizing cost, while providing a minimum satisfactory level of engine performance.

Since biodiesel is produced mainly as a whole cut fuel, where the goal is to take all of the vegetable oil or animal fat and turn it into biodiesel, some of the properties of finished biodiesel depend heavily on the feedstock. These properties can include cetane, cold flow, bulk modulus (compressibility), and stability. In addition, testing has shown that differing biodiesel properties can also lead to different levels of NO_x emissions from compression ignition (diesel) engines, although this does not appear to be the case with other regulated emissions (HC, CO, PM) or unregulated emissions (PAH, NPAH) or with open flame combustion in boilers or home heating applications.

Biodiesel can be produced commercially from a variety of oils and fats:

- Animal fats: edible tallow, inedible tallow, and all the other variations of tallow, lard, choice white grease, yellow grease, poultry fats and fish oils.
- Vegetable oils: soy, corn, canola, sunflower, rapeseed, cottonseed
- Recycled greases: used cooking oils and restaurant frying oils.

It is also possible to make biodiesel from other oils, fats and recycled oils such as mustard, palm, coconut, peanut, olive, sesame, and safflower oils, trap greases, and even oils produced from algae, fungi, bacteria, molds, and yeast.

Compared to the chemistry of diesel fuel, which contains hundreds of compounds, the chemistry of different fats and oils typically used for biodiesel are very similar. Each fat or oil molecule is made up of a glycerine backbone of three carbons, and on each of these carbons is attached a long chain fatty acid. These long chain fatty acids are what react with methanol to make the methyl ester, or biodiesel. The glycerin backbone is turned into glycerin and sold as a byproduct of biodiesel manufacturing. The fats and oils listed above contain 10 common types of fatty acids which have between 12 and 22 carbons, with over 90% of them being between 16 and 18 carbons. Some of these fatty acid chains are saturated, while others are monounsaturated and others are polyunsaturated. Within the limits of the specifications, the differing levels of saturation can affect some of the biodiesel fuel properties. This can be important when selecting the biodiesel for your application.

What makes each of these feedstocks different from the others is that they are made of different proportions of saturated, monounsaturated, and polyunsaturated fatty acids (Figure 2). A “perfect” biodiesel would be made only from monounsaturated fatty acids.

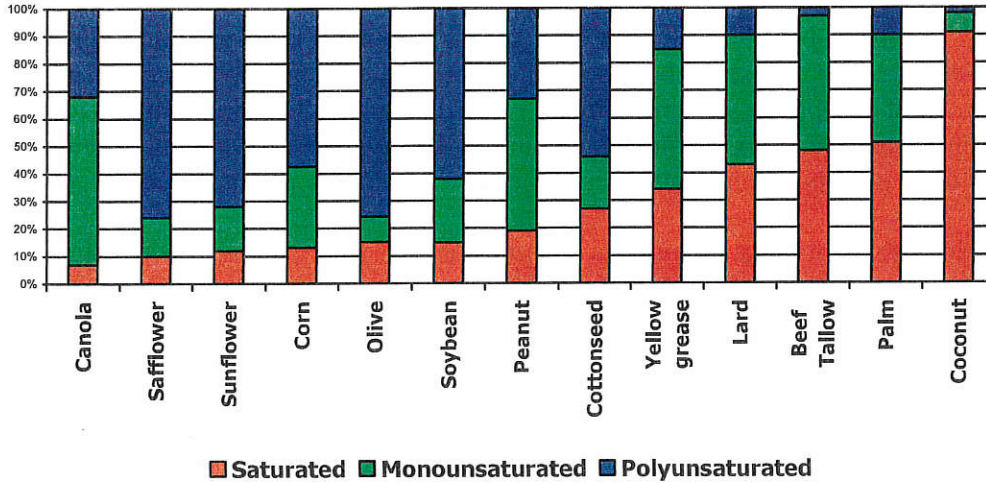


Figure 2. Composition of various biodiesel feedstocks

Under each category heading in Table 3 we show what types of fatty acids are considered saturated, monounsaturated, or polyunsaturated and their general impact on the fuel properties and emissions. The first number of the combination shows the number of carbons in the fatty acid chain; the second number is the level of saturation or unsaturation—0 for saturated, 1 for monounsaturated, and 2 or 3 for polyunsaturated. For example, 18:1 is a fatty acid containing 18 carbons and one point of unsaturation (monounsaturated). It should be noted that these are general trends only and that other factors such as the use of additives may modify the effects shown below.

Table 3. Fuel Properties as a Function of Fuel Composition in Diesel Engines

	Saturated	Monounsaturated	Polyunsaturated
Fatty acid	12:0, 14:0, 16:0, 18:0, 20:0, 22:0	16:1, 18:1, 20:1, 22:1	18:2, 18:3
Cetane Number	High	Medium	Low
Cloud Point	High	Medium	Low
Stability	High	Medium	Low
NO _x Emissions	Reduction	Slight increase	Large increase

As with conventional diesel fuel, the best type of biodiesel for your applications will be based on several factors. A No. 2 petrodiesel fuel with a cetane of 50 but that starts to freeze at 20°F may be perfectly suitable for December in Texas, while a No. 1 petrodiesel with a cetane of 42 and that starts to freeze at -40°F may be best for a December in Minnesota. The considerations and trade-offs made every day with petrodiesel fuel will also apply to the choice of biodiesel. The data below provides more detail about B100 properties and considerations.

3.3 B100 Energy Content

With conventional diesel fuels, the inherent energy content of the fuel, measured typically in BTUs per gallon, is the largest factor in the fuel economy, torque, and horsepower delivered by the fuel. The energy content of conventional diesel can vary up to 15% from supplier to supplier or from summer to winter. This variability in conventional diesel is due to changes in its composition, and these changes are determined by the refining and blending practices. Number 2 diesel fuel usually has a higher energy content than number 1 diesel fuel, with blend values somewhere in between.

With biodiesel, or B100, the refining and blending methods have no significant effect on energy content (Figure 3). The reason B100 does not vary much is because the energy content of the fats and oils used to make biodiesel do not vary nearly as much as the components used to make diesel fuel. Therefore, B100 made from most of the common feedstocks will have the same impact on fuel economy, power, and torque. Compared to most No. 2 diesel fuel in the United States, B100 has a slightly lower (12.5% per pound or 8% per gallon) energy content (Figure 3). Typically losses in power, torque, and fuel economy are similar to the difference seen in energy content.

The energy content of blends of biodiesel and diesel fuel is proportional to the amount of biodiesel in the blend and the BTU value of the biodiesel and diesel fuel used to make the blend. For example, B20 users experience a 1% loss in fuel economy on average and rarely report changes in torque or power.

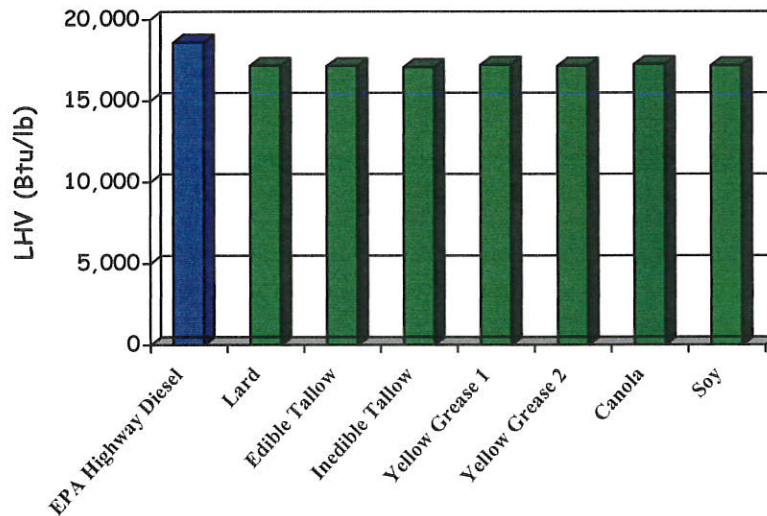


Figure 3. Heating value of diesel and biodiesel (B100) fuels

3.4 B100 Cold Flow Properties

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 engines: cloud point, cold filter plug point, and pour point. They are described in more detail 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 is 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 10th 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 10th 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 10th 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.

Table 4. Cold Flow Data for Various B100 Fuels

Test Method	Cloud Point ASTM D2500		Pour Point ASTM D97		Cold Filter Plug Point IP 309	
	°F	°C	°F	°C	°F	°C
B100 Fuel						
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

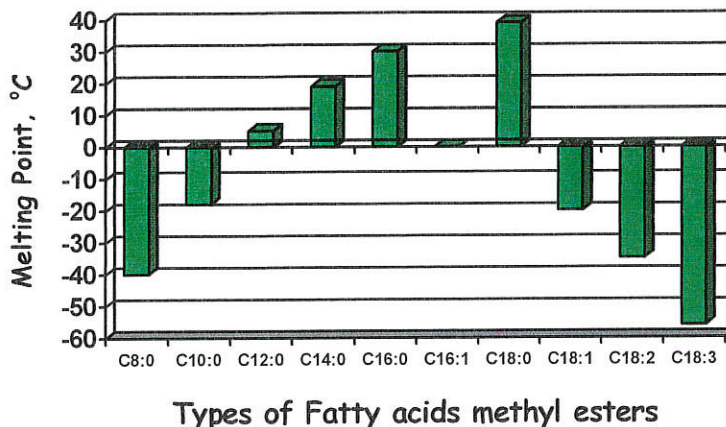


Figure 4. Melting points of biodiesel components.

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.

3.5 B100 Cetane Number

Most of the B100 made today that meets D6751 has a cetane number higher than 47. This is compared to the minimum of 40 for highway diesel fuel, whose national average is between 42 and 44. Therefore, biodiesel has a higher cetane number than most U.S. diesel fuel, which is believed to provide easier starting and quieter operation. Highly saturated B100, such as animal fats and used cooking oils, can have a cetane number of 70 or higher. Common polyunsaturated fuels that contain high levels of C18:2 and C18:3 fatty acids include soy, sunflower, corn, and canola (rapeseed) oils. These will be at the lower end of the scale, at 47 or slightly higher. Figure 5 shows the cetane number of various pure fatty acid methyl esters. Figure 6 shows the cetane number of various biodiesel samples.

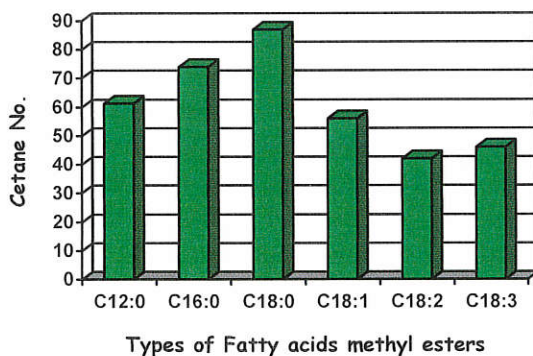


Figure 5. Cetane number of fuels made from pure fatty acids

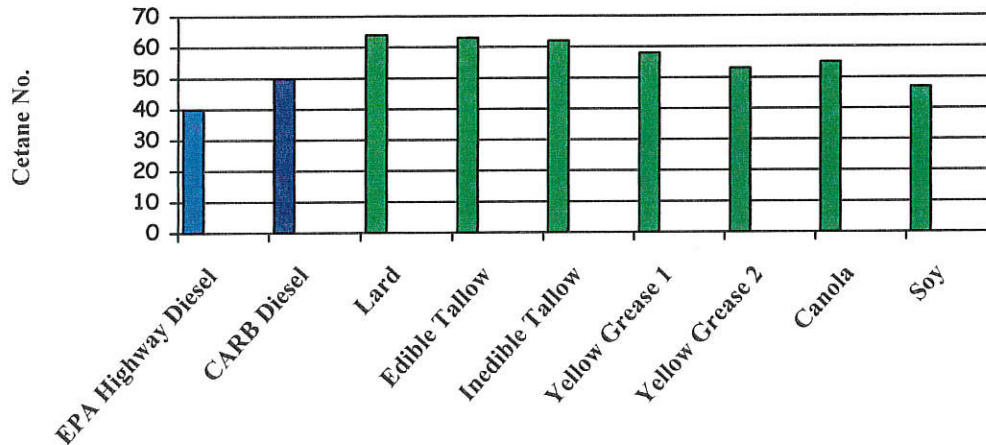


Figure 6. Cetane number of fatty acid methyl esters, petroleum diesel and various biodiesel fuels

3.6 B100 Stability

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.

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.

Even though there is no ASTM specification for the stability of either biodiesel or diesel fuel at this time, several organizations have experimented with diesel test methods (ASTM D4625 or ASTM D2274), modifying them to work with biodiesel and trying to determine how well they might predict fuel stability. So far, none of the modifications are good enough for an ASTM round robin, but these experiments have provided data to better understand B100 stability. Tests can measure fuel degradation over time, but few are good at predicting what actually happens in the field, and even fewer test methods can be correlated to field performance problems such as filter plugging, deposit formation, or fuel injector failure. Most test methods can identify the worst and the best of fuels, but differentiating between the average or borderline fuels has yielded mixed results.

There are some guidelines that help identify fuels and conditions that will provide the highest levels of stability.

- The higher the level of unsaturation the more likely it is that the fuel will oxidize. As a rule, saturated fatty acids (such as 16:0 or 18:0) are stable. And each time the level of unsaturation increases (for example from 18:1 to 18:2 to 18:3) the stability of the fuel goes down by a factor of 10. So a fuel composed primarily of C18:3 is 100 times more unstable than a fuel made of C18:1. The points of unsaturation on the biodiesel molecule can react with oxygen, forming peroxides that break down into acids, sediments, and gums.
- Heat and sunlight will accelerate this process, so it is best not to store B100 outside in clear totes in the summer.
- 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. B100 should not be stored for long periods of time in systems that contain these metals. Metal chelating additives, which serve to de-activate these metals, may reduce or eliminate the negative impact of the presence of these metals.
- Some types of feedstock processing and biodiesel processing can remove natural anti-oxidants, potentially lessening fuel stability. Vegetable oils and fats are produced with natural antioxidants—nature's way of protecting the oil from degradation over time. Bleaching, deodorizing, or distilling oils and fats, either before or as part of the biodiesel process, can remove these natural antioxidants while other processes leave the antioxidants in the finished biodiesel.
- Keeping oxygen from the fuel reduces or eliminates fuel oxidation and increases storage life. Commercially, this is done using a nitrogen blanket on fuel tanks or storing biodiesel in sealed drums or totes for smaller amounts of fuel.
- Antioxidants, whether natural or incorporated as an additive, can significantly increase the storage life or stability of B100.

In many commercial systems, the fuel turn over is in a range (two to four months) where fuel stability with B100 has not been problematic. The ASTM D4625 data (Figure 7)

suggests that the least stable B100 could be stored for up to 8 months,⁹ while the most stable could be stored for a year or more. The National Biodiesel Board recommends a six month storage life for B100.

There is not a lot of experience with B100 storage for periods greater than six months, so if the fuel is kept longer than six months, anti-oxidants should be used and/or periodic tests for acid number and sediments, and perhaps viscosity, should be performed to insure that the fuel remains within the boundaries of ASTM D6751.

Thermal stability is generally meant to be an indicator of fuel degradation when subjected to high temperatures for a short period of time, similar to what would be experienced in the fuel injector or fuel system of a modern diesel engine. If the fuel degrades here, the primary concern is the potential for injector coking. The data available regarding thermal stability generally show that B100 has good thermal stability. This makes some sense, as saturated vegetable oils and animal fats are used as frying oils and are subjected to extremely hot temperatures for relatively long periods of time. In addition, most reports from the field have indicated that biodiesel produces less injector coking than conventional diesel fuel, but much of this information is anecdotal.

The most common thermal stability test method is ASTM D6468. It measures the black residue formed as the fuel is subjected to very high temperatures for 90 or 180 minutes through a reflectance measurement on the filtered material. B100 forms very little black residue upon extreme heating and performs well in this test. There is some question about whether the biodiesel sediment could be brown or gray and not be measured in this reflectance test, as well as some questions about whether the biodiesel residue is completely washed from the aging apparatus with the current solvents and these questions are being further investigated.

⁹ Appendix X.1, Section x.1.4 of ASTM D4625 states: "For most practical purposes, it has been shown that aging fuel at 43°C results in an approximately fourfold acceleration of the degradation for an ambient temperature of 21°C, that is, a week of 43°C storage is roughly equivalent to a month of storage at normal (environmental) ambient temperatures. Depending on fuel composition and actual storage conditions, this correlation may vary substantially in either direction."

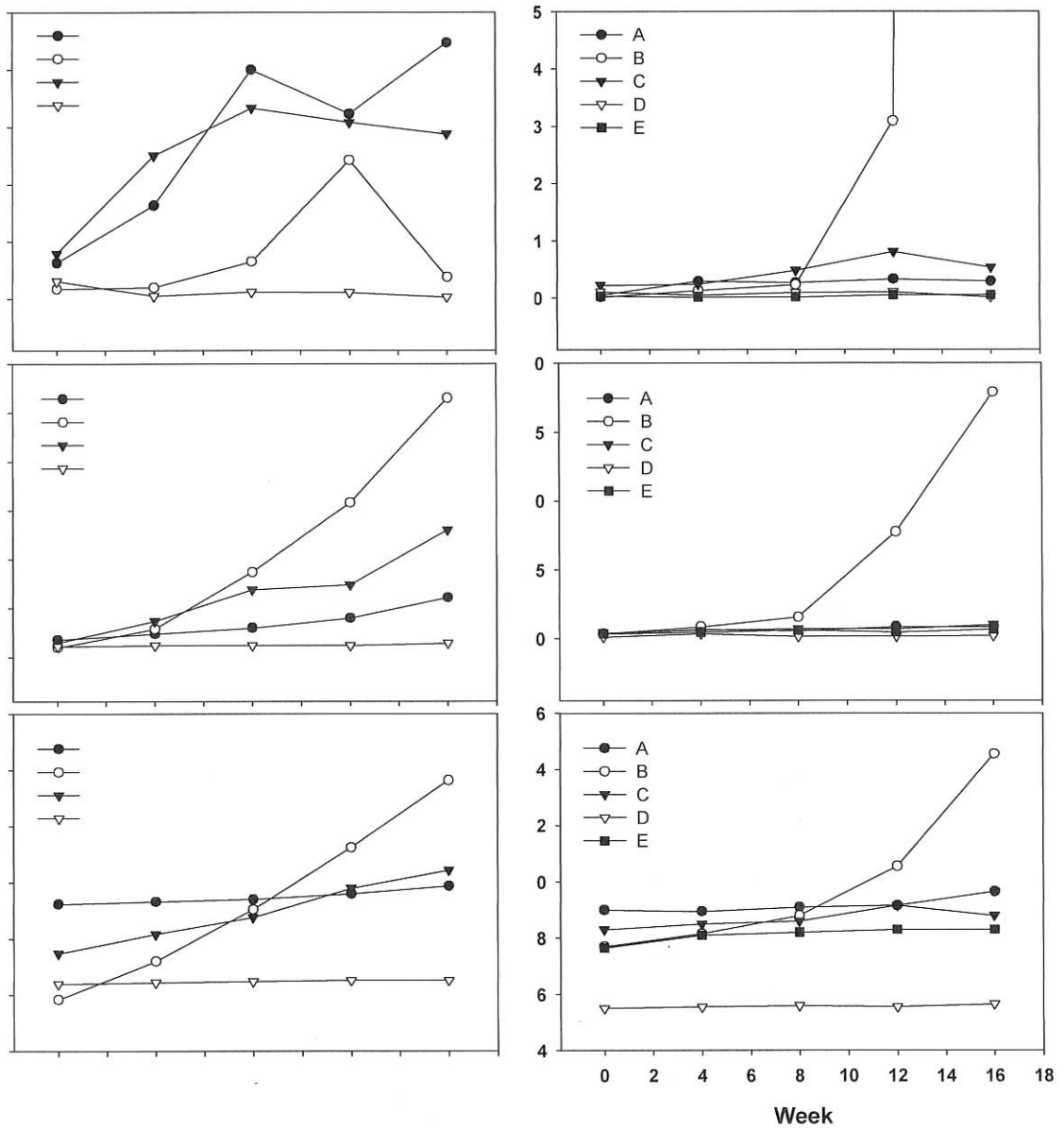


Figure 7. ASTM D4625 (43°C) Long-term storage stability. B100 on left. B20 on right. Some fuels contain natural antioxidants, some contain additions, some B100 distilled, some natural.

While B100 thermal stability does not appear to be an issue, additional investigation is under way with both existing diesel engines and, more importantly, newer and future diesel engines. The newest engines, and future engines, will be operating at higher temperatures and pressures than most engines in operation today. These engines may recirculate more fuel than ever before and there is not much information about operating

these engines on B100. If any problems do occur, they are more likely with B100 than with lower blends.

3.7 B100 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 contamination needs to be controlled since the aerobic fungus, bacteria, and yeast hydrocarbon utilizing microorganisms (HUMBUGS) usually grow at the fuel-water interface. Anaerobic colonies, usually sulfur reducing, can be active in sediments on tank surfaces and cause corrosion. Since the biocides work where the HUMBUGS live (in the water), products that are used with diesel fuels will work equally well with biodiesel.

3.8 B100 Cleaning Effect

Methyl esters have been used as low VOC (volatile organic compound) cleaners and solvents for decades. Methyl esters make an excellent parts cleaner, and several companies are offering methyl esters as a low VOC, non-toxic replacement for the volatile solvents used in parts washers. B100, being comprised of methyl esters meeting ASTM D6751, has a tendency to dissolve the accumulated sediments in diesel storage and engine fuel tanks. These dissolved sediments can plug fuel filters and in some cases cause the fuel filters to burst, sending all the sediment through the fuel injection system. If this happens, it can cause injector deposits and even fuel injector failure. If you plan to use or store B100 for the first time, clean the tanks and anywhere in the fuel system where sediments or deposits may occur before filling with B100.

The level of 'cleaning' depends on the amount of sediment in the system (i.e. if the system is sediment free there should be no effect) as well as the blend level of biodiesel being used. The cleaning effect is much greater with B100 and blends with 35% or more biodiesel, compared to B20 and lower blends. Most people do not clean their tanks before B20 use, although it is still wise to keep some extra filters on hand and monitor potential filter clogging a little closer than normal when first starting up with B20. The cleaning effect of the biodiesel in B20 is sufficiently diluted so that most problems encountered are insignificant, but an occasional plugged fuel filter may occur upon initial use. Drivers should be aware that sediments in the vehicle system might plug fuel filters during the first few weeks of using B20. Any filter clogging with B20, if it occurs at all, typically goes away after the first few tanks of fuel.

Some consumers who did not encounter problems with B20 assume they can switch to higher blends because the B20 has already cleaned their tanks. B20 is too dilute to "clean" tanks and therefore caution is still warranted with blends over B20.

You should keep biodiesel spills wiped up because it can remove some types of body and engine paint if the fuel is not wiped up immediately. It can also remove decals that are stuck on tanks or vehicles near the fueling areas. All materials that are used to wipe up biodiesel spills should be considered combustible and should be stored in a safety can.

3.9 B100 Material Compatibility

B100 will degrade, soften, or seep through some hoses, gaskets, seals, elastomers, glues, and plastics with prolonged exposure. Some testing has been done with materials common to diesel systems but more data is needed on the wide variety of grades and variations of compounds that can be found in these systems, particularly with B100 in U.S. applications. Nitrile rubber compounds, polypropylene, polyvinyl, and Tygon materials are particularly vulnerable to B100. Before handling or using B100, contact the equipment vendor or OEM and ask if the equipment is suitable for B100 or Biodiesel. In some cases, the vendor may need the chemical family name for biodiesel (i.e. the methyl esters of fats and oils) to look up the information or even the exact chemical name of some of the biodiesel components such as methyl oleate, methyl linoleate, methyl palmitate, or methyl stearate. There have not been significant material compatibility issues with B20.

If your existing equipment or engine components are not compatible with B100, they should be replaced with those that are. Materials such as Teflon, Viton, fluorinated plastics, and Nylon are compatible with B100. B100 suppliers and equipment vendors should be consulted to determine material compatibility. Also consult other B100 vendors in other regions of the country to see what problems they may have experienced and what kind of replacement materials they are using. It is advisable to set up a monitoring program to visually inspect the equipment once a month for leaks, seeps, and seal decomposition. It would be wise to continue these inspections even after one year, as the experience is still relatively limited with B100.

Older vehicles, manufactured before approximately 1993, are more likely to contain seals, gaskets, etc., that will be affected by B100 over long periods of time. Modern rebuild kits or engines after 1993 may contain biodiesel compatible materials, but not always. Ask your dealership for recommendations.

Most tanks designed to store diesel fuel will store B100 with no problem. Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene, Teflon®, and most fiberglass. If in doubt, contact the tank vendor or check the National Biodiesel Board web site.

Brass, bronze, copper, lead, tin, and zinc may accelerate the oxidation of diesel and biodiesel fuels and potentially create fuel insolubles (sediments) or gels and salts when reacted with some fuel components. Lead solders and zinc linings should be avoided, as should copper pipes, brass regulators, and copper fittings. The fuel or the fittings will tend to change color and insolubles may plug fuel filters. Affected equipment should be replaced with stainless steel, carbon steel, or aluminum.

3.10 Suggestions for Transporting B100

As with petrodiesel, it is important that B100 be transported in a way that does not lead to contamination. The following procedures are recommended and are also used by distributors and transporters of petroleum derived diesel.

- Trucks and Railcars: Aluminum, carbon steel, or stainless steel
 1. Proper inspection and/or washout (washout certificate)
 2. Check for previous load carried and residual. Generally only diesel fuel is acceptable as a residual. If the vessel has not gone through a washout, some residuals may not be acceptable like:
 - a. food products or raw vegetable oils
 - b. gasoline
 - c. lubricants
 3. No residual water
 4. Hoses and seals clean, compatible with B100
 5. Determine need for insulation or method to heat truck or rail car contents if shipping during cold weather.

B100 is challenging to ship in cold weather. In the winter, most B100 is shipped one of the following ways:

- Hot (or at least warm) in trucks for immediate delivery (130°F to 80°F)
- Hot (120°F to 130°F) in railcars for delivery within 7-8 days (arrives warm if only 1 week has passed since loading)
- Frozen in railcars equipped with external steam coils (the fuel in the tank cars is melted at the final destination with steam),
- In a blend with winter diesel, kerosene, or other low cloud point fuel in either railcars or trucks.

Regardless of how the biodiesel arrives, it must be stored and handled using procedures that do not allow the temperature of B100 or blend to drop below its cloud point. The cloud point of the biodiesel, the biodiesel temperature, the ambient temperature, and the time the fuel is in transport are all factors that should be taken into consideration when transporting B100 to insure that the fuel does not freeze in transport.

3.11 Suggestions for Using B100

If you want to use B100, these recommendations should help:

- Contact other B100 users. If you manage a fleet, contact your Fleet Management Association or Clean Cities Coalition to find out if anyone near you has experience with B100. Contact the National Biodiesel Board and look through its

news and other outreach material for references to B100 users. Ask your B100 vendor for some recommendations.

- Ask other users what they did, how they did it, how long it took, how much it cost, what problems (if any) they encountered, how long have they been using B100, and what kind of engines and equipment have they been using it in.
- Contact your dealership and discuss your needs and ask for advice, including any recommendations from their European distributors or other U.S. fleet customers. You are probably not alone.
- Replace materials you know will be problematic and institute a monitoring program.
- Plan and budget for the time and expense of increased fuel filter changes or cleaning your fuel system when first starting to use B100.

3.12 B100 and NO_x Emissions

The composition of the biodiesel will affect how much NO_x a biodiesel will produce from a CI engine. Figure 8 and Figure 9 below show the percentage increase in NO_x from B100 compared to diesel fuel with engines representative of what is on the road today. Some kinds of B100, such as those high in polyunsaturated fatty acids, produce more NO_x than B100 high in saturated fatty acids. Of course, highly saturated biodiesel starts to freeze at a higher temperature.

Beginning in 2007, new diesel engine and after-treatment technologies that use fuel with less than 15 ppm sulfur content will be required in an effort to *reduce NO_x emissions by over 90%* compared to today's level. Biodiesel has not been thoroughly tested in these new types of engines, so we don't know how much benefit these new technologies may provide. The NREL and NBB web sites will provide updated test data as it becomes available.

While new diesel technology appears to be the long-term solution for reducing NO_x with biodiesel, further study is occurring to find ways to reduce NO_x with B100, and to further understand the biodiesel NO_x phenomenon with existing engines. A slight engine timing retard (1 to 5 degrees) can bring B100 NO_x to diesel baselines or provide NO_x reductions. Retarding engine timing with EPA certified diesel engines, however, without re-certification with EPA is considered tampering and re-timing modern diesel engines is generally not a user serviceable item. It is best to check with your engine manufacturer about this option for their equipment, but most manufacturers have not looked into this option for B100 due to the low volumes used in the United States.

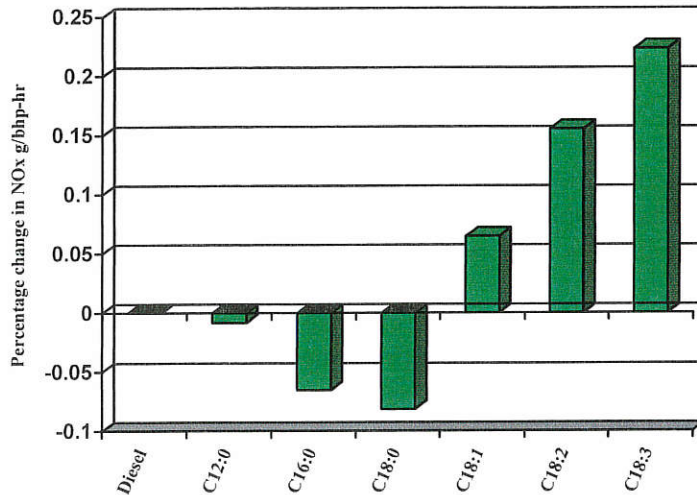


Figure 8. NOx emissions of B100 made from single types of fatty acids¹⁰

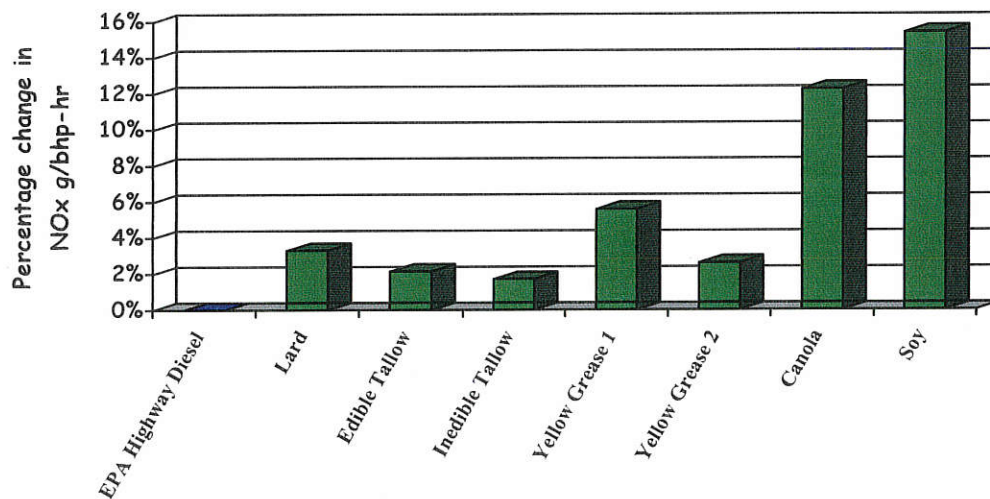


Figure 9. Increase in NOx emissions from CI engines using various B100 fuels

Additive manufacturers are working on additives that can improve NO_x, but testing done by NREL with B100 has shown that they provide little benefit while adding significant costs. Most commercial additive tests to date have not been validated with EPA heavy-duty transit emission testing that shows a direct comparison between the B100 fuel with and without the additive and a No. 2 diesel baseline. If you are shopping for an additive, you should ask for data from comparative testing of all three fuels. If you only have steady state mode data, make sure NO_x reductions occur at the high load, high RPM

¹⁰ Graboski et al. February 2003. *The Effect of Biodiesel Composition on Engine Emissions from a DDC Series 60 Engine*. NREL-SR/510-31461.

ranges. NO_x emissions are generally not a problem at low load, low RPM ranges. Make sure that the data show emissions of B100 with and without the additive and a diesel No. 2 baseline.

The NO_x reduction seen with biodiesel blends used in boilers appears to be independent of the type of biodiesel used. NO_x is reduced 1% for every 1% biodiesel used in heating oil.

4. USING 20% BIODIESEL BLENDS

This section is focused on blending B100 with petrodiesel to make a B20 blend, but the approach is similar for other blend levels such as B2 or B5. As discussed in the previous chapters, the performance properties of B100 can be significantly different from conventional diesel. Blending biodiesel into petroleum diesel is a way to minimize these property differences while still retaining some of the benefits of B100. We are not going to repeat the information provided in the B100 section, just elaborate where it specifically applies to blends.

B20 is popular because it represents a good balance of cost, emissions, cold weather performance, materials compatibility, and solvency. B20 is also the minimum blend level that can be used for EPA Act compliance for covered fleets (see Chapter 8).

A blending level above 20% can provide higher emission reduction benefits for CO, PM, and HC; with the impact on NO_x depending on the application (increases in most diesel engines, decreases in boiler or home heating applications). Higher blend levels of biodiesel significantly reduce polycyclic aromatic hydrocarbons and other toxic or carcinogenic compounds found in diesel exhaust. High blend levels also promote faster biodegradation should a spill occur. However, at biodiesel levels above 20%, cold flow management is a more significant issue, the cleaning effect is more severe, and hoses and gaskets will be more affected.

4.1 B20 Cold flow

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 (Figure 10 through Figure 15). 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 additives, or both. So ask your diesel distributor to provide some samples of winter diesel.

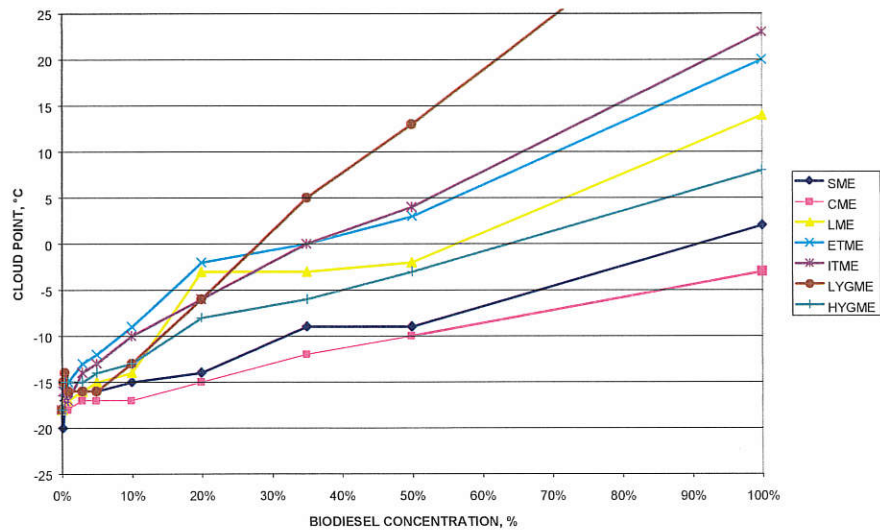


Figure 10. Biodiesel/diesel blend cloud point test results¹¹

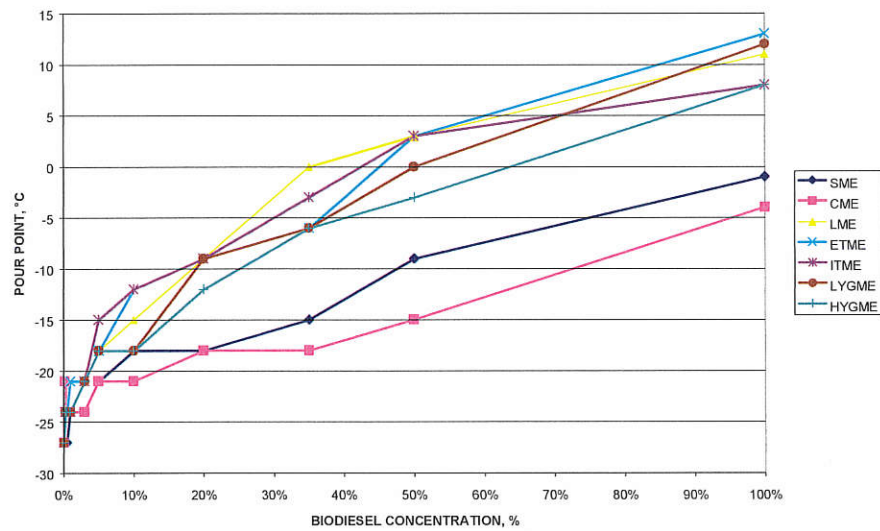


Figure 11. Biodiesel/diesel blend pour point test results

¹¹ SME= soy methyl ester, CME=canola methyl ester, LME=lard methyl ester, ETME=edible tallow methyl ester, ITME=inedible tallow methyl ester, LYGME=low free fatty acid yellow grease, HYGME=high free fatty acid yellow grease. As a note, since these tests, we have found that the free fatty acid content of the starting feedstock, whether it is yellow grease or some type of animal fats, does not have any effect on fuel properties. So LYGME and HYGME can be viewed as two different samples of yellow grease methyl esters.

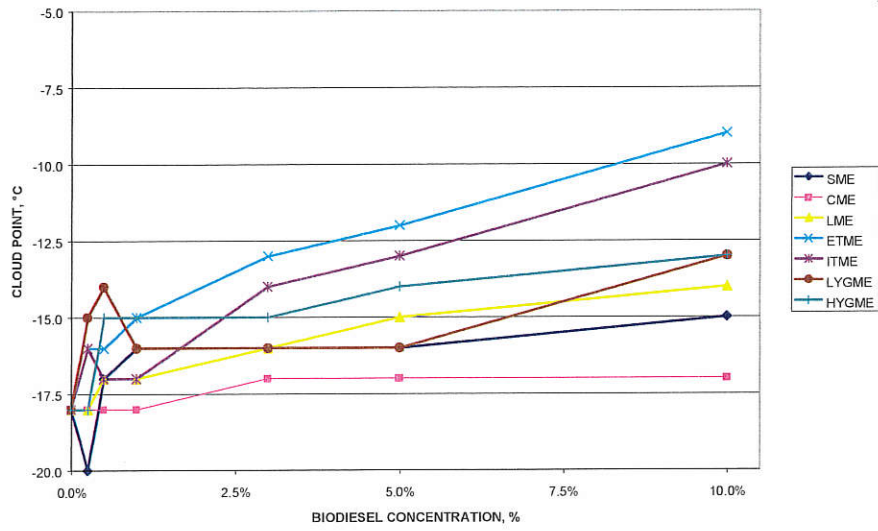


Figure 12. Biodiesel/diesel blend cloud point test results (0–10% biodiesel blend range)

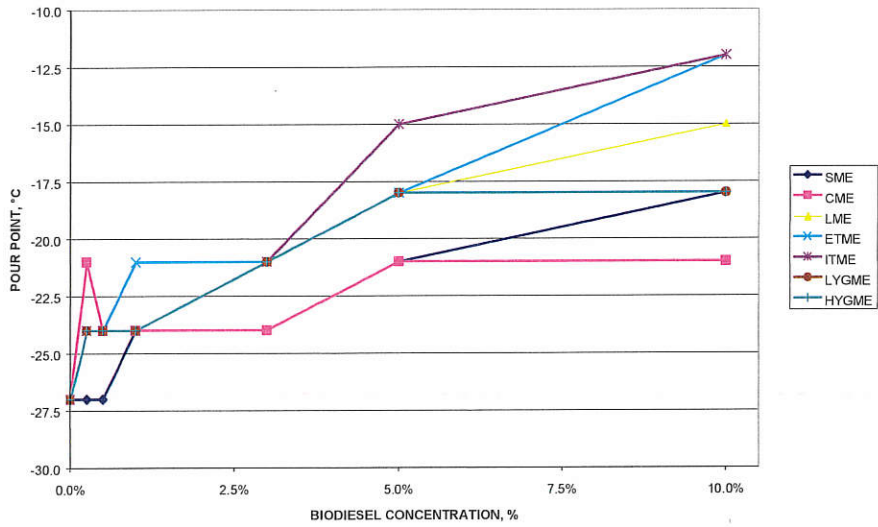


Figure 13. Biodiesel/diesel blend pour point test results (0–10% biodiesel blend range)

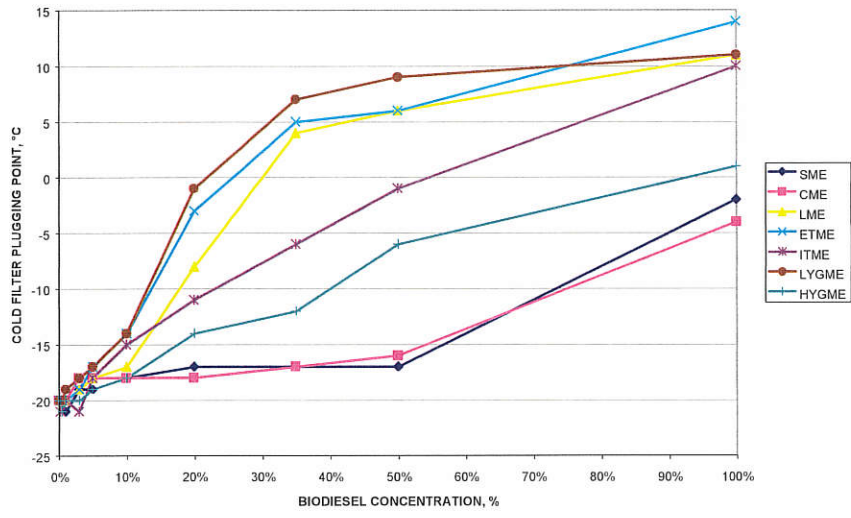


Figure 14. Biodiesel/diesel blend cold filter plugging point test results

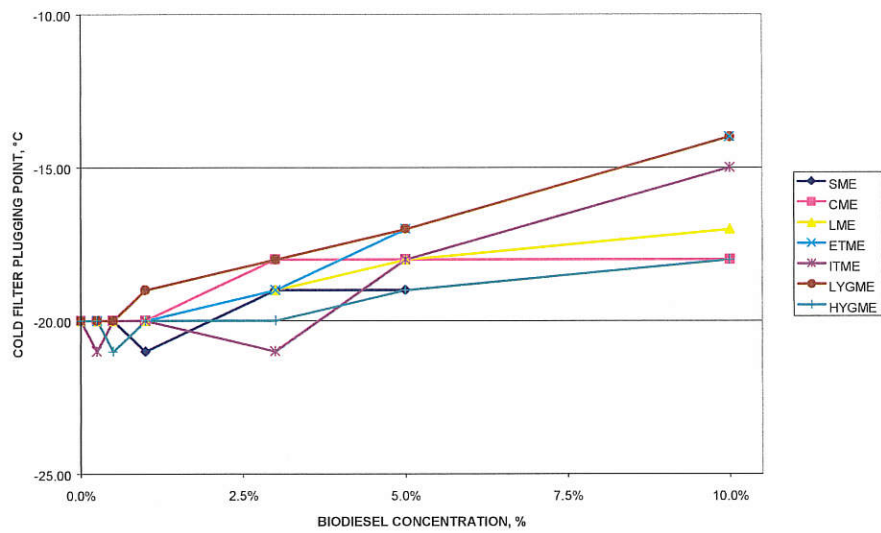


Figure 15. Biodiesel/diesel blend cold filter plugging point test results (0-10% biodiesel blend range)

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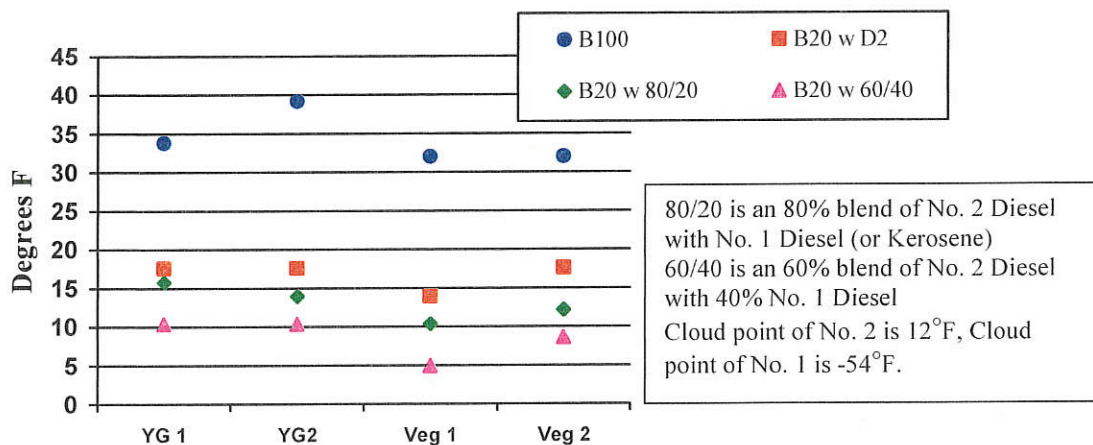


Figure 16. Adjusting cloud points of B20 fuels with blends of No. 1 and No. 2 diesel

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%) show 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.

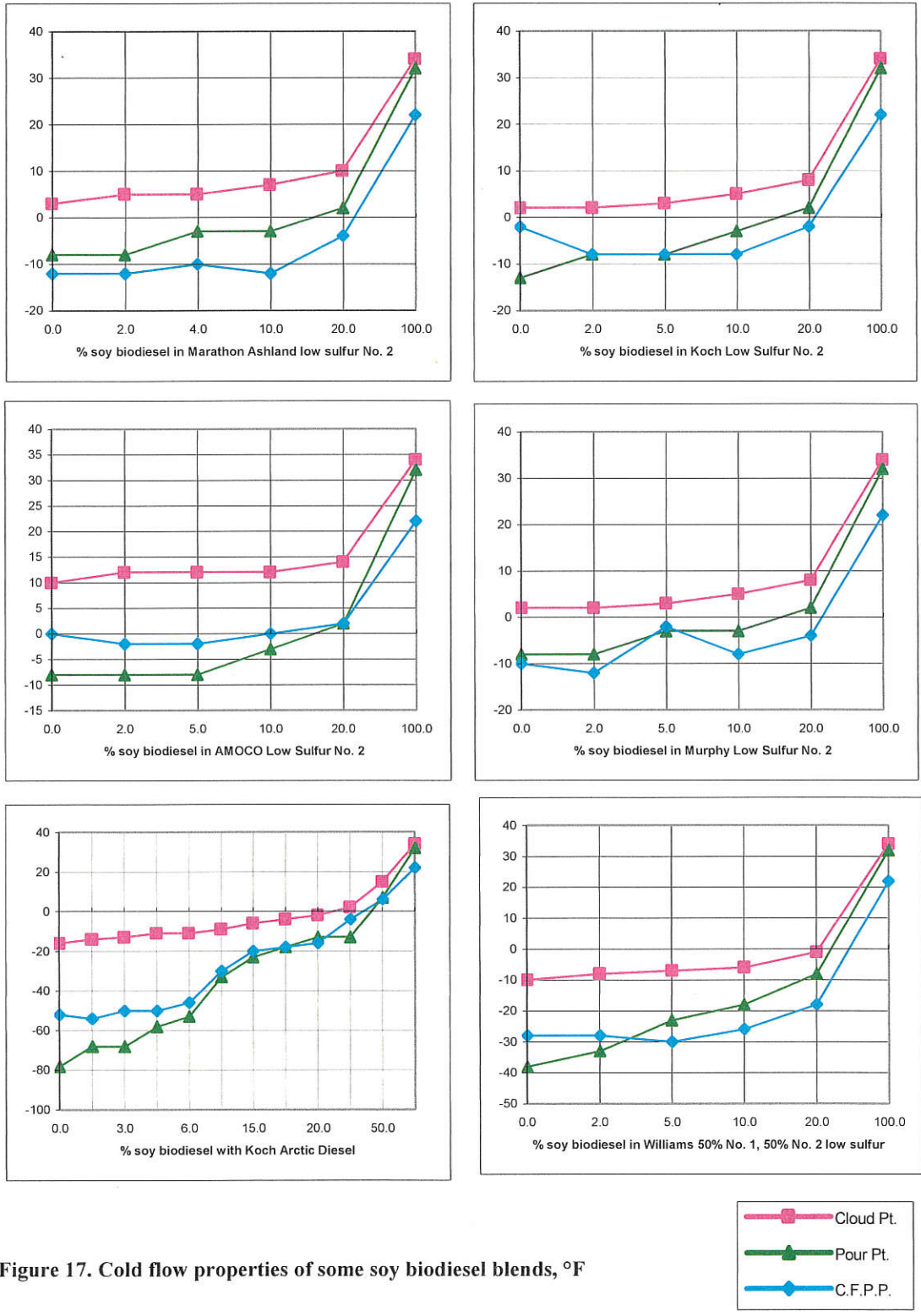


Figure 17. Cold flow properties of some soy biodiesel blends, °F

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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 (lower NO_x) 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 EPA's requirements, this approach may not work because EPA 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.

4.2 Blending Biodiesel to Make B20 or Lower Blends

Many biodiesel users are now purchasing finished B20 or lower blends from their petroleum distributor or outlet. If this is the case, the petroleum distributor takes care of ensuring the biodiesel has been properly blended and that the cold flow properties of the finished blend will provide satisfactory performance for the area of the country and time of the year. You may wish to specify that the fuel meet certain cold flow requirements in your purchase contract or agreement.

This is exactly the way that conventional No. 2 petrodiesel is handled, and this is also the optimum way for users to purchase and use B20 and lower blends. As with No. 2 diesel fuel, if you are buying biodiesel blends in the summer and plan to use the fuel in the winter or drive to colder conditions, you should check with your supplier to make sure the cold flow properties of the fuel you are buying are acceptable for those climates.

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 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 end user.
2. Blended (via a variety of means) by a jobber or distribution company and offered for sale as a finished blend, usually B20 or B2.
3. Blended at a petroleum terminal or rack by a pipeline or terminal company and offered as a finished blend. This product is sold directly to customers or to a petroleum jobber or distribution company for further sale to customers.

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.

More recently, as demand increases, petroleum terminals and pipeline racks 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 some type of on-site storage. Even more recently, there are an increasing number of public pumps and key card pumps 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 user 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. Indeed, all three options are commonly used in practice today.

Splash Blending. Splash blending is an operation where the biodiesel and diesel fuel are loaded into a vessel separately with relatively little mixing occurring as the fuels are placed in the vessel. The vessel is usually an individual vehicle fuel tank or a fuel delivery truck, although in some cases it could be a drum or a tote. Once the fuels are in the vessel, driving down the road is regarded as sufficient agitation to allow the biodiesel and diesel fuel to become thoroughly mixed. Usually this approach is successful, but on occasion difficulties in mixing can be encountered if the biodiesel is loaded into the vessel first under very cold temperature conditions .

In-Tank 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 tank may need to be recirculated or further mixed in order to get the two fuels thoroughly blended. Since biodiesel and diesel fuel mix easily and completely, in tank blending is sufficient to get a homogeneous blend in many cases, depending on the exact means of adding the fuel, the tank geometry, etc.

In-Line Blending. In-line blending is where 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—or by the mixing that occurs once the fuel is loaded into its 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. In some cases, distributors who carry B100 and petrodiesel in separate compartments and blend the two as they are loading into a customer’s tank also use this method.

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 above ground tanks or with 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 if they are present. Filter clogging in warm months can be caused by this property.

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. See the NBB quality program, BQ-9000, for more details. The test procedure for the percent biodiesel by infrared spectroscopy is from Europe, EN 14078, and ASTM is developing an official ASTM number for this test method. 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

¹² ASTM D4057, Standard Practice for Manual Sampling of Petroleum and Petroleum Products

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. It can also be complicated for small users. A variety of different types of equipment are available for in-line blending. Systems have to be sized for a specific blend level (B2, B20) and are generally not able to handle both types of blends. When two blend levels are needed, a B20 tank is generally created and B2 is blended from that.

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.

Consider an example. Your target cloud point for B20 using winter diesel is 0°F, the cloud point of your diesel is -10°F and you are using biodiesel with a cloud point of 34°F. Your diesel fuel temperature is about 21°F on the day you decide to blend. Your diesel fuel temperature is less than the cloud point of your B100. This is an acceptable situation because the B20 cloud point is below the temperature of your diesel fuel and the gap between the temperature of the diesel fuel and the target B20 cloud point is pretty generous, about 21°F. Any crystals that form will go back into solution. If the gap was narrow, like 5°F, crystals might be slow going back into solution and may settle out.

Consider another example. Your target B2 cloud point is -8°F, your B100 cloud is 34°F and your diesel cloud is -10°F. It's a really cold day and your diesel fuel temperature is 10°F. Since the target cloud for your blend is lower than the temperature of your fuel, any crystals formed should go back into solution. In addition, since biodiesel is such a small fraction of the blend for B2, the diesel fuel should act like a solvent and help that process along. Once again, any agitation used to blend the fuels will also help. You do not need to heat the biodiesel, since that will not heat up the 98% of the gallon that is diesel fuel any perceptible amount.

Some distributors in northern climates follow a protocol of filtering biodiesel blends before delivery to customer tanks. This is thought to prevent clogging of the refueling pump filter caused by crystallized saturated fatty acid methyl esters that can form if the petroleum diesel is too cold during blending. This protocol was developed, in part, because the consumers were testing B20 made from biodiesel with a high cloud point. Researchers recommend using a filter that is at least as fine as the vehicle fuel filters.

Some biodiesel is transported as a 50:50 blend with kerosene to prevent it from freezing during transportation. When you blend that down to B20, recognize that the kerosene fraction will provide some cloud point benefit for your final B20 blend. It is important to

adjust the blending formula so that you have the desired blend level of biodiesel in the final fuel (for example: 60% No. 2, 40% 50:50 mixture of biodiesel and kerosene results in a B20 blend).

Blends should be stored in tanks that can ensure the fuel temperature will remain above the cloud point of the blend.

- Blends of biodiesel and diesel should be stored at temperatures at least 5°F to 10°F above the cloud point of the blended fuel.
- Blended fuels can be stored below ground in most climates. B20 may be stored in aboveground tanks, depending on the cloud and pour points of the blended fuel and the local ambient weather conditions.

4.3 B20 and Emissions

The impact of B20 on emissions is less than that of higher blends. Research has shown that NO_x emissions vary in a straight-line fashion (see Figure 1) with biodiesel blending level. B20 reduces CO, PM, HC, and air toxic compounds. Emissions trends for CO, HC, and PM are slightly curved with the lower blends having slightly more impact per unit of biodiesel burned than the higher blends. The NO_x emissions may vary depending on the source of the biodiesel and some B20 blends may be NO_x neutral, while HC, PM, and CO reductions do not appear to change with biodiesel composition.

In blends with heating oil up to 20%, NO_x is also linear but biodiesel provides reductions rather than increases. For every 1% biodiesel added, NO_x decreases by 1%. A B20 heating oil fuel will reduce NO_x by about 20%.

4.4 B20 Cleaning Effect

Blends of 20% biodiesel or less minimize any cleaning effect or solvency issues with accumulated sediments in tanks, although minor filter plugging may be observed during the initial weeks of B20 use in some cases. Blends above 20% should always be stored in clean, dry tanks as recommended for conventional diesel fuel. Using B20 for a year or more will probably not “clean” your tanks and is not a substitute for a thorough tank cleaning when preparing for higher level blends or B100 storage.

4.5 B20 Material Compatibility

B20 or lower blends minimize most issues associated with material compatibility. Experience over the last 10 years with B20 indicates compatibility with all existing elastomers in diesel fuel systems, even those that are sensitive to higher blends, such as nitrile rubber. Customers should continue to check for leaks, however, and fix them if they occur. B20 may degrade faster than petrodiesel if oxidizing metals such as copper, bronze, brass, or zinc are in fueling systems. If filter clogging occurs more frequently with B20 than with petrodiesel, the fueling system should be checked for these materials and they should be replaced with biodiesel compatible parts. There is a growing body of

long-term experience with B20 in the United States that will ultimately allow a better assessment of the long-term effects of biodiesel and biodiesel blends on engines and fueling systems, but B20 experience has been positive so far.

4.6 Lubricity

Blending biodiesel into petroleum diesel at even low levels can increase the lubricity of diesel fuel. As little as 0.25% biodiesel can significantly increase fuel lubricity (Figure 18). Some fleets choose to use B2 for its lubricity properties instead of using other additives. The exact blending level required to achieve adequate lubricity will depend on the properties of the conventional diesel. Preliminary evidence suggests that 2% biodiesel imparts adequate lubricity in almost all cases.

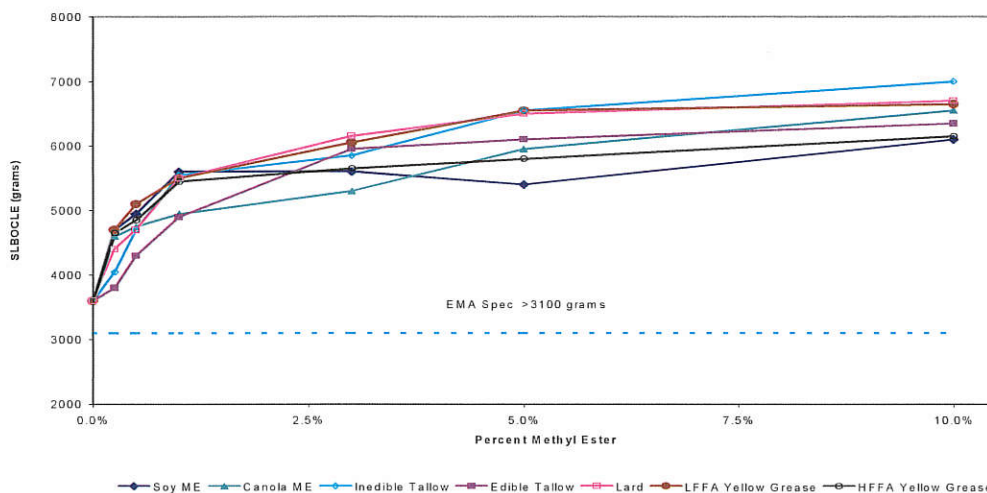


Figure 18. Scuffing Load Ball on Cylinder (SCBOCLE) lubricity data for various biodiesel fuels

4.7 B20 Stability

As of this date there is a growing database available on B20 but more data is needed to accurately predict the impact of biodiesel on blend oxidative and thermal stability. Data in the previous chapter (see Figure 9) includes results of the ASTM D4625 stability test for several B20 fuels. Compared to the B100 data on the same fuels, it appears that B20 may have a longer storage life than B100. Those data also show that some B20 can have good stability and others do not depending on the B100 used for blending. The D4625 data suggests that most B20 can be stored for 8 to 12 months. The National Biodiesel Board recommends that B20 be used within 6 months. This is comparable to the recommendations of petrodiesel suppliers, some of whom recommend petrodiesel be used within 3-4 months. Adding antioxidants and/or stability additives is recommended for storage over longer periods.

We recommend using stability additives when long-term stability is a concern. For example, during one demonstration of heating oil blends with 20% biodiesel, stability additives were only added in the summer months when the fuel turnover rate was low. Good fuel management and frequent turnover should minimize stability concerns for most applications.

As biodiesel ages in storage, the acid number tends to increase and go out of specification, gums and varnish can form, and the viscosity can increase. Acid number, Viscosity, and Water and Sediment tests can be used to ensure your B20 meets ASTM specifications for either biodiesel or diesel fuel. There are data suggesting that when oxidized or aged biodiesel is blended with diesel to make B20, some of the sediments and gums soluble in the B100 become insoluble and come out of solution, forming sediments. This information is presented as a warning only. You should never blend out-of-specification B100 into diesel to make B20. Make sure the Water and Sediment, Acid number, and Viscosity values are all within spec before blending.

5. WARRANTY ISSUES

There are a variety of statements about biodiesel use from engine/vehicle manufacturers, including some that make reference to warranty. Engine and vehicle manufacturers provide a material and workmanship warranty on their products. Such warranties do not cover damage caused by some external condition. Thus, if an engine that uses biodiesel experiences a failure unrelated to the biodiesel use, it must be covered by the OEM's warranty. Federal law prohibits the voiding of a warranty just because biodiesel was used—it has to be the cause of the failure. If an engine experiences a failure caused by biodiesel use (or any other external condition, such as bad diesel fuel), the damage will not be covered by the OEM's warranty.

Many engine OEMs are acknowledging biodiesel use by stating their observations about harmful effects (or the lack of effects) with various blends in their equipment. Most OEMs declare a lack of harmful effects for B5 and lower blends based on a statement by the leading fuel injection equipment suppliers, as long as the biodiesel meets D6751 and/or the European biodiesel specification. Some OEMs recognize higher blend levels. More evaluation is underway in the diesel engine industry related to biodiesel and its effects on diesel engines.

Damage directly attributable to biodiesel will not be covered by an engine OEM's warranty, but should be covered by the fuel supplier's general liability insurance. New biodiesel users should be sure that their biodiesel suppliers provide liability coverage on the biodiesel and its blends. For an updated list of OEMs and their positional statements, visit the National Biodiesel Board Web page at URL <http://www.biodiesel.org/>.

6. TAXES AND INCENTIVES

Biodiesel is not exempt from federal excise taxes and it is not exempt from most state or local taxes. That means that biodiesel and biodiesel blends are taxed at the same rate as diesel fuel and the taxes are handled in the same manner. Some states have passed legislation that either reduces fuel excise taxes or provides other incentives. For local exceptions to this statement, please contact the local tax authorities.

There are currently no federal tax incentives for using biodiesel. Check with local agencies regarding local incentives. DOE's Clean Cities Program maintains a Web site that summarizes state and local laws and incentives related to alternative fuels. This can be accessed at <http://www.eere.energy.gov/cleancities/vbg/progs/laws.cgi>.

If you are using biodiesel in a vehicle that uses any public road (B100 or any blend of biodiesel), then you are responsible for remitting federal, state, and local taxes on the fuel, **including the biodiesel fraction**, to the appropriate agencies in a timely manner. The taxes that apply to off-road use of diesel fuel will also apply to B100 and blends of biodiesel in these applications. This requirement applies to biodiesel you make yourself and to B100 that you purchase and use in your own operations. If you are blending B100 that you purchased, and either using the B20 yourself, or selling it to others, you are responsible for remitting the federal, state, and local taxes in a timely way to the appropriate agencies. Most B100 is sold on a pre-tax basis, which leaves the blender responsible for collecting and remitting taxes. For most commercial B20 users, the blenders have already included the taxes owed in the sale price of the fuel. Check your invoice or with your supplier if you have questions. The customer has the responsibility to ensure that the appropriate taxes have been paid.

7. SAFETY, HEALTH, AND ENVIRONMENTAL ISSUES

Biodiesel contains no hazardous materials and is generally regarded as safe to use. Like any fuel, certain fire safety precautions must be taken. Appendix III contains a Material Safety Data Sheet (MSDS) with details on concerns in these areas.

A number of studies have found that biodiesel biodegrades much more rapidly than conventional diesel. Users in environmentally sensitive areas such as wetlands, marine environments, and national parks have taken advantage of this property.

8. USING BIODIESEL UNDER THE ENERGY POLICY ACT

The Energy Policy Act of 1992 (EPAct) was passed by Congress to reduce the nation's dependence on imported petroleum by requiring certain fleets to acquire alternative fuel vehicles (AFVs), which are capable of operating on non-petroleum fuels. Compliance with EPAct is met by credits awarded for acquisition of AFVs.

The Energy Conservation Reauthorization Act of 1998 (ECRA) amended EPAct to allow credit for B20 use. DOE's Biodiesel Fuel Use Credit Interim Final Rule became effective in January 2001, allowing covered fleets to meet EPAct requirements through the purchase of biodiesel fuel.

One biodiesel fuel use credit, which is counted as one AFV acquisition, is allocated to fleets for each purchase of 450 gallons of neat biodiesel fuel, for use in diesel vehicles more than 8,500 lbs. GVWR. The biodiesel must be neat (B100) or in blends that contain by volume at least 20% biodiesel (B20). Fleets are allowed to use these credits to fulfill up to 50% of their EPAct requirements. (Biodiesel fuel providers can meet up to 100% of their requirements through the use of biodiesel fuel use credits.) These credits can be claimed only in the year in which the fuel is purchased for use, and they cannot be traded among fleets.

For further information, visit the EPAct web page at
http://www.eere.energy.gov/vehiclesandfuels/deployment/fcvt_epact.shtml

For specific information about biodiesel use in federal fleets, contact:
Shabnam Fardanesh
202 586-7011
shabnam.fardanesh@ee.doe.gov

For specific information about biodiesel use in state and fuel provider fleets, contact:
Linda Bluestein
202 586-6116
Linda.Bluestein@ee.doe.gov

9. FREQUENTLY ASKED QUESTIONS ABOUT USING BIODIESEL

What is biodiesel made from?

Biodiesel can be made from a variety of renewable sources, such as vegetable oils (soybeans or other crops), recycled cooking grease, or animal fats. These feedstocks are used to manufacture a mixture of chemicals called fatty acid methyl esters (biodiesel).

Which feedstock is best?

Each feedstock can produce a high quality B100 fuel but with slightly different properties, especially cloud point, cetane number, oxidative stability, and NO_x emissions. Cost might also factor into the selection process. Most operational differences seen with B100 are reduced when B20 is produced. Most remaining differences can be managed with additives or diesel fuel blending strategies.

Does biodiesel affect how my engine operates?

Biodiesel blends of 20% or less should not change the engine performance in a noticeable way. Some users of biodiesel blends notice significant reductions in soot, and CO and HC emissions are reduced. Higher blend levels can reduce fuel economy, torque, and power but will also produce lower PM, HC, and CO emissions. NO_x may also rise with higher blend levels. Less noise and a better exhaust smell have also been noticed with biodiesel fuels.

Does using biodiesel void my warranty?

OEMs provide a material and workmanship warranty on their products. Such warranties do not cover damage caused by external conditions, such as fuel. Thus, if an engine using biodiesel experiences a failure unrelated to the biodiesel use, it must be covered by the OEM's warranty. Federal law prohibits the voiding of a warranty just because biodiesel was used—it has to be the cause of the failure. If an engine experiences a failure caused by biodiesel (or any other external condition, such as bad diesel fuel), it will not be covered by the OEM's warranty.

Who is using biodiesel?

The largest user of B20 is the U.S. Department of Defense, who planned to purchase more than 5.2 million gallons of biodiesel during the 2003-2004 contracting year. Many other federal, state, and alternative fuel provider fleets are also using B20, because it allows them to comply with EPA regulation. B20 is even sold at retail pumps throughout the country.¹³

B2 is sold in many outlets throughout the Midwest. Several states are considering legislation that requires the use of low-level biodiesel blends (B2-B5), and many operators in agricultural areas use biodiesel blends to support their local economies. Some fleets and many private consumers use B100.

¹³ Producers, distributors, and retail stations can be found at <http://www.biodiesel.org/buyingbiodiesel/guide/>.

Equipment that has been successfully used with biodiesel blends includes on-road vehicles of all types; construction, logging, farming equipment, power generators, boats and barges, heating oil boilers and industrial boilers, and even locomotives.

How much does biodiesel cost?

The wholesale cost of biodiesel is typically higher than diesel fuel by \$1 to \$2 per gallon. The size of the cost difference depends on the size of the biodiesel producer, their feedstock cost, transportation costs, production incentives, tax incentives, and other local variables. Historically, the cost of B20 has been about 20 cents per gallon higher than diesel fuel. B2 is only a few cents higher than diesel fuel.

How can I tell if the biodiesel I receive is good quality?

The biodiesel industry has developed a voluntary quality control program for producers and distributors to ensure that biodiesel is produced according to ASTM specifications and contamination or degradation does not occur during distribution, storage, or blending. That program is called the BQ9000. It is managed by an independent organization—the National Biodiesel Accreditation Commission. There are “Accredited Producers” and “Certified Distributors” depending on which activity a firm specializes in. The firm receives the accreditation, not the fuel, but the fuel supplied by either an accredited producer or a certified distributor meets all applicable standards for sale and use in the United States. There is no logo for an accredited producer. The logo for a certified distributor is shown below.



Figure 19. Logo for a Certified B100 Distributor

The certified distributor must:

- Purchase its B100 from an accredited producer, or
- Conduct fuel quality testing on all biodiesel purchased from non accredited producers

Testing each batch of biodiesel is the only way to ensure good quality—just like with conventional fuels. The simple tests that consumers may perform such as looking at clarity by filling a clear glass container and doing a visual inspection, cannot determine the quality of the fuel. Other fleets conduct more extensive tests either in-house or by sending the fuel to independent testing laboratories for more specialized testing of fuel properties. The consumer saves money on testing by purchasing biodiesel fuels through certified marketers.

Are there standards or specifications for biodiesel?

ASTM has a biodiesel blend stock standard (ASTM D6751) that describes minimum standards for biodiesel properties. The Department of Defense has specification for B20 blends (<http://assist.daps.dla.mil/docimages/0004/29/73/AA59693.PD0>).

Do I need to modify my vehicle to use biodiesel?

Based on user experience, no vehicle modifications appear to be necessary for blends of biodiesel as high as 20% biodiesel mixed with diesel fuel. Higher blend levels may require minor modification to seals, gaskets, and other parts. Tank and fuel line/fuel filter heaters (arctic packages) are recommended for blends of more than 20% biodiesel. Detailed long-term engine durability data have not been established for B20 in the United States so good maintenance practices are recommended.

Do I need to modify my dispensing equipment to use biodiesel?

Dispensing equipment does not need to be modified for blends of 20% biodiesel or lower blend levels, unless there is an issue with specific elastomers that are not compatible with B20. Occasional fuel filter plugging has been reported and some people filter the biodiesel fuels entering and/or leaving the tank. Some exposed parts of the dispensing systems may need protection from freezing in cold climates. Some people recommend tank cleaning before switching to B20 fuels.

How do biodiesel (B20 and B100) emissions compare to diesel emissions?

The EPA has conducted a comprehensive study of 80 biodiesel emission tests in CI engines that are presented in an easy to read chart in Chapter 2: Biodiesel Basics. The chart shows emission benefits for different biodiesel blend levels.

Does biodiesel use raise NO_x emissions?

The use of biodiesel will raise NO_x emissions of most CI engines. Blends of less than 5% do not have a significant increase in NO_x, with B20 blends raising NO_x emissions by about 2% over conventional diesel. Some B20 does not increase NO_x in B20 blends. Some B100 can raise NO_x above the certification limits of CI engines.

Biodiesel blends used in heating oil equipment will reduce NO_x by 1% for every 1% of biodiesel used in the blend. A B20 with heating oil will reduce NO_x by 20%.

How much biodiesel is used and produced in the United States?

Current production capacity for biodiesel is estimated at 60 - 80 million gallons per year, and in 2004, the Energy Information Agency (EIA) estimated that over 26 million gallons were used in transportation applications.¹⁴

Can I use biodiesel in a cold climate?

User experience with cold weather varies. B20 blends are used in some very cold climates such as northern Minnesota and Wyoming, where temperatures routinely fall

¹⁴ http://www.eia.doe.gov/cneaf/alternate/page/datatables/afvtable10_03.xls

below -30°F in the winter. B20 was used in an airport shuttle fleet for four years in Boston with no problems.

Some users have reported using B100 in extremely cold climates such as in Yellowstone National Park. The vehicles were equipped with winterization packages, and no other precautions were noted. Since widespread experience with B100 and higher blends in cold climates is lacking in the United States, users should be alert to potential problems and take reasonable steps to prevent them.

10. INFORMATION RESOURCES

The National Biodiesel Board has compiled an impressive library of online documents located at <http://www.biodiesel.org/resources/reportsdatabase/>. It can add detail to these guidelines. The search engine is set up by market segment. You have to be creative and use a variety of key words to search on specific non-market topics or call 1-800-841-5849 for information.

The U.S. Department of Energy has some technical documents located at http://www.eere.energy.gov/biomass/document_database.html.

The EPA has reviewed many emission reports and has summarized them at <http://www.epa.gov/OMS/models/biodsl.htm>.

Iowa State University has an online tutorial on biodiesel at <http://www.me.iastate.edu/biodiesel/Pages/biodiesel1.html>. They also offer classes in biodiesel production, analytical test methods, and business management for producers and marketing firms.

Department of Defense A-A-59693A Biodiesel Commercial Item Description (CID) is located at <http://assist.daps.dla.mil/docimages/0004/29/73/AA59693.PD0> in PDF format.

Also contact your Clean Cities representative, biodiesel suppliers, and others for information.

11. GLOSSARY/DEFINITIONS

additive: material added in small amounts to finished fuel products to improve certain properties or characteristics.

antioxidant: substance that inhibits reactions promoted by oxygen

aromatic compound: a hydrocarbon based on a six-carbon benzenoid ring

biodiesel: methyl esters of fatty acids meeting the requirements of ASTM specification D6751.

biodegradable: capable of being broken down by the action of microorganisms

boiling range: the spread of temperature over which a fuel, or other mixture of compounds, distills.

cetane index: an approximation of cetane number based on an empirical relationship with density and volatility parameters such as the mid-boiling point. This approximation is not valid for biodiesel or biodiesel blends.

cetane number: a measure of the ignition quality of diesel fuel based on ignition delay in an engine. The higher the cetane number, the shorter the ignition delay and the better the ignition quality.

chelating compound: a fuel additive that deactivates the catalytic oxidizing action of dissolved metals, notably copper, on fuels during storage.

CI: compression ignition, i.e. a diesel engine

cloud point: the temperature at which a sample of a fuel just shows a cloud or haze of wax (or in the case of biodiesel, methyl ester) crystals when it is cooled under standard test conditions, as defined in ASTM D2500.

detergent: a fuel detergent is an oil-soluble surfactant additive that maintains the cleanliness of engine parts by solubilizing deposits or materials likely to deposit in the engine fuel system.

dispersant: a surfactant additive designed to hold particulate matter dispersed in a liquid.

elastomer: synthetic rubber-type material frequently used in vehicle fuel systems (but not necessarily natural or synthetic rubber, may also apply to other polymers).

energy content: the heat produced on combustion of a specified volume or mass of fuel, also known as heating value or heat of combustion.

EPAct: Energy Policy Act of 1992. Title III provides incentives to promote the use of alternative fuel vehicles in transportation.

fatty acid methyl esters (FAME): Mono alkyl ester of long-chain fatty acids from naturally occurring vegetable oil, animal fats, and recycled greases.

fatty acid: any of the saturated or unsaturated monocarboxylic acids that occur naturally in the form of triglycerides (or mono or diglycerides) or as free fatty acids in fats and fatty oils.

flash point: the lowest temperature at which vapors from a fuel will ignite on application of a small flame under standard test conditions.

Free fatty acids: any saturated or unsaturated monocarboxylic acids that occur naturally in fats, oils or greases but are not attached to glycerol backbones. These can lead to high acid fuels and require special processes technology to convert into biodiesel.

Hydrocarbon (HC): a compound composed of hydrogen and carbon. Hydrocarbons can refer to fuel components and to unburned or poorly combusted components in vehicle exhaust.

kerosene: a refined petroleum distillate of which different grades are used as lamp oil, as heating oil, blended into diesel fuel, and as fuel for aviation turbine engines.

lubricity: the ability of a fuel to lubricate.

microbial contamination: containing deposits or suspended matter formed by microbial degradation of the fuel.

multifunctional additive: an additive or blend of additives with more than one function.

OEM: original engine manufacturer.

oxidation: loosely, the chemical combination of oxygen to a molecule.

oxidative stability: the ability of a fuel to resist oxidation during storage or use.

oxygenate: a fuel component that contains oxygen; i.e., biodiesel or ethanol.

particulate matter (PM): the solid or semi-solid compounds of unburned fuel that are emitted from engines.

polycyclic aromatic hydrocarbons (PAH): aromatic compounds with more than one benzenoid ring (PAH). Also, NPAH for nitro-polyaromatic compounds.

polyunsaturated fatty acids: fatty acids with more than one double bond.

pour point: the lowest temperature at which a fuel will just flow when tested under standard conditions as defined in ASTM D97.

saturation: or saturated compound. A paraffinic hydrocarbon or fatty acid, i.e. with only single bonds and no double or triple bonds.

solvency: the quality or state of being a solvent.

specific gravity: the ratio of the density of a substance to the density of water.

splash blending: the fuels to be blended are delivered separately into a tank truck

stratification: to separate into layers.

storage stability: the ability of a fuel to resist deterioration on storage due to oxidation.

torque: a force that produces rotation.

viscosity: a measure of the resistance to flow of a liquid.

12. SAMPLE BIODIESEL MATERIAL SAFETY DATA SHEET

Chemical Product

General Product Name: **Biodiesel**

Synonyms: Methyl Soyate, Rapeseed Methyl Ester (RME),

Methyl Tallowate

Product Description: Methyl esters from lipid sources

CAS Number: Methyl Soyate: 67784-80-9; RME: 73891-99-3;

Methyl Tallowate: 61788-71-2

Composition/Information On Ingredients

This product contains no hazardous materials.

Hazards Identification

Potential Health Effects:

INHALATION:

Negligible unless heated to produce vapors. Vapors or finely misted materials may irritate the mucous membranes and cause irritation, dizziness, and nausea. Remove to fresh air.

EYE CONTACT:

May cause irritation. Irrigate eye with water for at least 15 to 20 minutes. Seek medical attention if symptoms persist.

SKIN CONTACT:

Prolonged or repeated contact is not likely to cause significant skin irritation. Material is sometimes encountered at elevated temperatures. Thermal burns are possible.

INGESTION:

No hazards anticipated from ingestion incidental to industrial exposure.

First Aid Measures

EYES:

Irrigate eyes with a heavy stream of water for at least 15 to 20 minutes.

SKIN:

Wash exposed areas of the body with soap and water.

INHALATION:

Remove from area of exposure, seek medical attention if symptoms persist.

INGESTION:

Give one or two glasses of water to drink. If gastro-intestinal symptoms develop, consult medical personnel. (Never give anything by mouth to an unconscious person.)

-

Fire Fighting Measures

Flash Point (Method Used): 130.0° C min (ASTM 93)

Flammability Limits: None known

EXTINGUISHING MEDIA:

Dry chemical, foam, halon, CO₂, water spray (fog). Water stream may splash the burning liquid and spread fire.

SPECIAL FIRE FIGHTING PROCEDURES:

Use water spray to cool drums exposed to fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Oil soaked rags can cause spontaneous combustion if not handled properly. Before disposal, wash rags with soap and water and dry in well ventilated area. Firefighters should use self-contained breathing apparatus to avoid exposure to smoke and vapor.

Accidental Release Measures Spill Clean-Up Procedures

Remove sources of ignition, contain spill to smallest area possible. Stop leak if possible. Pick up small spills with absorbent materials such as paper towels, "Oil Dry", sand or dirt.

Recover large spills for salvage or disposal. Wash hard surfaces with safety solvent or detergent to remove remaining oil film. Greasy nature will result in a slippery surface.

Handling And Storage

Store in closed containers between 50°F and 120°F.

Keep away from oxidizing agents, excessive heat, and ignition sources.

Store and use in well ventilated areas.

Do not store or use near heat, spark, or flame, store out of sun.

Do not puncture, drag, or slide this container.

Drum is not a pressure vessel; never use pressure to empty.

Exposure Control /Personal Protection**RESPIRATORY PROTECTION:**

If vapors or mists are generated, wear a NIOSH approved organic vapor/mist respirator.

PROTECTIVE CLOTHING:

Safety glasses, goggles, or face shield recommended to protect eyes from mists or splashing. PVC coated gloves recommended to prevent skin contact.

OTHER PROTECTIVE MEASURES:

Employees must practice good personal hygiene, washing exposed areas of skin several times daily and laundering contaminated clothing before re-use.

Physical And Chemical Properties

Boiling Point, 760 mm Hg:>200°C Volatiles, % by Volume: <2

Specific Gravity (H₂O=1): 0.88 Solubility in H₂O, % by Volume: insoluble

Vapor Pressure, mm Hg: <2 Evaporation Rate, Butyl Acetate=1: <1

Vapor Density, Air=1:>1

Appearance and Odor: pale yellow liquid, mild odor

Stability And Reactivity**GENERAL:**

This product is stable and hazardous polymerization will not occur.

INCOMPATIBLE MATERIALS AND CONDITIONS TO AVOID:

Strong oxidizing agents

HAZARDOUS DECOMPOSITION PRODUCTS:

Combustion produces carbon monoxide, carbon dioxide along with thick smoke.

Disposal Considerations**WASTE DISPOSAL:**

Waste may be disposed of by a licensed waste disposal company. Contaminated absorbent material may be disposed of in an approved landfill. Follow local, state and federal disposal regulations.

Transport Information

UN HAZARD CLASS: N/A

NMFC (National Motor Freight Classification):

PROPER SHIPPING NAME: Fatty acid ester

IDENTIFICATION NUMBER: 144920

SHIPPING CLASSIFICATION: 65

Regulatory Information**OSHA STATUS:**

This product is not hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29 CFR 1910.1200. However, thermal processing and decomposition fumes from this product may be hazardous as noted in Sections 2 and 3.

TSCA STATUS: This product is listed on TSCA.

CERCLA (Comprehensive Response Compensation and Liability Act): NOT reportable.

SARA TITLE III (Superfund Amendments and Reauthorization Act):

Section 312 Extremely Hazardous Substances: None

Section 311/312 Hazard Categories: Non-hazardous under Section 311/312

Section 313 Toxic Chemicals: None

RCRA STATUS:

If discarded in its purchased form, this product would not be a hazardous waste either by listing or by characteristic. However, under RCRA, it is the responsibility of the product user to determine at the time of disposal, whether a material containing the product or derived from the product should be classified as a hazardous waste, (40 CFR 261.20-24)

CALIFORNIA PROPOSITION 65:

The following statement is made in order to comply with the California Safe Drinking Water and Toxic Enforcement Act of 1986. This product contains no chemicals known to the state of California to cause cancer.

Other Information

This information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any other process. Such information is to the best of the company's knowledge and believed accurate and reliable as of the date indicated. However, no representation, warranty or guarantee of any kind, express or implied, is made as to its accuracy, reliability or completeness and we assume no responsibility for any loss, damage or expense, direct or consequential, arising out of use. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. By investing in technology breakthroughs today, our nation can look forward to a more resilient economy and secure future.

Far-reaching technology changes will be essential to America's energy future. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a portfolio of energy technologies that will:

- Conserve energy in the residential, commercial, industrial, government, and transportation sectors
- Increase and diversify energy supply, with a focus on renewable domestic sources
- Upgrade our national energy infrastructure
- Facilitate the emergence of hydrogen technologies as vital new "energy carrier's."

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

1-68

BIODIESEL

COLD WEATHER BLENDING STUDY



Senate Agriculture
2-7-06 Committee
Attachment 2

COLD FLOW BLENDING CONSORTIUM

Disclaimer

This report was prepared as an account of work sponsored by the National Biodiesel Board and the Cold Flow Consortium. Neither National Biodiesel Board, the Cold Flow Consortium nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the National Biodiesel Board, the Cold Flow Consortium or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the National Biodiesel Board, the Cold Flow Consortium or any agency thereof.

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Mr. Brett Webb

Magellan Midstream Partners

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BP

Mrs. Sherry Boldt

ADM

Mr. Peter Reimers

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West Central Soy

Mr. Myron Danzer
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Farmer's Union Marketing and Processing Association – FUMPA

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Mr. Paul Heinz

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Schaeffer Manufacturing Company

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CANMET – Natural Resources

Canada

Mr. Ed Hogan

Murphy Oil USA Inc

Mr. Barry Jeffery

SOYMOR

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Mr. Steve Howell

University of Minnesota

Mr. Ken Bickel

Minnesota Department of Commerce

Mr. Jim Hedman

Executive Summary

Increased use of biodiesel has created some handling challenges for bringing blended fuels to the consumer. The most immediate handling concern for blenders is assurance that diesel fuels and biodiesel can be blended uniformly and in a single phase. More specifically, blenders need guidelines and parameters for blending diesel fuel and biodiesel in colder climates. Neat biodiesel has a much higher cloud point than conventional diesel fuels and this can impact handling procedures. This concern became a priority following the passage of a bill in Minnesota that required all on-highway diesel fuels to contain at least 2% biodiesel as early as July 1, 2005.

In response to the need in Minnesota, the National Biodiesel Board established a Biodiesel Cold Flow Consortium to study the blending properties of biodiesel. Members of the consortium included petroleum marketers, biodiesel producers, fuel blenders, and other experts and interested parties. The members designed a project to investigate this cold flow problem. The project goal was to define operating parameters for blending biodiesel with diesel fuel at a variety of temperatures, including those seen in the wintertime in Minnesota.

To achieve this goal, a small blending test rig was designed to simulate splash and proportional blending at the terminal. Unadditized No. 1 and No. 2 diesel fuels were selected, along with three biodiesels with a range of cold flow properties. The test temperatures were determined using Minnesota winter climate data. All testing focused on preparing 2 volume percent biodiesel blends.

Splash blending tests were based on visual observation of wax crystal formation and are thus qualitative. To ensure quantitative data was obtained, differential pressure drop measurements were collected. These measurements compared the pressure drop of neat diesel fuel through a filter with the pressure drop created by B2 blends at various temperatures.

Results from the testing showed that the biodiesel must be kept at least 10°F above its cloud point to successfully blend with diesel fuels in cold climates. Because generic, unadditized fuels were used in this project, the actual temperatures of the fuels will need to be determined on an individual basis.

Table of Contents

Cold Flow Consortium Committee	i
Executive Summary	iii
Introduction	1
Scope	1
Experimental Apparatus	1
Test Procedures	2
Test Fuels	3
Results and Discussion	3
Conclusions	5
Small Group Steering Committee Members	6
Appendix A. P&ID of Splash Blending Rig.	7
Appendix B. P&IF of Modified Test Rig.....	8
Appendix C. Step-by-step Analytical Procedures	9
Appendix D. Certificate of Analysis for #1 Diesel Fuel	11
Appendix E. Certificate of Analysis for #2 Diesel Fuel.....	13
Appendix F. Certificate of Analysis for Soy Biodiesel.....	15
Appendix G. Certificate of Analysis for Yellow Grease Biodiesel	16
Appendix H. Certificate of Analysis for Tallow Biodiesel	17
Appendix I. Qualitative Blending Data	18
Appendix J. Listing of Consortium Members Comments.....	22

Introduction

In response to the recent passage of Minnesota's bill requiring 2% biodiesel in all diesel fuels starting as early as July 1, 2005, the National Biodiesel Board convened a Cold Flow Consortium. The Consortium was tasked with investigating the blending of biodiesel into diesel fuel at temperatures similar to those experienced in the Minnesota winter, with the objective of defining parameters for successfully preparing homogeneous single-phase blends. The Consortium was composed of fuel providers, marketers, blenders, and other interested parties. Each member had an equal voice in the Consortium.

Scope

This study was designed to accurately determine the temperature where biodiesel and No. 1 and No. 2 diesel could be blended at 2 volume percent (2%) biodiesel, while meeting standards for blend precision and homogeneity. The approach taken was to fabricate a small scale blending system to simulate splash and proportional blending. The system has the capability to blend biodiesel at different rates with different grades of diesel fuel at different temperatures. This study focused on preparing 2% biodiesel (B2) blends exclusively. The blending system was self-contained to include tanks, pumps, motors, and necessary appurtenances. The system included the ability to heat and/or cool the biodiesel as needed and cool the diesel as needed.

Experimental Apparatus

The test unit was designed to be totally portable to allow for future testing at various locations. The design of the test skid was specifically sized for testing B2 as mandated in the state of Minnesota. The test skid included an environmental chilling chamber, capable of cooling fuel to near -60°F in a reasonably short period of time. A photograph of the blending unit is in Figure 1. Each process and test was recorded manually and with video equipment along with the blending equipment records of volume amounts. To assist in recording the results of these tests, the finished product tank included interior lighting, viewing ports, and sample ports. The finished product tank was manufactured of a clear material to offer the best possible opportunity for evaluating the formation of crystals.

The design for the first series of testing simulated splash blending into a clear blending container maintained at ambient temperature. A process and instrumentation diagram (P&ID) of this test bench configuration is contained in Appendix A. For proportional blending, a flow loop was created to allow the fuels to circulate through the piping while inside the cooling chamber. The piping loop included a filter and differential pressure across the filter was employed to monitor fuel viscosity changes and determine if the fuels were plugging the filters or strainers. Large increases in viscosity or filter plugging would indicate the formation of wax or biodiesel crystals. A P&ID of this configuration is shown in Appendix B.

Figure 1. Photograph of Small Scale Test Unit for Blending Biodiesel and Diesel Fuel



Test Procedures

Sequential Blending into Visible Container. These tests simulated splash blending. Four scenarios were tested:

1. Cold No. 1 diesel was loaded into the container. The first type of biodiesel was added to the top to create a B2 blend. This procedure was repeated for each type of biodiesel.
2. Cold No. 2 diesel was loaded into the container. The first type of biodiesel was added to the top to create a B2 blend. This procedure was repeated for each type of biodiesel.
3. Biodiesel was loaded into the container first. The No. 1 diesel fuel was loaded on top to create the B2 blend. This scenario was repeated for each type of biodiesel.
4. Biodiesel was loaded into the container first. The No. 2 diesel fuel was loaded on top to create the B2 blend. This scenario was repeated for each type of biodiesel.

Proportional Blending. The biodiesel and diesel fuels were blended through proportional blending. To accomplish this, four gallons of cold No. 1 or No. 2 diesel fuel were circulated through the filters and the pressure drop across the filters measured. Biodiesel was then proportionally blended at 2% and any change in the filter pressure drop monitored. This procedure was repeated with each of the three biodiesels. Step-by-step procedures are given in Appendix C.

Test Fuels

A local truck rack operator provided the diesel fuels for this project. The fuels were unadditized commercial grades of No. 1 and No. 2 diesel fuels. The certificates of analysis are in Appendix D and E, respectively. The biodiesels were soy-, yellow grease-, and tallow-derived fuels. The certificates of analysis are in Appendices F, G, and H, respectively. West Central Soy provided the soy biodiesel. Rothsay/Laurenco provided the yellow grease and tallow biodiesels.

The biodiesels were sent to a test facility to measure the cloud and pour points of the neat biodiesels and the B2 blends. Because the unadditized diesel fuel (Appendices D and E) was not available, a typical no. 2 diesel was used to make the blends for cloud point and pour point determination. The results of this testing are shown in Table 1.

Table 1. Measured Low Temperature Properties of Fuels Used in this Study

Fuel	Cloud Point		Pour Point	
	°C	°F	°C	°F
No. 2 Diesel	-23	-9	-27	-17
Soy Biodiesel	2	35	0	32
Yellow Grease Biodiesel	5	41	3	37
Tallow Biodiesel	14	57	18	64
2% Soy Biodiesel	-21	-5	-27	-17
2% Yellow Grease Biodiesel	-21	-5	-27	-17
2% Tallow Biodiesel	-20	-4	-27	-17

Results and Discussion

The initial testing used visual observation to determine if shock crystallization occurred. Testing revealed several drawbacks with this method. First, the fuel was pushed through the apparatus with nitrogen gas. Bubbles of nitrogen remained suspended in the fuels impeding visual observation. To allow for visual observation, the clear blending vessel was exposed to ambient temperatures. Although the fuel was preconditioned to the test temperatures and the plumbing was insulated, the ambient air warmed the fuels and the test temperature was unknown. Due to the qualitative nature of the data, no conclusions could be drawn from the visual data, however they are included in Appendix I.

To resolve these issues, vane pumps were used to push the fuel rather than nitrogen gas. Temperature monitoring was used to ensure the pumps were not heating the fuels. The clear blending vessel was replaced with a steel blending vessel. The steel blending vessel was placed in an environmental chamber designed to keep the apparatus at the desired temperature. These changes no longer allowed for visual observation of the blending results.

A quantitative measure of changes in the blend was needed. Swagelok SS-8TF2 filters of varying porosities were used in conjunction with differential pressure gauges to indicate changes in viscosity or solid formation. The diesel fuels were circulated through a 15 micron filter to determine the baseline pressure drop. Results of this baseline testing are listed in Table 2. The duration is the amount of time needed to dispense 1 gallon of fuel.

Table 3 shows the results of testing with the three biodiesels. The fuels were circulated

through the pump rig for 180 seconds. The differential pressure was measured at various intervals throughout the testing. For the low and middle cloud point fuels, the 100 mesh strainer was clean at the end of the circulation period. For the high cloud point fuel, the strainer was 50% plugged with solids. The 15 micron filter did not allow for usable data, as the biodiesels exceeded the gauge range and bypassed the loop through the relief valve.

Table 2. Baseline Testing with Fuels to Determine Pressure Drop Across Various Size Filters and Strainers

Fuel	Strainer	Flow Rate, GPM	Temperature, °F	Duration, sec	Differential Pressure, PSI
#2	None	1	64	60	0
#2	None	3.3	64	18	0
#2	100 mesh	3.3	68	18	7.5
#2	15 micron	1.9	68	31	82
#2	100 mesh	1.4	68	42	1
#2	15 micron	0.85	68	71	35
#1	100 mesh	3.3	50	18	3
#1	15 micron	2.1	50	29	not measured
#1	100 mesh	1.5	51	39	not measured
#1	15 micron	1.1	51	37	not measured

Table 3. Baseline Testing with Biodiesel Fuels to Determine Pressure Drop Across 100 Mesh Filter. Shaded lines indicate biodiesel was at or below its cloud point.

Biodiesel Cloud Point, °F	Flow Rate, GPM	Temperature, °F	Test Time, sec	Differential Pressure, PSI
32	3.3	50	60	5
32	3.3	51	90	5
32	3.3	51	120	5
32	3.3	51	150	5
32	3.3	51	180	5
43	3.3	50	60	6
43	3.3	51	90	6
43	3.3	51	120	6
43	3.3	51	150	6
43	3.3	51	180	6
58	3.3	51	60	17
58	3.3	51	90	16
58	3.3	51	120	16
58	3.3	51	150	16
58	3.3	52	180	14

The diesel fuel was filtered through the 15 micron filter then switched to the 100 mesh strainer. The differential pressure was measured before, during, and after blending with biodiesel at a constant temperature. The final differential pressure reading was taken through the 15 micron filter and compared to the diesel baseline results to determine the rise in pressure of the blend (Table 4).

Table 4. Differential Pressure Results of Biodiesel Blending into Diesel Fuels
 The shaded lines indicate that the biodiesel temperature is at or below its cloud point.

Test	Type of Diesel Fuel	Diesel Fuel Temp. F	Biodiesel Cloud Point, F	Biodiesel Temp. F	% Biodiesel in Test Sample	Unblended Fuel DP PSI	B2 DP PSI	DP Rise in PSI	Comments
1RR	#2	10	32	58	1.7	70	75	5	
2	Kerosene	10	32	50	2	40	40	0	
3	# 2	10	43	50	1.9	75	80	5	
4	Kerosene	10	43	50	1.9	45	45	0	
5	#2	10	58	56	1.8	75	82	7	
6	Kerosene	10	58	58	1.7	40	42	2	
7	Kerosene	0	32	50	1.7	33	35	2	
8	Kerosene	-10	32	50	1.8	50	55	5	
9	Kerosene	-10	43	50	1.8	45	45	0	
10	Kerosene	0	43	50	1.9	32	35	3	
11	Kerosene	0	58	53	1.9	40	45	5	
12	Kerosene	-10	58	53	2	35	45	10	Blend Unsuccessful

All above tests were performed using a 15 micron Filter and 2% Biodiesel Blends. All samples were top samples.

Under the conditions used in this study, researchers determined that the biodiesel must be at least 10°F warmer than its cloud point when it is blended in cold diesel fuel. Although some testing was conducted below the cloud point of the biodiesels, there is not enough data to draw definite conclusions and the recommendation above is a conservative estimate. Unadditized diesel fuels were deliberately chosen for this study. Due to various fuel properties encountered in the real world, the target temperatures will need to be determined on an individual basis based on the fuels in use.

The results were shared with the Consortium members. A record of their comments is in Appendix J.

Conclusions

This study was designed to simulate different types of blending for biodiesel and diesel fuels. A small test rig was constructed to simulate real world blending scenarios. The original tests used visual observation to determine when the blends were successful. This method did not provide objective data. A modification to the test methodology was made – filters and differential pressure gauges were used to determine the change in differential pressure between the base fuel and the B2 blends.

Based on tests with the fuels described above, the study findings are:

- Qualitative visual observations of sequential blending with diesel and biodiesel fuels showed clouding and possible crystallization of the fuel.
 - This may be a concern in Northern and Midwest states where biodiesel will be blended into colder diesel fuel that *may* result in crystal formation without adequate mixing.

- A typical rack blending system is “once through only” without circulation through a pump.
 - Circulating diesel or biodiesel fuels through a pump does not match up with real world rack blending systems.
 - In this study, test run blending used circulation through a pump that *may* have provided additional shearing and mixing that helped to eliminate “shock” or wax crystallization.

In this study, successful B2 blends were made when the biodiesel was 10°F above its cloud point. Unadditized diesel fuel was deliberately chosen for this study and the three biodiesels were selected to span a range of cloud points and are not meant to be representative of all fuels encountered. Because of the variety of fuel properties, the target temperatures for blending will need to be determined on an individual basis based on the fuels and actual winter temperatures at the terminal. It will be important for blenders to request cloud point information from suppliers for cold weather considerations.

Small Group Steering Committee Members

Steve Howell-Marc IV Consulting Group

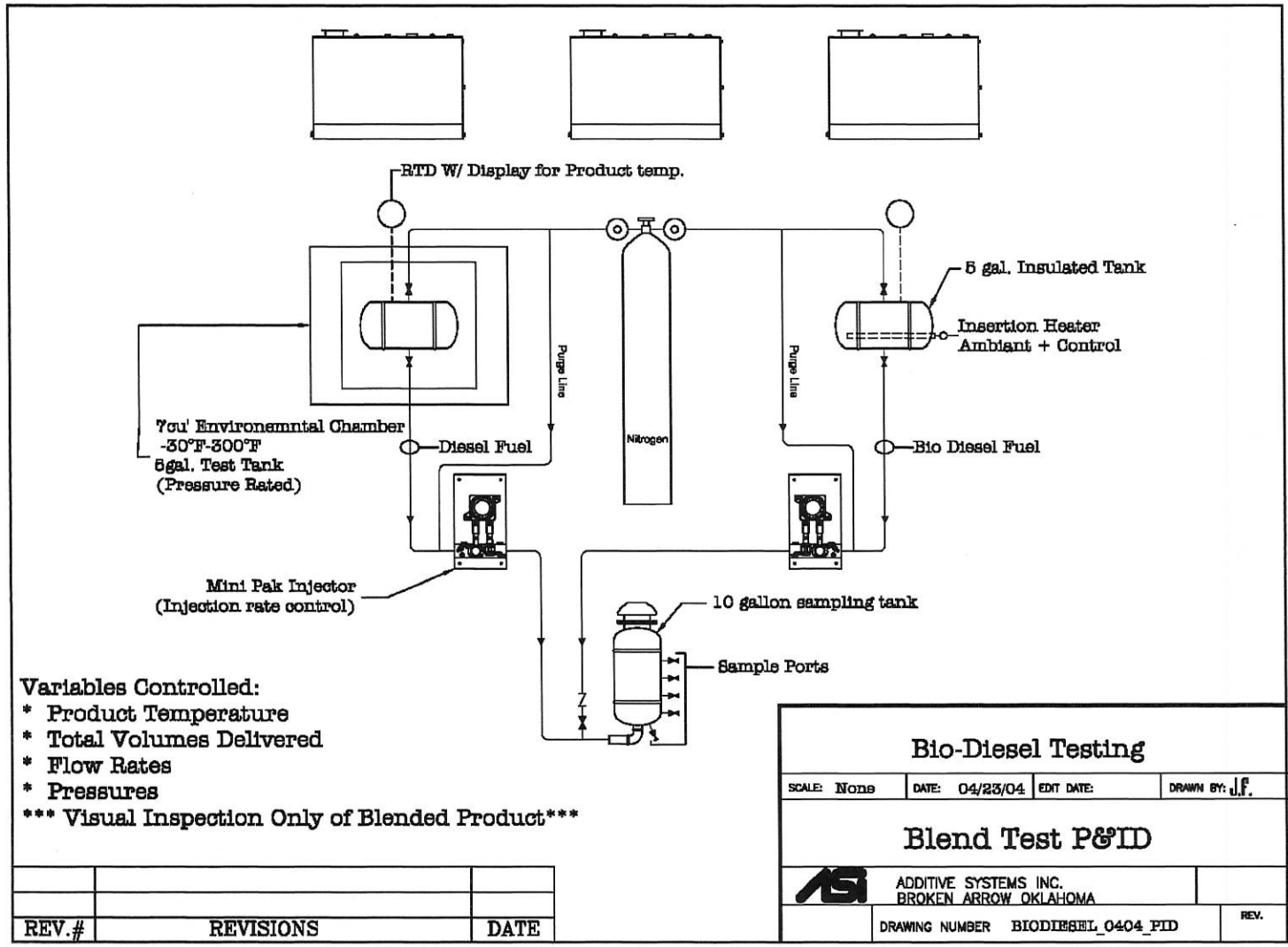
Paul Nazzaro-Advanced Fuel Systems

Charley Selvedge-Flint Hills Resources

Rick Stanko-Marathon Ashland Petroleum Company

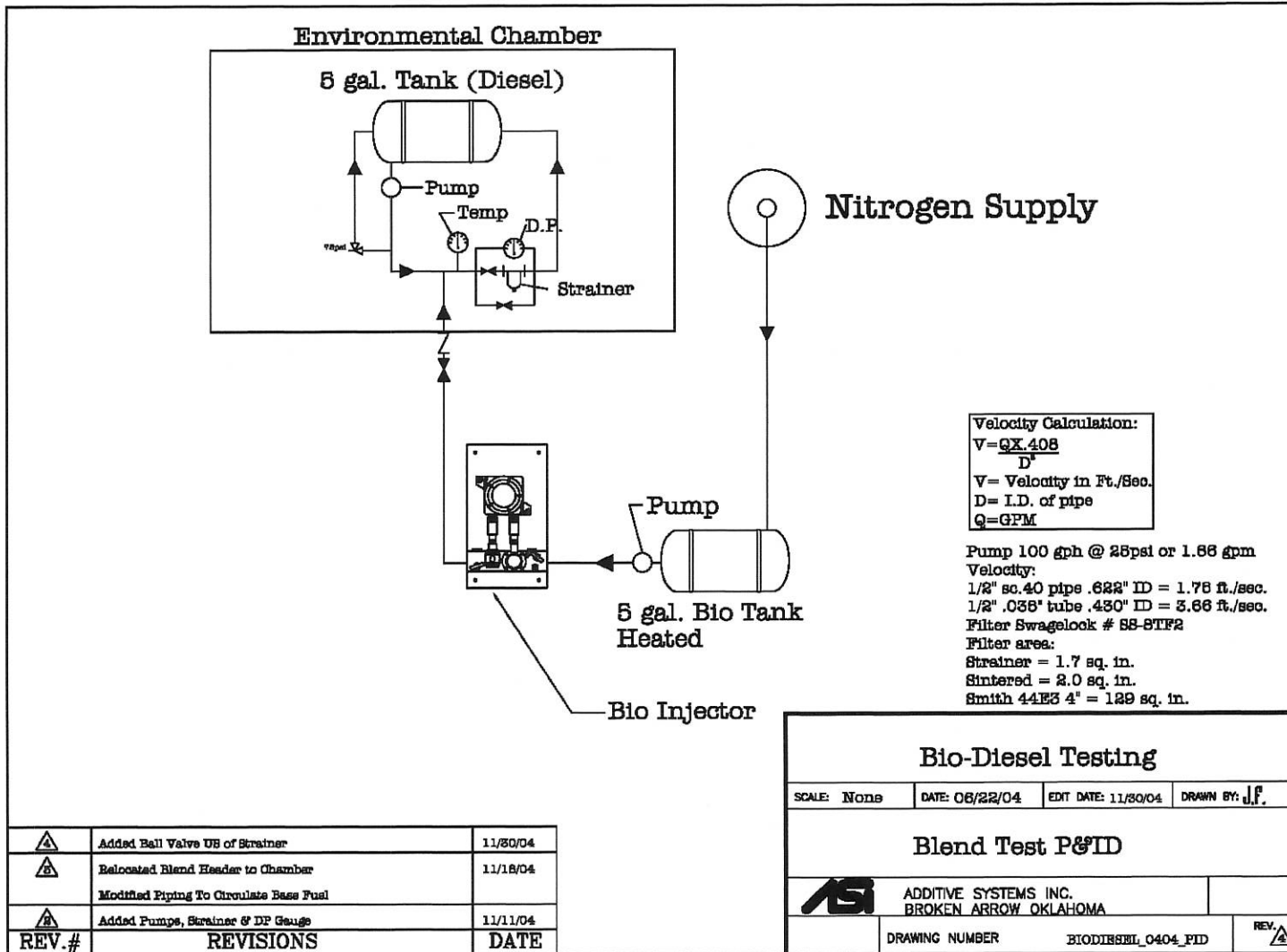
Rod Lawrence- Magellan Midstream LP

Appendix A. P&ID of Splash Blending Rig.



2-12

Appendix B. P&ID of Modified Test Rig



2-13

Appendix C. Step-by-step Analytical Procedures

The step-by-step analytical procedures follow.

Baseline Determination

1. Turn on the diesel fuel pump. Set the temperature controller to the test temperature.
2. Assure that Flow Control Valve #1 (FCV1) is closed, i.e. no fuel is passing through the Differential Pressure Gauge (DPG).
3. Allow the system to run for XX minutes. (Calculated value based on the volume of diesel fuel in the tank and the flow rate; volume pumped > volume in the tank.)
4. Assure the temperature has stabilized. Record the temperature.
5. Open FCV1 and start timer.
6. At 1 minute intervals record the reading on the DPG.
7. If the DP increases to over 10? mm Hg, record the time and turn off the pump.
8. At 10 min record the reading on the DPG as the Final Differential Pressure (FDP).
9. Repeat steps 1 – 8.
10. Record the results from the two runs and report the average.

Biodiesel Blend Filterability Determination

1. Turn on the diesel fuel pump. Set the controller to the test temperature.
2. Assure that FCV1 is closed.
3. Allow the system to run for XX minutes
4. Load the desired amount of biodiesel into the injector.
5. Record the injector temperature.
6. Assure the diesel fuel temperature has stabilized. Record the temperature.
7. Open FCV1 and allow the diesel fuel to flow through the DPG for 1 minute.
8. Record the DP.
9. Inject the biodiesel
10. If the DP increases to over 10? mm Hg, record the time and turn off the pump.
11. At 10 minutes record the reading on the DPG as the FDP.
12. Repeat steps 1 – 11, with new diesel fuel and biodiesel.
13. Record the results from the two runs and report the average.

Biodiesel Solubility Determination

1. Turn on diesel fuel pump. Set the temperature controller to the test temperature.
2. Assure that FCV1 is closed.
3. Allow the system to run for XX minutes
4. Load the desired amount of biodiesel into the injector.
5. Record the injector temperature.
6. Assure the diesel fuel temperature has stabilized. Record the temperature.
7. Inject the biodiesel
8. Circulate the blended fuel for 10 minutes.
9. Open FCV1 and allow the blended fuel to flow through the DPG.
10. Record the DP every one minute.
11. If the DP increases to over 10? mm Hg, record the time and turn off the pump.
12. At 10 minutes record the reading on the DPG as the FDP.
13. Repeat steps 1 – 11, with new diesel fuel and biodiesel.
14. Record the results from the two runs and report the average.

The ability to use the rig and the procedures above to assess the cold temperature properties of blends below the cloud point of diesel fuel depends on the repeatability of the rate of filter plugging, because at these temperatures, the filter is going to plug.

Appendix D. Certificate of Analysis for #1 Diesel Fuel

Laboratory Analysis Report

Date Printed: 5/20/2005

Report To: Rod Lawrence
Magellan Analytical Services
1090-A Sunshine Rd
Kansas City KS 66115 -

Submitted By: Paul Hinkle
Additive Systems Inc
407 S Main
Broken Arrow OK 74012

cc:

Sample ID: KS04100778 Type of Sample: Diesel Fuel
Tank:

Sample Description: Jet Fuel

Sample Notes: D9

Method	Results
--------	---------

D 86 - Distillation

165.6 °C	IBP
185.8 °C	10%
191.8 °C	20%
210.9 °C	50%
250.0 °C	90%
272.9 °C	FBP
97.6 mL	Volume
1.0 mL	Loss
1.4 mL	Residue

D 93 - Flash-Point by Pensky-Martens Closed Cup Tester

37 °C

D 5453 - Total Sulfur by Ultraviolet Fluorescence

920 ppm (wt/wt)

D 4737 - Cetane Index

44.9

D 5773 - Cloud Point

-54 °F

D 5949 - Pour Point

-70 °F



10/20/2004

Results in boxes do not meet ASTM D975 specifications.

Appendix E. Certificate of Analysis for #2 Diesel Fuel

Laboratory Analysis Report

Date Printed: 5/20/2005

Report To: Rod Lawrence
Magellan Analytical Services
1090-A Sunshine Rd
Kansas City KS 66115 -

Submitted By: Paul Hinkle
Additive Systems Inc
407 S Main
Broken Arrow OK 74012

cc:

Sample ID: KS04100777 Type of Sample: Diesel Fuel
Tank:

Sample Description: # 2 LSD

Sample Notes: D9

Method	Results
--------	---------

D 86 - Distillation

181.8 °C IBP
213.3 °C 10%
224.2 °C 20%
262.1 °C 50%
324.6 °C 90%
351.8 °C FBP
97.8 mL Volume
1.0 mL Loss
1.2 mL Residue

D 93 - Flash-Point by Pensky-Martens Closed Cup Tester

50 °C

D 5453 - Total Sulfur by Ultraviolet Fluorescence

292 ppm (wt/wt)

D 4737 - Cetane Index

47.3

D 5773 - Cloud Point

6 °F

D 5949 - Pour Point

-10 °F



10/20/2004

Results in boxes do not meet ASTM D975 specifications.

Appendix F. Certificate of Analysis for Soy Biodiesel

MAR.22.2005 10:11AM ADDITIVE SYSTEMS NO.887 P.1/3



West Central Coop
 PO Box 68
 406 1st Street
 Ralston, IA 51459
 Phone: 712-667-3411
 Fax: 712-667-3306
 www.soypower.net



Certificate of Analysis

Order Number:		Rail/Truck Number:	
Shipping Date: 9-1-04		Attention:	
Customer: ASI		Post Office Box:	
Street Number:		State: OK	Zip Code:
City: Broken Arrow			

Product ID No.:
 Product Name: BioDiesel Product Color: Gardner #11

Lot Number:	040730107
Test	Results
Free Glycerine %:	0.0032
Total Glycerine %:	0.1186
Flashpoint C°:	153
Water & Sediment % Volume:	0.01
Carbon Residue % Mass:	0.02
Sulfated Ash % Mass:	0.001
Kinematic Viscosity cSt:	4.20
Total Sulfur by UV Fluorescence % Mass:	0.00014
Cetane Number:	52.7
Cloudpoint C°:	0
Copper Corrosion:	1B
Acid Number mg KOH/g:	0.61
Phosphorus by ICP % Mass:	<0.0001
Distillation at reduced pressure C°:	348
Temperature °F	72

Prepared by: Ronnie Brown 11/01/2004
 Ronnie Brown, West Central Process Chemist

Intel-Ved Form E542 rev 1

PAGE 08/08 SOY DEPT 7126673479 11/01/2004 13:24

2-20

Appendix G. Certificate of Analysis for Yellow Grease Biodiesel

MAR.22.2005 10:12AM ADDITIVE SYSTEMS

NO.887 P.2/3

Rothsay / Laurenco
 605, 1^{ere} Avenue
 Ville Ste-Catherine, Québec, Canada
 J0L 1E0



Un Membre du Groupe Les Aliments Maple Leaf Inc.
 A Member of Maple Leaf Foods Inc.

Tel: (450) 832-3250

Fax: (450) 832-4709

CERTIFICATE OF ANALYSIS
 Meet or exceed designation: D6751-02 standard

DATE: 30-09-2004

Biodiesel made from : Recycled frying oil

Recycled Frying Oil based Biodiesel

Lot Number: 300804.001

PROPERTY	ASTM METHOD	RESULTS	UNITS	LIMITS
Flash point	D 93	165	°C	100.0 min.
Water and sediment	D 2709	0.018	%	0.050 max.
Kinematic viscosity, 40 °C	D 445	5.3	mm ² /sec.	1.9 - 6.0
Sulfated Ash	D 874	0.011	% mass	0.020
Sulfur	D 2822	< 0.015	% mass	0.05
Copper Strip Corrosion	D 130	1a	-----	No.3 max.
Cetane	D 613	68	-----	40 min
Cloud point	D 2500	+ 6	°C	Report to customer
Carbon Residue	D 4530	0.03	% mass	0.050
Acid number	D 664	0.67	mg KOH/mg	0.80
Free glycerin	D 5584	0.000	% mass	0.020
Total glycerin	D 5584	0.168	% mass	0.240
Temperature		16.0	°C	

Quality control laboratory technician

Appendix H. Certificate of Analysis for Tallow Biodiesel

MAR.22.2005 10:12AM ADDITIVE SYSTEMS

NO.887 P.3/3

Rothsay / Laurenco
 605, 1^{ere} Avenue
 Ville Ste-Catherine, Québec, Canada
 JOL 1E0



Un Membre du Groupe Les Aliments Maple Leaf Inc.
 A Member of Maple Leaf Foods Inc.

Tel: (450) 632-3250

Fax: (450) 632-4703

CERTIFICATE OF ANALYSIS
 Meet or exceed designation: D6751-02 standards

DATE:02-10-2004

Biodiesel made from Tallow

Lot Number: 021004.001

PROPERTY	ASTM METHOD	RESULTS	UNITS	LIMITS
Flash point	D 93	165	°C	100.0 min.
Water and sediment	D 2708	0.022	%	0.050 max.
Kinematic viscosity, 40 °C	D 445	5.3	mm ² /sec.	1.9 - 6.0
Sulfated Ash	D 874	-----	% mass	0.020
Sulfur	D 2622	-----	% mass	0.05
Copper Strip Corrosion	D 130	-----	-----	No.3
Cetane	D 613	-----	-----	40
Cloud point	D 2600	+ 16	°C	Report to customer
Carbon Residue	D 4530	-----	% mass	0.050
Acid number	D 664	0.63	mg KOH/mg	0.80
Free glycerin	D 6584	0.002	% mass	0.020
Total glycerin	D 6584	0.108	% mass	0.240
pH		4.32		

2-22

Appendix I. Qualitative Blending Data

Blend Type	Diesel Type	Diesel Temp, F	Biodiesel Cloud Point, F	Biodiesel Temp, F	Temp Differential	Comments
Ratio	No. 2	40	32	72	32	Mixed well
Ratio	No. 2	30	32	72	42	Mixed well
Ratio	No. 2	20	32	72	52	Mixed well
Ratio	No. 2	10	32	72	62	Mixed well
Ratio	No. 2	0	32	72	72	Mixed well, Signs of icing revealed paraffin dropout, clogged 80 M strainers on #2 Fuel. Removed strainers and retest.
Ratio	No. 2	-5	32	72	77	Mixed well
Ratio	No. 2	-5	32	72	77	Mixed Well, No icing
Ratio	No. 2	-10	32	72	82	Mixed Well, No icing
Ratio	No. 2	-10	32	72	82	Mixed Well, No icing
Ratio	No. 2	-15	32	72	87	Mixed Well, Some icing
Ratio	No. 2	-17	32	72	89	#2 slushy. Bio blended throughout though.
Ratio	No. 2	-20	32	72	92	#2 slushy, Partially frozen. Bio did not blend throughout
Ratio	No. 2	-25	32	72	97	#2 Froze
Ratio	No. 2	-10	32	55	65	Mixed Well, No icing
Ratio	No. 2	-10	32	50	60	Mixed Well, No icing
Ratio	No. 2	-10	32	45	55	Bio Crystallizing on contact, Mixing but not blending.
Ratio	No. 2	-15	32	50	65	Small amounts of bio Crystallizing on contact, Mixing but not blending.
Ratio	No. 2	-15	32	55	70	Mixed Well, No icing
Ratio	No. 2	0	43	60	60	Mixed Well
Ratio	No. 2	-5	43	60	65	Mixed well
Ratio	No. 2	-5	43	55	60	Mixed Well, No Crystals
Ratio	No. 2	-10	43	55	65	Mixed Well, No Crystals
Ratio	No. 2	-10	43	50	60	Mixed Well, No Crystals, Hazy Fuel
Ratio	No. 2	-15	43	45	60	Mixed Well, No Crystals, Hazy Fuel
Ratio	No. 2	-15	43	40	55	Mixed thoroughly, Very Cloudy
Ratio	No. 2	-15	43	35	50	Bio icing, Creating large crystals, Did not Blend
Ratio	No. 2	-15	43	30	45	Bio icing, Solids Present, Did not Blend
Ratio	No. 2	-5	43	35	40	Mixed Thoroughly, Crystals forming on contact.
Ratio	No. 2	-5	43	40	45	Mixed Well, No icing
Ratio	No. 2	0	43	35	35	Mixed well but stayed hazy, cloudy

Blend Type	Diesel Type	Diesel Temp, F	Biodiesel Cloud Point, F	Biodiesel Temp, F	Temp Differential	Comments
Ratio	No. 1	-30	32	45	75	Icing, mixed fair
Ratio	No. 1	-30	32	50	80	Icing, mixed fair
Ratio	No. 1	-30	32	60	90	Icing, mixed fair
Ratio	No. 1	-25	32	60	85	Icing, mixed fair
Ratio	No. 1	-20	32	60	80	Mixed well
Ratio	No. 1	-20	32	55	75	Icing, mixed fair
Ratio	No. 1	-15	32	55	70	Mixed Well
Ratio	No. 1	-15	32	50	65	Icing, mixed fair
Ratio	No. 1	-15	32	53	68	Mixed well
Ratio	No. 1	-10	32	50	60	Mixed Well
Ratio	No. 1	-10	32	45	55	Mixed Well, No icing
Ratio	No. 1	-10	32	50	60	Mixed Well, No icing
Ratio	No. 1	-5	32	45	50	Blended well
Ratio	No. 1	-5	32	40	45	Blended well
Ratio	No. 1	0	32	35	35	Icing, mixed fair
Ratio	No. 1	-15	43	40	55	Mixed well
Ratio	No. 1	-20	43	40	60	Mixed well
Ratio	No. 1	-25	43	40	65	Slight Icing of bio
Ratio	No. 1	-30	43	40	70	Icing of bio
Ratio	No. 1	-15	43	35	50	Blended well
Ratio	No. 1	-10	43	35	45	Icing of bio
Ratio	No. 1	-25	43	45	70	Mixed Well, No icing
Ratio	No. 1	-30	43	45	75	Icing
Ratio	No. 1	-30	43	50	80	Icing
Ratio	No. 1	-25	43	50	75	Blended well
Ratio	No. 1	-30	43	55	85	Blended well
Ratio	No. 1	-35	43	55	90	Icing
Ratio	No. 1	-35	43	60	95	Blended

Blend Type	Diesel Type	Diesel Temp, F	Biodiesel Cloud Point, F	Biodiesel Temp, F	Temp Differential	First Product: Comments
Sequential	No. 2	0	32	50	50	Bio: Mixed Well
Sequential	No. 2	0	32	50	50	No. 2: Mixed Well
Sequential	No. 2	-5	32	45	50	Bio: Mixed Well
Sequential	No. 2	-5	32	45	50	No. 2: Mixed Well
Sequential	No. 2	-10	32	45	55	Bio: Mixed Well
Sequential	No. 2	-10	32	45	55	No. 2: Mixed Well
Sequential	No. 2	-10	32	40	50	Bio: Icing
Sequential	No. 2	-10	32	40	50	No. 2: Mixed Well
Sequential	No. 2	-10	32	45	55	Bio: Mixed Well
Sequential	No. 2	-15	32	55	70	Bio: Mixed Well
Sequential	No. 2	-15	32	55	70	No. 2: Mixed Well
Sequential	No. 2	-15	32	50	65	Bio: Mixed Well
Sequential	No. 2	-15	32	50	65	No. 2: Mixed Well
Sequential	No. 2	-15	32	45	60	Bio: Mixed Fair/ Slower Dispersing
Sequential	No. 2	-15	32	40	55	Bio: Icing/ Still mixed fair
Sequential	No. 2	0	32	45	45	No. 2: Slight Icing
Sequential	No. 2	0	43	50	50	Bio: Mixed Well
Sequential	No. 2	0	43	50	50	No. 2: Mixed Well
Sequential	No. 2	-5	43	45	50	Bio: Mixed Well
Sequential	No. 2	-5	43	45	50	No. 2: Mixed Poorly
Sequential	No. 2	-10	43	45	55	Bio: Mixed Well
Sequential	No. 2	-10	43	45	55	No. 2: Mixed Poorly
Sequential	No. 2	-10	43	40	50	Bio: Icing
Sequential	No. 2	-10	43	40	50	No. 2: Bio blobbing, no blending at all
Sequential	No. 2	-10	43	45	55	Bio: Mixed Well
Sequential	No. 2	-15	43	55	70	Bio: Mixed Well
Sequential	No. 2	-15	43	55	70	No. 2: Slow to blend but did mix with agitation.
Sequential	No. 2	-15	43	50	65	Bio: Mixed Well
Sequential	No. 2	-15	43	40	55	No. 2: Bio blobbing, no blending at all
Sequential	No. 2	-15	43	45	60	Bio: Blended well
Sequential	No. 2	-15	43	40	55	Bio: Blended Well, but Crystals Forming
Sequential	No. 2	0	43	45	45	No. 2: Slow to blend but did mix.

Blend Type	Diesel Type	Diesel Temp, F	Biodiesel Cloud Point, F	Biodiesel Temp, F	Temp Differential	First Product: Comments
Sequential	Kerosene	-20	32	60	80	Kerosene: Mixed Well
Sequential	Kerosene	-15	32	55	70	Bio: Mixed Well
Sequential	Kerosene	-15	32	55	70	Kerosene: Mixed Well
Sequential	Kerosene	-10	32	50	60	Bio: Mixed Well
Sequential	Kerosene	-10	32	50	60	Kerosene: Not Blending
Sequential	Kerosene	-10	32	40	50	Bio: Mixed Well
Sequential	Kerosene	-10	32	45	55	Bio: Mixed Well
Sequential	Kerosene	-5	32	55	60	Bio: Mixed Well
Sequential	Kerosene	-5	32	55	60	Kerosene: Mixed Well
Sequential	Kerosene	-5	32	50	55	Bio: Mixed Well
Sequential	Kerosene	0	32	50	50	Kerosene: Mixed Well
Sequential	Kerosene	0	32	45	45	Kerosene: Icing
Sequential	Kerosene	0	32	40	40	Bio: Blended Well
Sequential	Kerosene	0	32	40	40	Kerosene: Not Blending, Icing
Sequential	Kerosene	-30	43	40	70	Bio: Slight icing of bio
Sequential	Kerosene	-30	43	40	70	Kerosene: Icing of bio. Poor Mix
Sequential	Kerosene	-25	43	40	65	Bio: Minor icing of bio. Mix Well
Sequential	Kerosene	-25	43	40	65	Kerosene: Minor icing of bio. Mix Poor
Sequential	Kerosene	-20	43	40	60	Bio: Mix well, no icing
Sequential	Kerosene	-25	43	45	70	Bio: Mix well, no icing
Sequential	Kerosene	-30	43	45	75	Bio: Icing
Sequential	Kerosene	-20	43	40	60	Kerosene: Icing of bio. Poor Mix
Sequential	Kerosene	-15	43	35	50	Bio: Mixed well
Sequential	Kerosene	-15	43	35	50	Kerosene: Did not blend well.
Sequential	Kerosene	-25	43	50	75	Bio: Mixed Well
Sequential	Kerosene	0	43	50	50	Kerosene: Blended well
Sequential	Kerosene	-30	43	55	85	Bio: Blended Well
Sequential	Kerosene	-30	43	50	80	Bio: Icing
Sequential	Kerosene	-35	43	55	90	Bio: Icing
Sequential	Kerosene	-40	43	60	100	Bio: Icing
Sequential	Kerosene	-35	43	60	95	Bio: Blended Well

Appendix J. Listing of Consortium Members Comments

Contributors of the Consortium have offered the following statements for consideration:

- Optimal biodiesel blending is dependant on accurate knowledge of B100 and Petroleum diesel cold flow properties to help determine parameters.
- The impact of blending method type (splash, ratio, and sequential blending) and mechanical mixing on B2 blend homogeneity was not evaluated in this study.
- The impact of B2 biodiesel blends on D975 test parameters was not evaluated in test runs completed and documented in this report.
- The impact of water contamination on wax/ice crystallization was not evaluated within this study although desiccant filters were used to help prevent moisture contamination of the B100 and fuels for testing.
- In many cases the pressure drop of the B2 blend was greater than that of the base diesel fuel. In no case was the B2 blend a lower pressure drop than the base diesel fuel. The potential implications of this for users of B2 blends made during cold weather blending are not known.
- In several cases the bottoms samples had slightly higher biodiesel concentrations than the “bulk” samples. This might indicate the existence of not completely homogenous mixtures for these test conditions.



KANSAS FARM BUREAU
The Voice of Agriculture

2627 KFB Plaza, Manhattan, Kansas 66503-8508 • 785-587-6000 • Fax 785-587-6914 • www.kfb.org
800 SW Jackson St., Suite 1300, Topeka, Kansas 66612-1219 • 785-234-4535 • Fax 785-234-0278

PUBLIC POLICY STATEMENT

SENATE COMMITTEE ON AGRICULTURE

RE: SB 388, 389, 393 – acts concerning taxation; relating to incentives for biofuel facilities.

**January 31, 2006
Topeka, Kansas**

**Testimony provided by:
Brad Harrelson
State Policy Director
KFB Governmental Relations**

Chairman Taddiken, and members of the Senate Committee on Agriculture, thank you for the opportunity to appear today and offer testimony in support of SB's 388, 389, and 393. I am Brad Harrelson, State Policy Director—Governmental Relations for Kansas Farm Bureau. KFB is the state's largest general farm organization representing more than 40,000 farm and ranch families through our 105 county Farm Bureau Associations.

On behalf of Kansas Farm Bureau (KFB) I would like to extend our appreciation to the Kansas Legislature for it's past support for bio-fuels. You undoubtedly share our firm commitment to this valuable, renewable energy resource. We at KFB stand ready to assist you in your mission to promote these alternative fuels.

Biodiesel has tremendous upside not only for ag producers, but also fuel consumers. Consumption of biodiesel fuel reduces our dependence on foreign oil and enhances market demand for soybeans and other crops, which is good for Kansas agriculture, and the rural Kansas economy.

As you know, our members consume large quantities of fuel, oil and fertilizer in a variety of uses ranging from running the tractor or combine, to the irrigation engine, to the application of nitrogen fertilizers that are petroleum derived products. In fact,

*Senate Agriculture Committee
2-7-06
Attachment 3*

within their communities, many of them purchase larger quantities of fuel than their local school district. Regularly, fuel expense is the largest input cost in overall production outlay. Farmers, as you know, operate their business without the opportunity to pass costs on to others. They are subject to receiving only what the market will pay for their commodities without regard for the costs of production. For these reasons, proactive programs that potentially lower future fuel costs are of vital importance.

A study released December 1, 2005 by the Agriculture Economics Department at Kansas State University indicates that for energy inputs (fuel and oil, irrigation energy, and fertilizer) costs in 2005 are expected to increase significantly over the previous 5-year average. The study estimates that energy and fertilizer prices across all farms will increase 2005 costs an average of \$9.30 per acre when compared to 2004. Additionally, continued spiking of prices, especially for fertilizer, will add approximately \$6.37 per acre in 2006.

Therefore, producing fuel from Kansas corn and soybeans is better long-term than continuing to rely on imported foreign oil. That's why putting new biofuels incentives in place are important to Kansas Farm Bureau. These new incentives would help us build more local demand for Kansas soybeans, while at the same time lowering the long-term cost of biofuel production. It is a win-win for Kansas farmers and consumers.

The U.S. Congress approved federal tax credits for biodiesel a year ago as a part of the American JOBS Creation Act of 2004. Those biodiesel tax credits were extended to 2008 with passage of the Energy bill to ensure long-term growth for the biodiesel industry. In addition to these federal tax credits, we believe similar proactive efforts are appropriate, and needed at the state level.

In Kansas, there are currently a number of biodiesel production facilities in various stages of development now being considered. Several surrounding states have already enacted policies similar to those contemplated in these three bills. To avoid further competitive disadvantage, the need to take bold and swift action is now. For these reasons, KFB supports the proposals contained in SB 388, SB 389 and SB 393, which are a positive step and viable commitment by the state that should be seriously considered.

In conclusion, thank you for your consideration, your support of bio-fuels and Kansas agricultural producers. We stand ready to assist as you consider these important measures. Thank you.

Kansas Senate Agriculture Committee
February 1, 2006 hearing on SB 393

Chairman Taddiken and members of the committee. The Kansas Soybean Association (KSA) has been actively involved in the promotion of the use of biodiesel in Kansas, making this effort our number one market development priority. The use of biodiesel has increased steadily over the past few years and is on the verge of a rapid increase in use. All of the soy-based, or other biodiesel sold in Kansas, is imported from nearby states. This ultimately increases the cost of biodiesel to Kansans and limits sales of product and the use of Kansas' agricultural feedstocks in its production. Realizing the economic benefits it could provide, we are encouraging the building of biodiesel production plants in Kansas so biodiesel can be made in Kansas with Kansas agriculture products.

Attached is the Kansas Soybean Commission's presentation to the Kansas Legislature Select Joint Committee on Energy on the **incentives provided to biodiesel and biodiesel producers in surrounding states**. There is a great concern that biodiesel production facilities will not be located in Kansas if we are not competitive in our ability to assist this emerging industry with incentives similar to those given in nearby states, so we are here to speak in favor of SB 393. **I have attached a list developed of those considering investing in biodiesel plants in Kansas**. I spoke with NCKP (North Central Kansas), Kan-Agri Energy (Lawrence), St. John and NE Kansas Agri-Energy (Hiawatha) and they are all in favor of this bill.

In order for farmers and other investors in biodiesel plants to compete with nearby states, the Kansas Soybean Association asks that you exempt biodiesel plants located in Kansas from ad valorem taxes as provided in SB 393. This incentive would complement any other incentives the legislature would provide to assist this fledgling industry. We feel it would be one of several components to assist the biodiesel production industry in Kansas.

As a technical matter, we would suggest you adopt the definition of biodiesel as defined in KSA 55-443.

KSA also supports the other component of SB 393, the exemption of personal property tax for items used in the point of sale in the storage, blending, dispensing, or preparation for sale of biodiesel. **I have attached lists of the growth of retail outlets and off-road and on-road retail outlets**. You can see the spikes in the increase of outlets at two times. The first time when the legislature passed the law mandating the use of biodiesel by state entities and the second time when the federal blending tax incentive was enacted. With the passage of this bill, we may see an additional spike in the availability of biodiesel blends in Kansas as biodiesel retailers would benefit from this component of the bill. With increased availability, we should see an increase in sales. Many of the retailers who may benefit from this legislation are local independent fuel retailers or co-ops who must store 100% biodiesel and blend it with diesel fuel themselves. The two components of this bill are complementary and we support them both.

Kenlon Johannes, CEO, Kansas Soybean Association

Senate Agriculture Committee
2-7-06
Attachment 4

Kansas Soybean Commission

Kenlon Johannes, Administrator

Requested information on other state legislature's support of biodiesel.

Report to the Kansas Legislature
Select Joint Committee on Energy
December 15, 2005

State Policy Concepts

- **Demand side policies:**

- Requirements
 1. All diesel sold must contain biodiesel.
 2. State fleets & equipment must use biodiesel (Executive Order & legislative).
- Financial Incentives
 1. Reimbursements for schools to use biodiesel.
 2. Excise/Sales Tax exemptions or reductions.
- Petroleum Reduction/Renewable Portfolio Standards/Renewable Fuel Standards

State Policy Concepts

- **Supply side policies:**

- Production Incentives
 - Tax credits for capital investments.
 - Producer Incentive Funds- per gallon grants/low - interest loan programs.
- Blending, Distribution, Retailing Incentives
 - Tax credits for capital investments made in blending, storage, dispensing infrastructures.

State Policy Concepts

- **General Initiatives**

- Studies examining potential benefits associated with encouraging biodiesel production & use.
- Point of taxation, harmonize with federal point of taxation.
- State should recognize biodiesel standard D6751 – Kansas already has this recognition

Arkansas

- 10 cent/gallon grant to qualified biodiesel producers (located within Arkansas).
 - Limited to the first 5 million gallons of biodiesel produced annually, not to exceed 5 years.
- Income tax credit for "facilities and equipment" for biodiesel suppliers (wholesale or retailers that sell in bulk) of 5% of the cost of facilities and equipment. The credits may be carried forward 3 years.
- 50 cent/gallon state fuels tax credit for biodiesel suppliers for each gallon blended into undyed diesel fuel to make up to a B2; and that is used in trade or business.

Illinois

- Sales Tax Exemption.
 - Biodiesel blends between B1 and B10 are given a partial exemption of 20%. B100 and blends above B10 are totally exempt.
 - All exemptions on all fuels end December 31, 2013.
- Executive Order requires all diesel state vehicles to use biodiesel when practical. Directs Central Management Services to procure B2 for state fleets and to increase availability of B2 for flexible fuel fleet, including the establishment of state- operated B2 filling stations.
- Fuel Cost Differential Rebate. Owners of vehicles operating on a domestic renewable fuel are eligible to apply for a fuel cost differential rebate. Rebate program is applicable to fleets.

Iowa

- Department of Economic Development to provide an infrastructure cost-share incentive program for E85 and biodiesel.
- Governor's Executive Order to increase state agency energy efficiency and use of renewables. Directs agencies to ensure all bulk diesel bought is at least B5 by 2007; B10 by 2008; B20 by 2010.
- Tax credits for cooperative's producing "value-added agricultural products".
 - Credit may be claimed up to 10 percent of a new investment that involves the creation of new jobs.
 - May elect to receive a refund of all or a portion of the unused tax credit.
- Biodiesel Fuel Revolving Fund.
 - Money received from the sale of Energy Policy Act (EPA) credits.
 - Administered by Iowa Department of Transportation (IDOT).
 - The fund shall be used by IDOT for the purchase of biodiesel fuel for use in IDOT vehicles. Vehicles using biodiesel will have an informational sticker so stating.

Minnesota

- B2 requirement: Effective 09/29/2005.
- Sales Tax exemption for purchase of equipment used to blend biodiesel.
- Feasibility study examining biodiesel use as home/industrial heating fuel.

Missouri

- MO Qualified Biodiesel Producer Incentive Fund.
 - Administered by Department of Agriculture.
 - Qualified producers eligible to receive \$.30/gallon grant for the first 15 million gallons produced annually (up to 60 months).
 - Producers can receive \$.10/gallon grant up to 15 million gallons of biodiesel produced beyond their initial 15 million gallons produced in a fiscal year.
 - All feedstock must be US produced and 51% must come from MO.
- School district reimbursement for incremental cost of biodiesel (B20 or higher).
- Self-Sustaining Biodiesel Revolving Fund.
 - Administered by the Department of Natural Resources & is available to all state fleets.
 - The fund pays the incremental cost of biodiesel.

Nebraska

- Governor did an executive order in May. The order directs Transportation Services Bureau and Department of Roads to take all reasonable actions necessary to investigate ways to strengthen infrastructure for increasing availability of E85 & B2 for state fleets. Also directs state employees to utilize E85 & B2 whenever "practical". "Practical" refers to reasonableness of obtaining E85 and B2.

North Dakota

- Interest rate buy down program for biodiesel production facilities.
- Income tax credit for fuel suppliers who make biodiesel blends of B5 and higher.
 - The value of the credit is 5 cents per gallon.
 - The credit is not "refundable" and unused credits can be carried forward up to 5 years.
- Income tax credit for a fuel seller for costs incurred to modify or add infrastructure to sell biodiesel blends of at least B2.
 - The value of the credit is 10% per year for 5 years of the direct costs associated with modification or installation of infrastructure.
 - The credit is not "refundable" and may be carried forward 5 years.

Oklahoma

- Income tax credit for biodiesel production facilities
 - 20 cents/gallon.
 - Credits can be accrued for facilities wholly or partially on-line before 12/31/2007.
 - Credits may be claimed for 60 months.
 - Beginning January 1, 2012, a biodiesel facility shall receive a 7.5 cents/gallon credit for new production for a period not to exceed 36 consecutive months.

4-5

South Dakota

- Contractors' Excise Tax-Sales Tax refund/credit.
 - Provides for a refund/credit to be taken on taxes imposed or paid for "new agriculture processing facilities" and for sales & use taxes imposed/paid on purchases of equipment for new agriculture processing facilities.

Texas

- Production grant program. Producers pay a 3.2 cents per gallon (cpg) tax into a fund. State matches by a multiplier of 5.25 cpg. The state issues grants of 20 cpg back to the plants. The net grant would equal 16.8 cpg. The producer is entitled to receive the 20 cpg for 10 years after the beginning of production. Grants are limited to 18 million gallons per year per producer per registered plant (\$3.6 million).
- The biodiesel portion of a blend is exempt from state excise tax provided the finished product is clearly identified as a blend.

For further information

- Kansas Soybean Commission
<http://www.kansassoybeans.org>
Phone: 877-KS-SOYBEAN (577-6923)
- National Biodiesel Board
<http://www.biodiesel.org>
Phone: 888-BIODIESEL (246-3437)

Proposed Kansas Biodiesel Plant start up dates and capacities

Location	Annual Capacity Million Gallons/Year	Estimated startup date based on calendar year
Lawrence (region)	30	4 th quarter of 2007
Hiawatha	30	3 rd quarter of 2007
Goodland	10-12	2 nd quarter of 2007
St. John	30	15-18 months from return of study
North Central Kansas	5	to de determined
South Central Kansas	30	3rd quarter of 2007

These are the proposed plants known to us as of January 23, 2006. Other proposed plants may exist that are not known to the Kansas Soybean Commission and some listed may have dropped their plans to build a biodiesel plant in Kansas.

Revised January 31, 2006

Growth of Biodiesel Retail Outlets in Kansas

2% or higher blend offered

Date	Off-road fuel retailers	On-road fuel retailers
January 1, 2003	25	2
October 1, 2003	111	11
October 1, 2004	130	17
October 1, 2005	172	29
January 1, 2006	172	29

Kansas Bulk Off-Road Dyed Biodiesel Retailers

2% or Higher Blends Available

Listing by City

City	Biodiesel Retailer	State	Phone Number
Abilene	Robson Oil	KS	785-263-2470
Agenda	Agenda Oil Co.	KS	785-732-6521
Andale	Andale Farmer's Coop	KS	316-444-2141
Arma	Doie Oil	KS	620-347-8508
Atchison	Consumer Oil Co., Inc.	KS	913-367-1528
Athol	Athol Coop	KS	785-695-2209
Attica	Dark Oil	KS	620-254-7266
Atwood	Dave's Oil Service	KS	620-626-3728
Bartlett	Bartlett Coop	KS	620-226-3322 or 800-314-2667
Belleville	Farmway Coop	KS	785-527-5417
Beloit	Farmway Coop	KS	785-738-2241
Beloit	Shamburg Oil Co.	KS	785-738-5181
Bendena	Consumer Oil Co., Inc.	KS	785-988-4459
Bern	Bern Oil Company, Inc.	KS	785-336-3518
Bird City	Frontier Equity Exchange	KS	785-734-2331
Blue Rapids	Home Oil Services, Inc.	KS	800-794-0945
Brewster	Frontier Equity Exchange	KS	785-694-2281
Buhler	Mid Kansas Coop	KS	620-543-2765
Burns	Mid Kansas Coop	KS	620-726-5287
Castleton	Mid Kansas Coop	KS	620-459-6950
Cawker City	Bob's Inc.	KS	785-454-6219
Chanute	Chandler Oil LLC	KS	800-274-4720
Cimarron	Dodge City Coop	KS	620-855-3421
Colby	Co-Ag	KS	785-462-2063
Colby	J. J. Oil	KS	785-425-7152
Columbus	Farmers Coop	KS	620-429-1294
Columbus	Midwest Propane	KS	620-429-3098
Columbus	Lopp Oil Co.	KS	620-429-1500
Concordia	Farmway Coop	KS	785-243-2394
Concordia	Walthers Oil Co.	KS	785-729-3398
Cottonwood Falls	Dieker Oil Co.	KS	620-273-6325
Courtland	Hoard Oil	KS	785-374-4425
Dighton	Shull Oil	KS	620-397-3175
Dodge City	Dodge City Coop	KS	620-225-4193
Downs	Midtown, Inc.	KS	785-454-6219
Durham	Agri-Producers, Inc.	KS	620-732-3315
Dwight	Dwight Fuel Service	KS	785-482-3389
Effingham	Jackson Farmers Inc.	KS	913-833-2070
Emporia	S&S Oil & Propane Co. Inc.	KS	620-342-2835
Elbing	Epp Service	KS	316-799-2333
Frankfort	Wanklyn Oil Co., Inc.	KS	785-292-4710
Fredonia	Burns Oil	KS	620-378-3226
Fredonia	Chandler Oil LLC	KS	620-378-2412 or 800-274-4720
Frontenac	Dobrauc Oil Co., Inc.	KS	620-231-9270
Garden City	Hampel Oil	KS	620-275-7777 or 877-430-4774

Garden City	Robinson Oil	KS	620-275-4237
Garden Plain	Hampel Oil	KS	316-648-7241
Garden Plain	Farmer's Coop Elevator	KS	800-525-7490
Garnett	Lybarger Oil, Inc.	KS	785-448-5512
Garnett	United Coop, Inc.	KS	785-448-3712
Girard	Producer's Coop	KS	620-724-4117
Goessel	Mid Kansas Coop	KS	620-367-2201
Goodland	Farmers Equity Exchange	KS	785-694-3681
Great Bend	Bird Oil Company	KS	620-793-5932
Great Bend	Great Bend Coop	KS	620-793-5031
Great Bend	Moeder Oil Co., Inc.	KS	620-792-1203
Greeley	United Coop, Inc.	KS	785-867-2140
Greensburg	Volz Oil Co.	KS	620-723-2652
Grinnell	Co-Ag	KS	785-824-3359
Gypsum	Gypsum Oil Co.	KS	785-822-4424
Halstead	Farmers Coop Elevator Co.	KS	316-835-2261 or 800-280-6042
Harris (Garnett)	United Coop, Inc.	KS	785-448-6808
Haven	Mid Kansas Coop	KS	620-465-2292
Hays	Midland Marketing Coop	KS	785-628-3221
Hiawatha	AG Partners Coop	KS	785-742-2196
Hiawatha	Davies Oil Company, Inc.	KS	785-742-2081
Hill City	Turnbull Oil Co.	KS	785-434-4629
Herington	Vahshottz Oil	KS	785-258-2498
Holton	Knotty Pine Oil	KS	785-364-3711
Hoxie	Bainter Oil Service, Inc.	KS	785-675-3903
Hoxie	Co-Ag	KS	785-675-3516
Hoxie	Town & Country	KS	785-675-3265
Hutchinson	Bridgman Oil	KS	620-665-6811
Hutchinson	Farmers Coop (Distribution Center)	KS	
Hutchinson	Ramsey Propane	KS	620-662-3851
Hutchinson	Ramsey Oil Hutchinson	KS	620-662-8365
Independence	Chandler Oil LLC	KS	800-274-4720
Inman	Mid Kansas Coop	KS	620-585-6649
Iola	Hampel Oil	KS	620-365-3621
Iuka	Kanza Cooperative Assn.	KS	620-546-2231
Jetmore	Dodge City Coop	KS	620-357-6414
Kansas City	Hampel Oil	KS	913-321-0139
Kincaid	United Coop, Inc.	KS	620-439-5600
Kingman	Farmer's Coop Elevator	KS	800-525-7490
LaCygne	United Coop, Inc.	KS	913-757-4567
Lansing	Leavenworth County Coop	KS	913-727-1900 or 800-644-1901
Leroy	Epp Service	KS	316-799-2333
Leroy	Leroy Coop	KS	620-964-2225 or 888-964-2225
Lincolnville	Agri-Producers, Inc.	KS	620-732-3315
Lindsborg	Mid Kansas Coop	KS	785-227-3343
Longford	Reed Bulk Fuel Service	KS	785-388-2334
Lyons	Boroughs Oil Co.	KS	620-257-2091
Manhattan	Farmers Coop Association	KS	785-776-9467
Manhattan	Oppys Amoco Service	KS	785-776-9940
Marquette	Mid Kansas Coop	KS	785-546-2214
Marysville	Kramer Oil Co.	KS	785-562-2466

McPherson	Hassman Oil	KS	620-241-3237
McPherson	Mid Kansas Coop	KS	620-241-1885
Medicine Lodge	Dark Oil	KS	620-886-3766
Menlo	Co-Ag	KS	785-855-2256
Minneapolis	D&G Oil	KS	785-392-3031
Moline	Murphy Oil	KS	620-647-3585
Montezuma	ADM Collingwood	KS	620-846-2218
Montezuma	Dodge City Coop	KS	620-846-2231
Moran	Moran Mini Mart	KS	620-237-4245
Mound City	United Coop, Inc.	KS	913-795-2311
Moundridge	Mid Kansas Coop	KS	620-345-6328
Mound Valley	Bartlett Coop Assn.	KS	620-328-2121 or 888-328-2330
Ness City	Right Co-op	KS	800-232-7183
Nickerson	Farmers Coop	KS	800-861-3207
North Newton	Mid Kansas Coop	KS	316-283-1970
Norton	Norton County Coop Assn.	KS	785-877-5131
Nortonville	Ruralgas Co. Inc.	KS	913-886-6420
Oakley	Co Ag	KS	785-672-4371
Oakley	Mitten, Inc.	KS	785-672-3062
Olpe	Murphy Oil	KS	620-475-3449
Osage City	Haskins Conoco & Oil Co.	KS	785-528-3732
Osage City	Home Oil	KS	785-528-4132
Oswego	Bartlett Coop Assn.	KS	620-795-2113 or 877-795-2113
Ottawa	Ottawa Coop	KS	785-242-5170
Overland Park	Carter Petroleum Products, Inc.	KS	913-643-2300
Palmer	Peters Oil Co.	KS	785-692-4540
Parsons	Manners Oil Co.	KS	620-421-5819
Phillipsburg	Rangeland Co-op	KS	785-543-2114
Plainville	Midland Marketing Coop	KS	785-434-4842
Plainville	Turnbull Oil Co.	KS	785-434-4629
Pratt	Hampel Oil	KS	620-672-3743 or 877-479-3343
Quinter	Midwest Cooperative	KS	785-754-3461
Rexford	Co-Ag	KS	785-462-8642
Rush Center	Mid State Farmers Coop	KS	785-372-4239
Sabetha	Berwick Oil	KS	785-284-2227
Salina	Fuel Unlimited	KS	785-823-2331
Seneca	Nemaha County Coop	KS	785-336-6153
Sharon Springs	Wallace County Coop	KS	785-852-4279
Solomon	Klein Fuel Service	KS	785-655-3403
St. John	Hampel Oil	KS	620-549-3324
St. Mary's	Farmers Union Coop Bus. Assn.	KS	785-437-2985
Stockton	Farmers Union Mercantile	KS	785-425-6511
Stockton	Sunflower Supply	KS	785-425-6218
Sublette	Sublette Cooperative Inc.	KS	620-675-2287
Studley	Midwest Cooperative	KS	785-627-4315
Thayer	W-G Fertilizer	KS	620-839-5251
Topeka	Capitol City Oil, Inc.	KS	785-233-8008
Topeka	Haag/Decker Oil, LLC	KS	785-357-0270
Troy	Davies Oil Company, Inc.	KS	785-985-3553
Wakeeney	Midwest Cooperative	KS	785-743-2223
Wakefield	Mason Petroleum	KS	785-461-5684

Walton	Mid Kansas Coop	KS	620-837-3313
Wamego	Wamego Supply, Inc.	KS	785-456-7875
Waterville	Route 77 Corner Store	KS	785-363-2641
Whiting	Parallel Farms, Inc.	KS	785-873-3246
Wichita	Hampel Oil	KS	316-529-1162 or 800-530-5848
Winona	Co-Ag	KS	785-846-7471
Wright	Right Co-op	KS	620-227-8611
Yates Center	Woodson County Coop	KS	620-625-2123
Butler	MFA Oil Company	MO	660-679-5071
Drexel	Bartholomew Oil Co.	MO	816-657-2072
Harrisonville	MFA Oil Company	MO	816-884-4470
Jasper	MFA Oil Company	MO	417-394-2100
Nevada	MFA Oil Company	MO	417-667-3753
Savannah	Andrew Co. Oil	MO	816-324-5654
St. Joseph	MFA Oil Company	MO	816-238-0555
These are suppliers known to us, as of November 7, 2005. Other suppliers may exist that are not known to the Kansas Soybean Commission, and some suppliers may have dropped biodiesel from their product line. For more information, please contact the Kansas Soybean Commission at 800-328-7390.			

Kansas Biodiesel On-Road Retailers at the Pump					
2% or Higher Blends Available					
Retailer	Address	City	State	Zip Code	Phone No.
Andale Farmer's Coop	219 N. Main	Andale	KS	67001	316-444-2141
Bird Express #203	1000 Main St.	Great Bend	KS	67530	620-792-7579
Bird Oil / Express	251 S. Main St.	Hoisington	KS	67544	620-653-2395
Bob's Inc.	604 Wisconsin	Cawker City	KS	67430	785-454-6219
Capital City Oil (B20 only)	4141 NW Lower Silver Lake Road	Topeka	KS	66618	785-233-8008
Coop Grain & Supply	512 E. D Street	Hillsboro	KS	67063	620-947-3917
Coop Grain & Supply	121 Santa Fe	Hillsboro	KS	67063	620-947-3917
Coop Grain & Supply	404 South 3rd	Marion	KS	66861	620-947-3917
Coop Grain & Supply	113 West Main	Lehigh	KS	67073	620-947-3917
Hillsboro Crop Production	121 Santa Fe	Hillsboro	KS	67063	620-947-3917
Hampel Oil	503 West St.	Iola	KS	66749	620-365-6321
Hampel Oil	921 N. Main	Pratt	KS	67124	620-672-3743 877-479-3343
Hampel Oil	3727 S. West St.	Wichita	KS	67217	316-529-1162 800-530-5848
Home Oil Services, Inc.	501 Main St.	Blue Rapids	KS	66411	800-794-0945
Kramer Oil	1330 E. River Road	Marysville	KS	66508	785-562-2466

4-13

4-14

Retailer	Address	City	State	Zip Code	Phone No.
Mid Kansas Coop	2114 W. Main St.	Castleton	KS	67501	620-459-6950
Mid Kansas Coop	112 W. 2nd St.	Haven	KS	67543	620-465-2292
Midland Marketing	8th & Oak	Hays	KS	67601	785-628-3061
Midtown, Inc.	919 Morgan	Downs	KS	67437	785-454-6219
Midwest Propane	430 E. Oak	Columbus	KS	66725	620-429-3098
Mitten Truck Stop	E. Hwy 40 & I-70	Oakley	KS	67748	785-672-3062 Ext. 10
LeRoy Coop	505 - 6th Street	LeRoy	KS	66857	620-964-2225 888-964-2225
Nemaha County Coop	Hwy 63	Corning	KS	66417	785-736-6153
Nemaha County Coop	223 E. Main St.	Seneca	KS	66538	785-336-6153
Parallel Farms, Inc.	18648 286 Road	Whiting	KS	66552	785-873-3246
Scott Co-op Association	410 E. 1st Street	Scott City	KS	67871	620-872-5823
Route 77 Corner Store	129 W. Main St.	Waterville	KS	66548	785-363-2641
Wallace County Coop	525 S. Main St.	Sharon Springs	KS	67758	785-852-4279
Woodson County Coop	700 W. Rutledge	Yates Center	KS	63947	620-625-2123

These are the suppliers known to us, as of November 3, 2005. Other suppliers may exist that are not known to the Kansas Soybean Commission, and some suppliers may have dropped biodiesel from their product line. Various locations may be cardtrol only. For more information, please contact the Kansas Soybean Commission at 800-328-7390.

Kansas Senate Agriculture Committee
February 7, 2006 hearing on SB 390

Chairman Taddiken and members of the committee. The Kansas Soybean Association (KSA) has been actively involved in the promotion of the use of biodiesel in Kansas, making this effort our number one market development priority. The use of biodiesel has increased steadily over the past few years and is on the verge of a rapid increase in use. All of the soy-based, or other biodiesel sold in Kansas, is imported from nearby states. This ultimately increases the cost of biodiesel to Kansans and limits sales of product and the use of Kansas' agricultural feedstocks in its production. Realizing the economic benefits it could provide, we are encouraging the building of biodiesel production plants in Kansas so biodiesel can be made in Kansas with Kansas agriculture products.

There is a great concern that biodiesel production facilities will not be located in Kansas. We need to be competitive in our ability to assist this emerging industry. Biodiesel plant feasibility studies are indicating that to reduce costs and increase the profitability of plants they need to be either located by feedstock sources, markets or distribution points. **I have attached a list developed of those considering investing in biodiesel plants in Kansas.** SB 390 assists in the development of the transportation infrastructure in Kansas aiding alternative fuel (biodiesel) manufacturers in the distribution of their product. It is our understanding that this bill will assist the railroads in constructing alternative fuel collection centers where unit trains can be loaded for movement to markets outside of Kansas. These sites would be strategically located between existing and proposed ethanol and proposed biodiesel plants. As you look at the possible sites for biodiesel production plants it would be advantageous to put these rail distribution centers in the center of these plants and as they relate to the ethanol plants in Kansas. This provides an option of marketing biodiesel outside of the state which provides additional markets and profit opportunities for the plants.

In order for farmers and other investors in biodiesel plants to compete with nearby states, the Kansas Soybean Association asks that you consider exempting biofuel railroad terminals from property and ad valorem taxes as provided in SB 390. This incentive would complement any other incentives the legislature would provide to assist this fledgling industry. We feel it would be one of several components to assist the biodiesel production industry in Kansas.

Kenlon Johannes, CEO
Kansas Soybean Association

Senate Agriculture Committee
2-7-06
Attachment 5

**Proposed Kansas Biodiesel Plant
start up dates and capacities**

Location	Annual Capacity Million Gallons/Year	Estimated startup date based on calendar year
Lawrence (region)	30	4 th quarter of 2007
Hiawatha	30	3 rd quarter of 2007
Goodland	10-12	2 nd quarter of 2007
St. John	30	15-18 months from return of study
North Central Kansas	5	to de determined
South Central Kansas	30	3rd quarter of 2007

These are the proposed plants known to us as of January 23, 2006. Other proposed plants may exist that are not known to the Kansas Soybean Commission and some listed may have dropped their plans to build a biodiesel plant in Kansas.

Revised January 31, 2006



WRITTEN STATEMENT

TO: Senate Agriculture Committee
FROM: Jere White, Executive Director
DATE: February 7, 2006
SUBJECT: Senate Bill No. 390

The Kansas Corn Growers Association and Kansas Grain Sorghum Producers wish to submit this brief testimony in regards to S.B. 390, a bill that would provide for the tax exemption and issuance of bonds to develop biofuels railroad facilities in Kansas.

Both organizations support programs that further the development of Kansas biofuels, such as those found in this bill. Railroad facilities are becoming an ever increasing layer of complexity when plants are being considered. To the extent the State of Kansas can provide assistance to future projects, we will see more projects locate within our state.

We do offer a simple but very significant suggestion to improve this bill. On page 1, beginning on line 19, we would respectfully suggest that the words "and its co-products" be added following the word biofuels. Without a change such as this, the transportation of distillers grains would render the facility ineligible for the program. Distillers grains are neither biofuels or an ingredient "actually used in the production of such biofuels". I assume that this would be an unintended consequence, as it defeats the intent of the bill.

Mr. Chairman, members of the committee, our members have consistently stood in support of pro-ethanol legislation considered by this legislature. S.B. 390 will provide a useful tool in the further development of biofuels in Kansas.

Thank you.

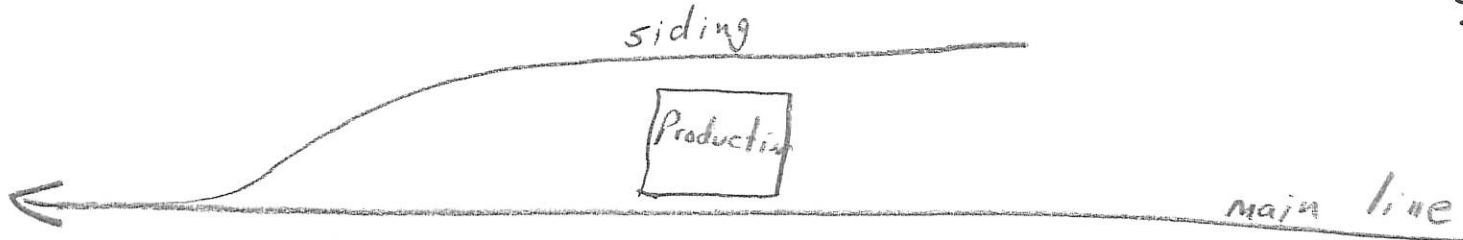
*Senate Agriculture Committee
2-7-06*

Attachment 6



①

Back-in

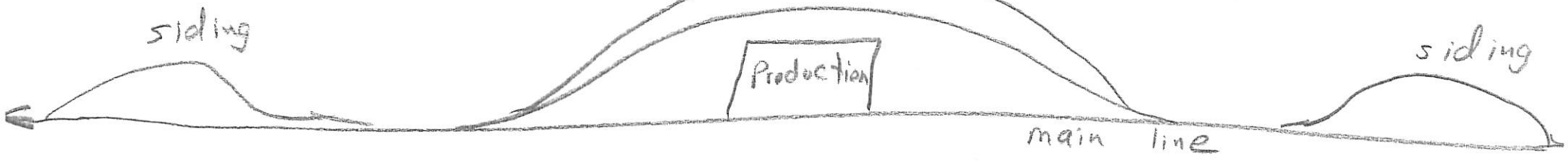


Senate Agriculture
 Committee
 2-7-06
 Attachment 7

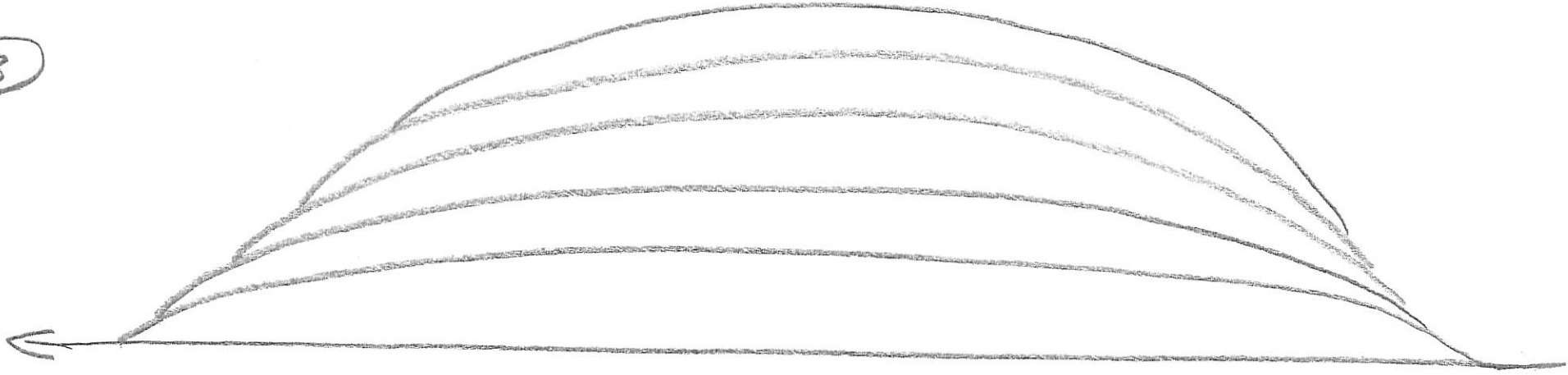
②

2 sidings

Pull thru with run-around



③



Railroad Terminal switch yard