Successfully Using Biodiesel in Your Fleet




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National Biodiesel Board

August 4, 2008

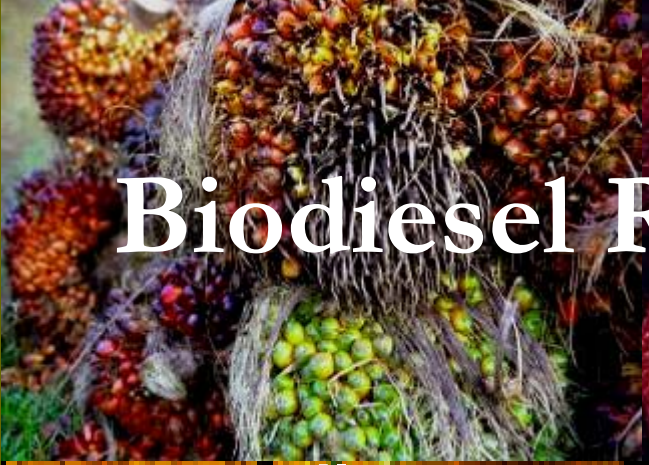
Biodiesel Basics

Biodiesel Defined

- **Biodiesel, n. -- a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM D 6751.**

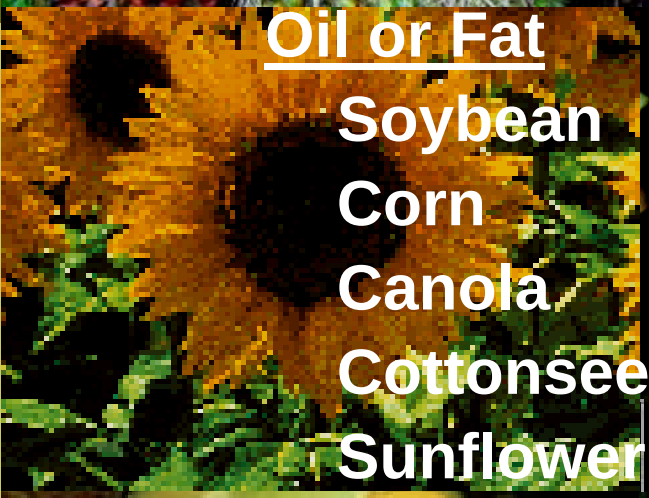
- **Biodiesel blend, n. -- a blend of biodiesel fuel meeting ASTM D 6751 with petroleum-based diesel fuel designated BXX, where XX is the volume percent of biodiesel.**

Biodiesel Raw Materials



Oil or Fat

- Soybean
- Corn
- Canola
- Cottonseed
- Sunflower
- Beef tallow
- Pork lard
- Used cooking oils




Alcohol

- Methanol
- Ethanol

Catalyst

- Sodium hydroxide
- Potassium hydroxide

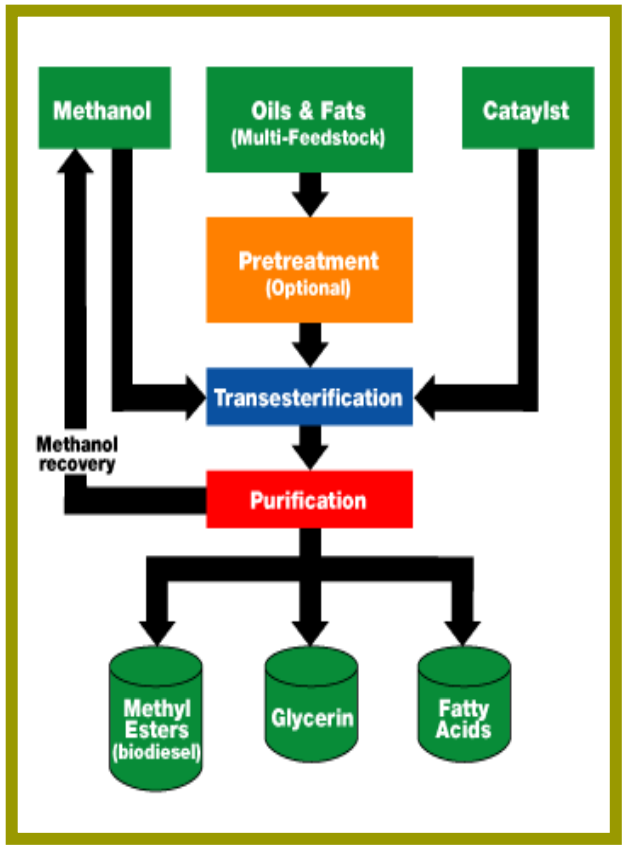



The Biodiesel Reaction

In the presence of a catalyst

Combining

Vegetable Oil
or
Animal Fat
(100 lbs.)
+
Methanol or
Ethanol
(10 lbs.)



Yields

Biodiesel
(100 lbs.)
+
Glycerine
(10 lbs.)

Biodiesel Physical Properties

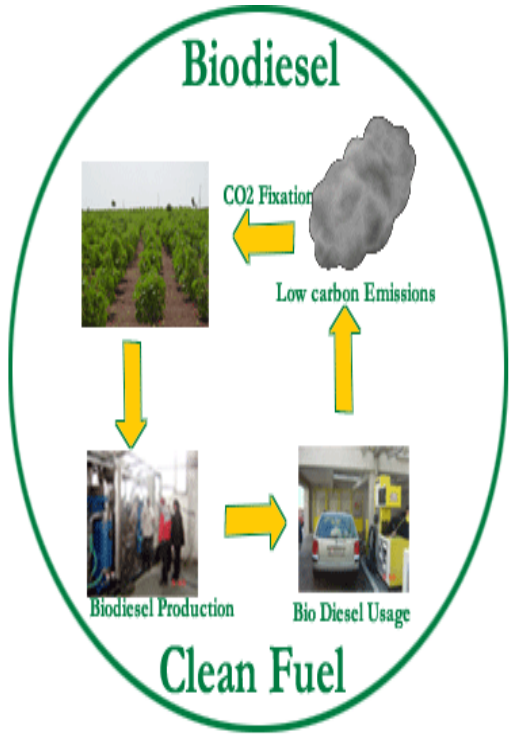
- High Cetane
  - (>50 vs. 42)
- Flash Point
  - (199° F vs. 126° F)
- Virtually Zero Sulfur
  - Meets 2006 ULSD rule
- No Aromatic Content
- Integrates into existing petroleum infrastructure

Cleaner Emissions

Emission Type	B100	B20	B2
Total Unburned Hydrocarbons	-67%	-20%	-2.2%
Carbon Monoxide	-48%	-12%	-1.3%
Particulate Matter	-47%	-12%	-1.3%
Oxides of Nitrogen (NO_X)	+10%	+2%	+.2%

Environmental Attributes

- **Energy Balance - for every one unit of energy needed to produce biodiesel, 3.5 units of energy are gained.**
- **Biodegradable and Non-Toxic - Tests sponsored by USDA confirm that biodiesel is safer than diesel and biodegrades as fast as dextrose, a test sugar.**
- **Greenhouse Gases – A 78% life cycle decrease in CO_2 according to a DOE/USDA.**



Biodiesel Performance Properties

BIODIESEL RETURNS ENVIRONMENTAL BENEFITS WITHOUT SACRIFICING OPERATING PERFORMANCE

- **B100 contains 7-9% fewer BTUs per gallon than #2 diesel fuel**
- **B20 Similar Performance to Petrodiesel:**
  - **Torque**
  - **Horsepower**
  - **Mileage**
  - **Range**
  - **1-2% fewer BTUs per gallon than #2 diesel**

Biodiesel Markets

ON-HIGHWAY USERS
- Trucking
- Fleets
- Passenger Vehicles

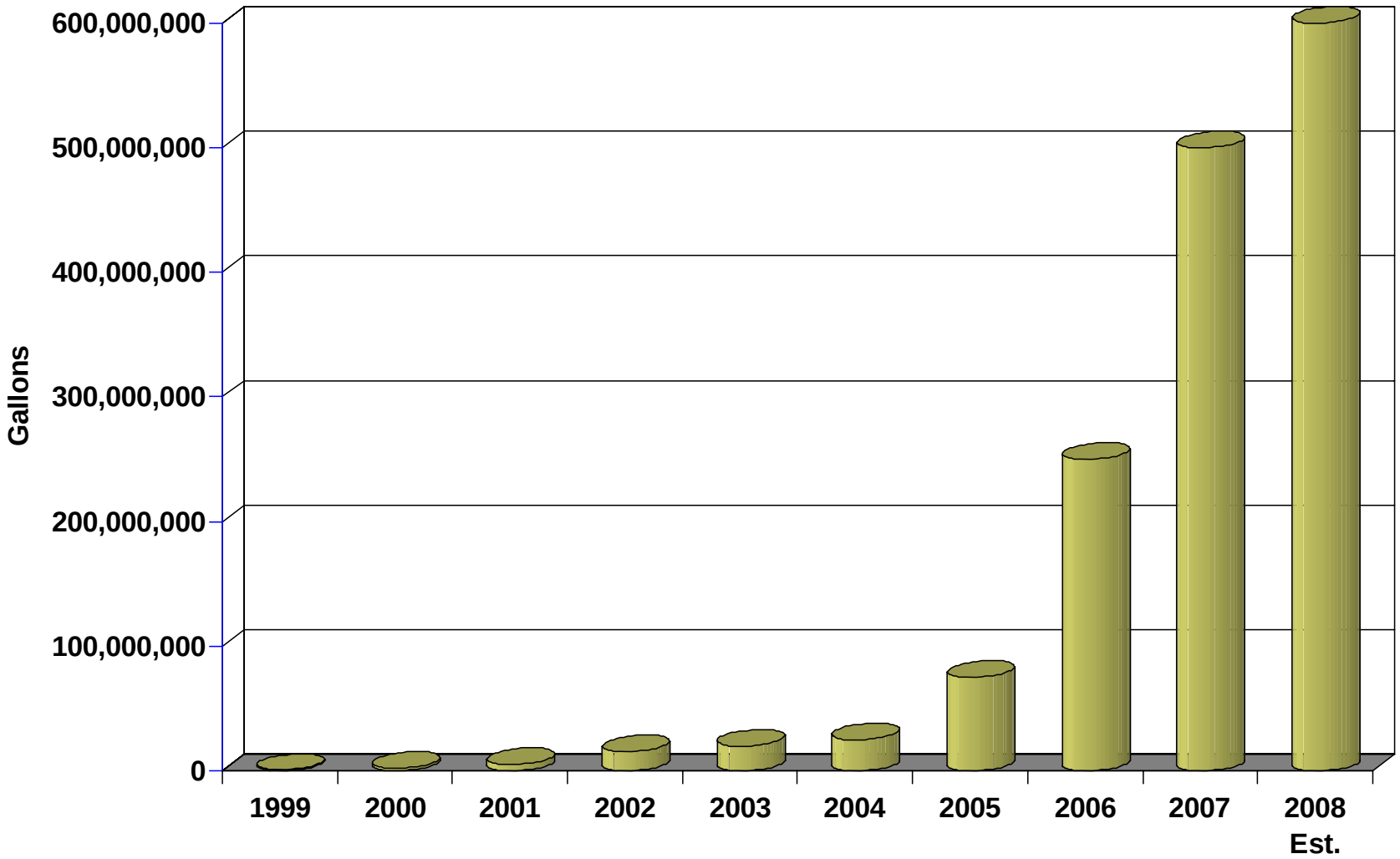
REGULATED FLEETS
- Federal
- State
- Utilities

HOME HEATING

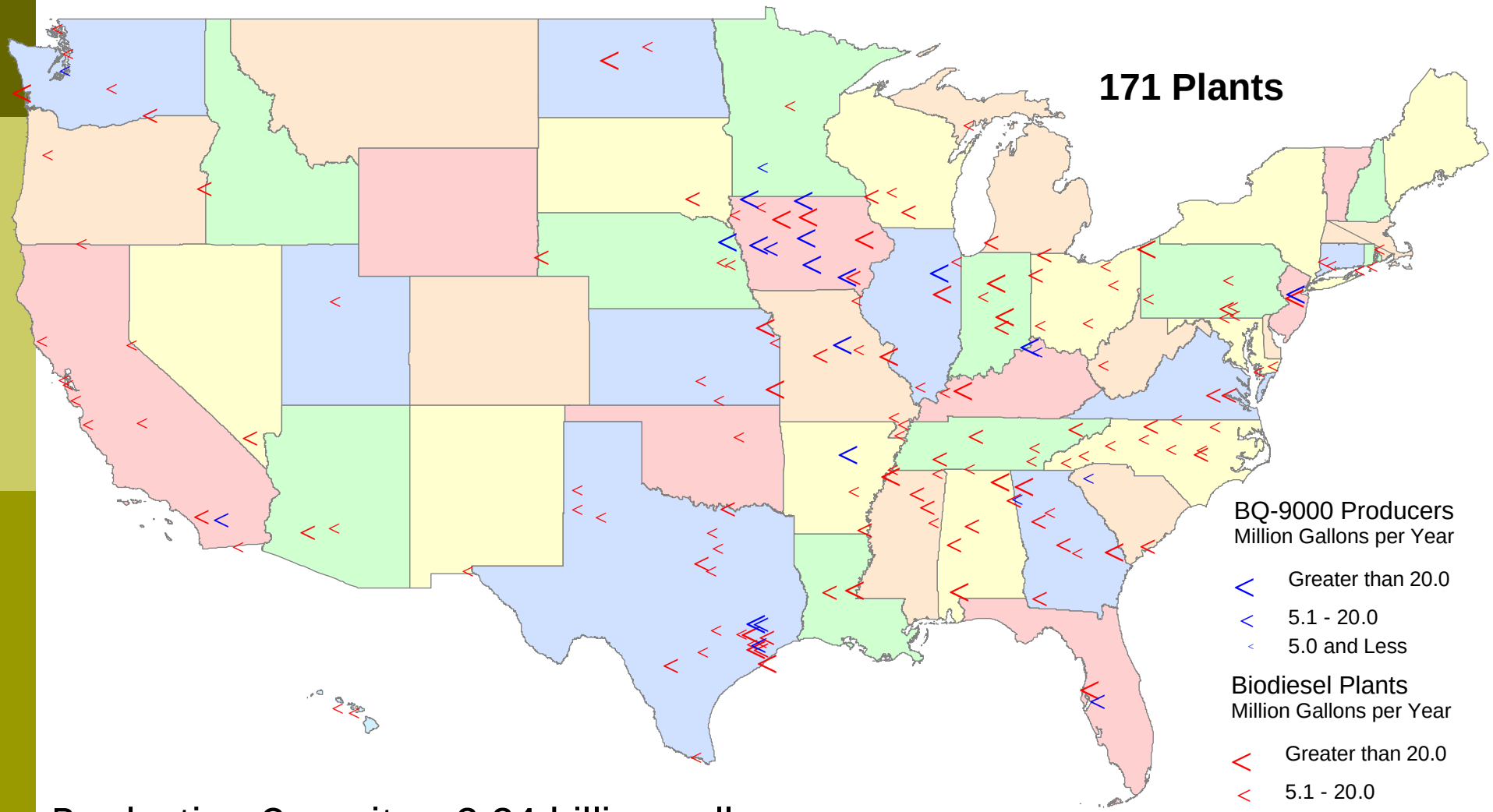
MARINE
- Recreational
- Tour Boats
- Environmentally Sensitive Areas

AG AND OFF-ROAD USERS

US Biodiesel Demand

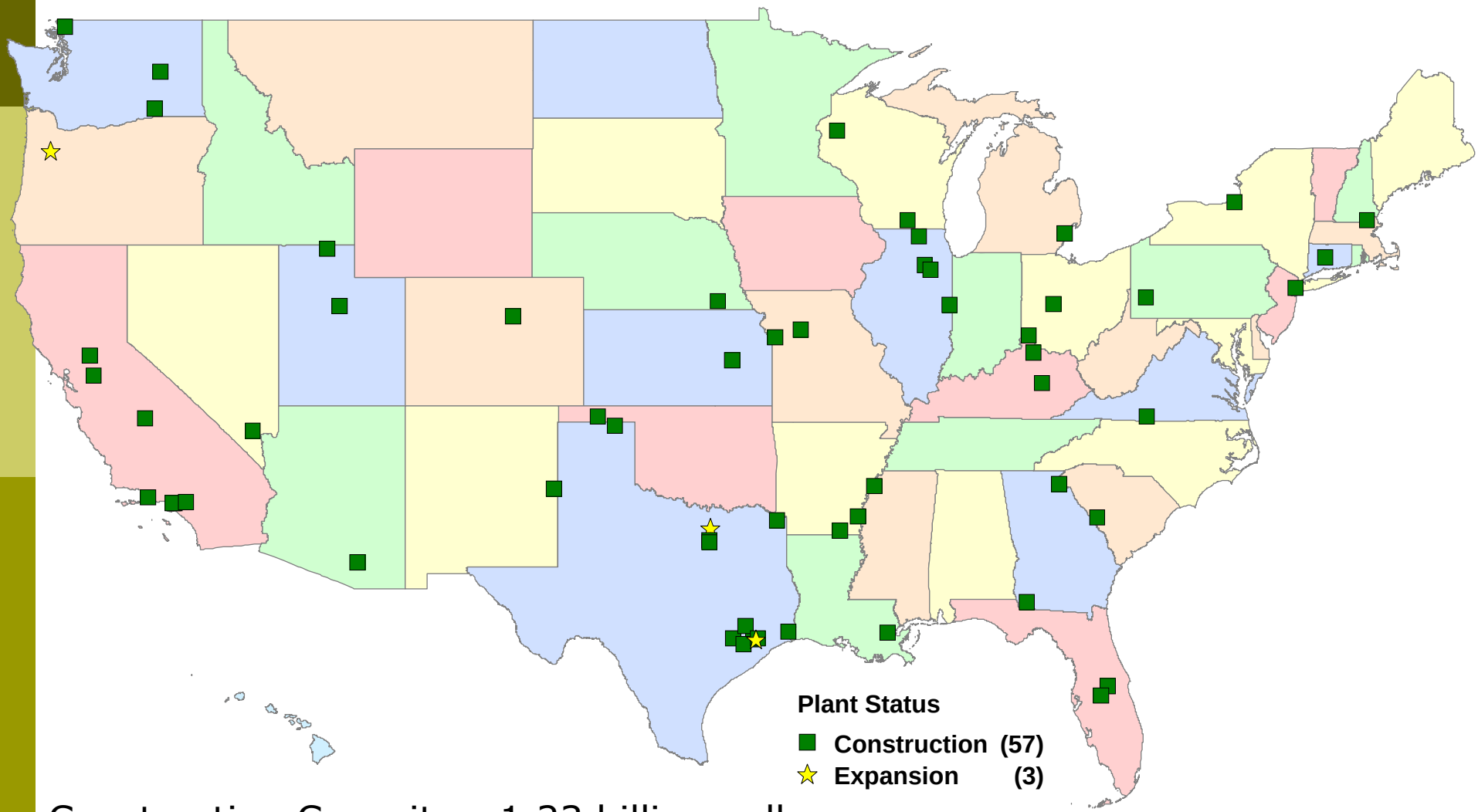


Production Locations (1/25/08)



Production Capacity - 2.24 billion gallons per year

Biodiesel Plants Under Construction & Expansion (1/25/08)



Construction Capacity - 1.23 billion gallons per year

Topics Fleet Managers Ask About

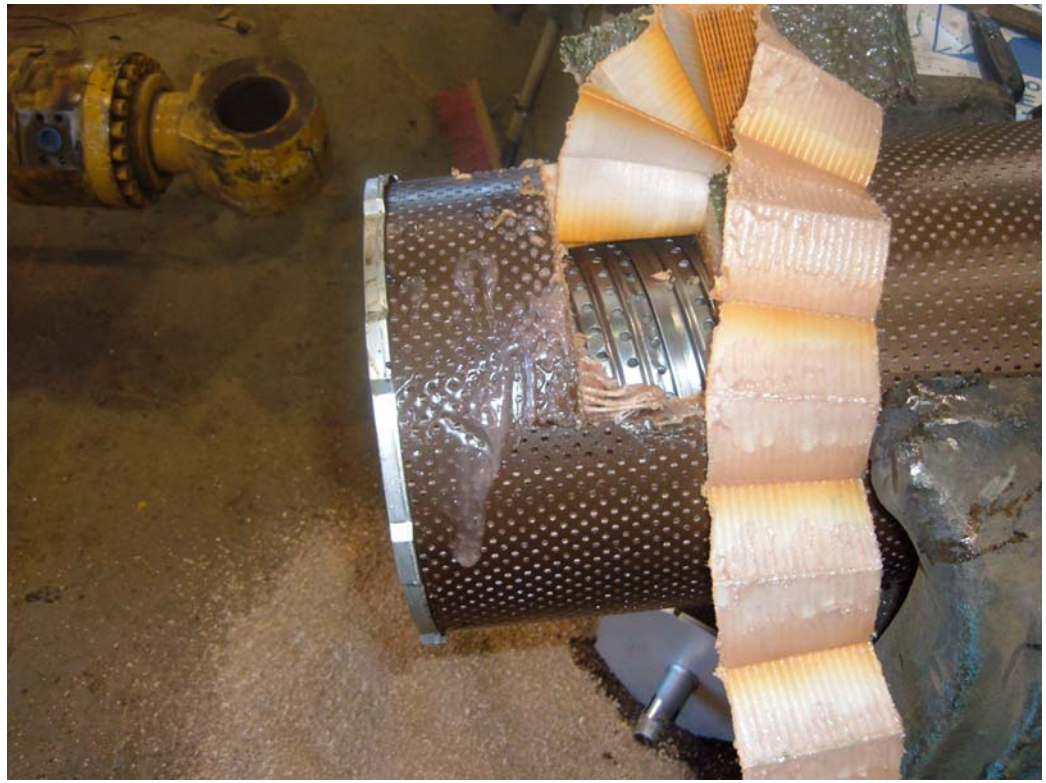
Fleet Manager Topics of Interest

- Fuel Quality
- Fuel Specifications
- Engine Warranties
- Performance in Cold Weather
- Filter Plugging
- Degradation of Engine Parts
- Fuel Stability
- Price
- Availability

Fuel Quality

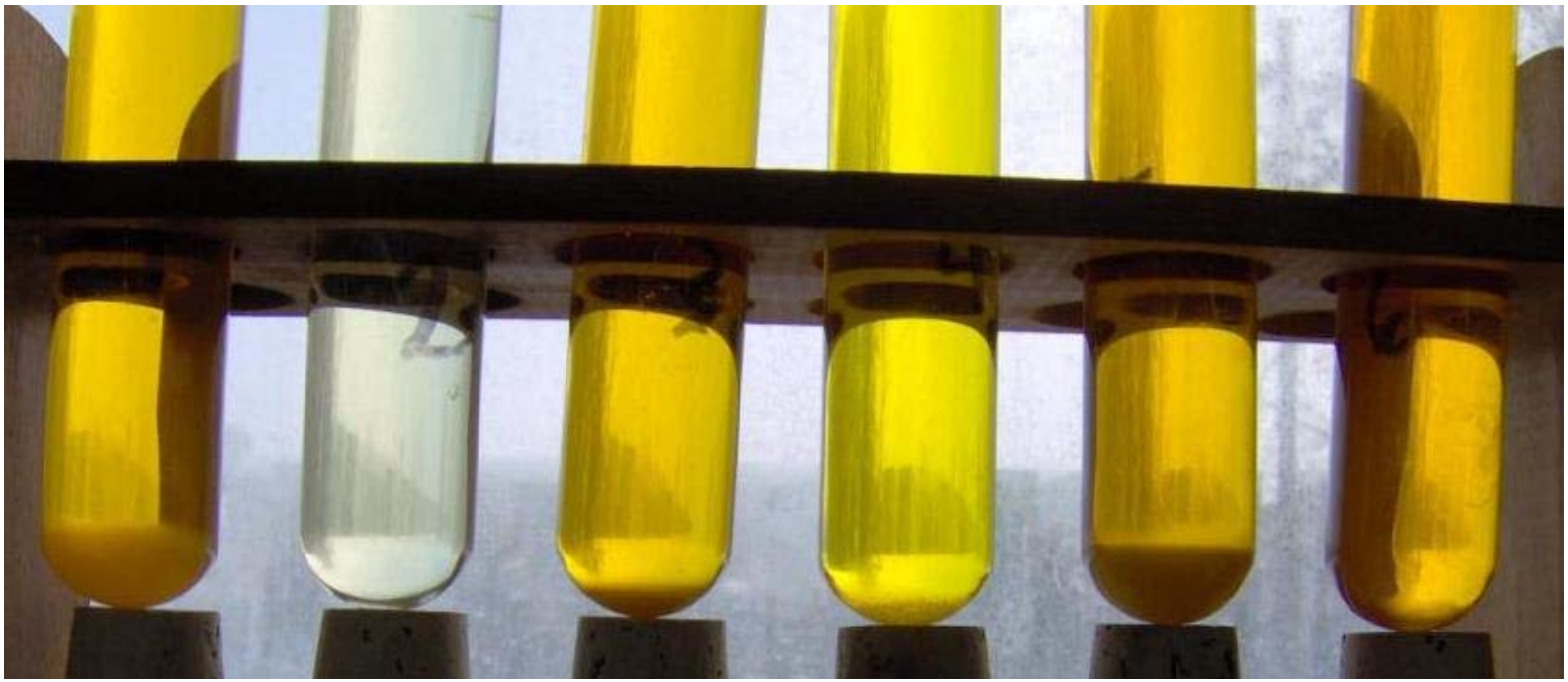
Poor Quality Fuel Leads To

- Filter Plugging
- Injector Failures
- Warranty Concerns
- Lost Customer Confidence



Fleet Managers Expect

- **Consistency in their B100 and biodiesel blends**
- **Trouble-free operation**
- **Someone else to do the discovery and monitoring of fuel quality from the producer to the fuel supplier**



Fuel Quality "Guarantee"

- **Specifications are typically developed by ASTM International**
  - **Consensus organization of government, industry, users, and general members**
- **Regulatory agencies adopt ASTM specifications for fuel quality enforcement**
  - **EPA fuel registration**
  - **IRS tax credits**
  - **State Weights and Measures**

Fuel Quality Enforcement

- **NBB is working with the National Council of Weights and Measures to enhance fuel quality enforcement activities**
  - **37 states have adopted D6751 into law**
    - **30 of these states have implemented the regulations**
  - **5 states are using D6751 as a guide**
  - **16 states are proactively testing B100**

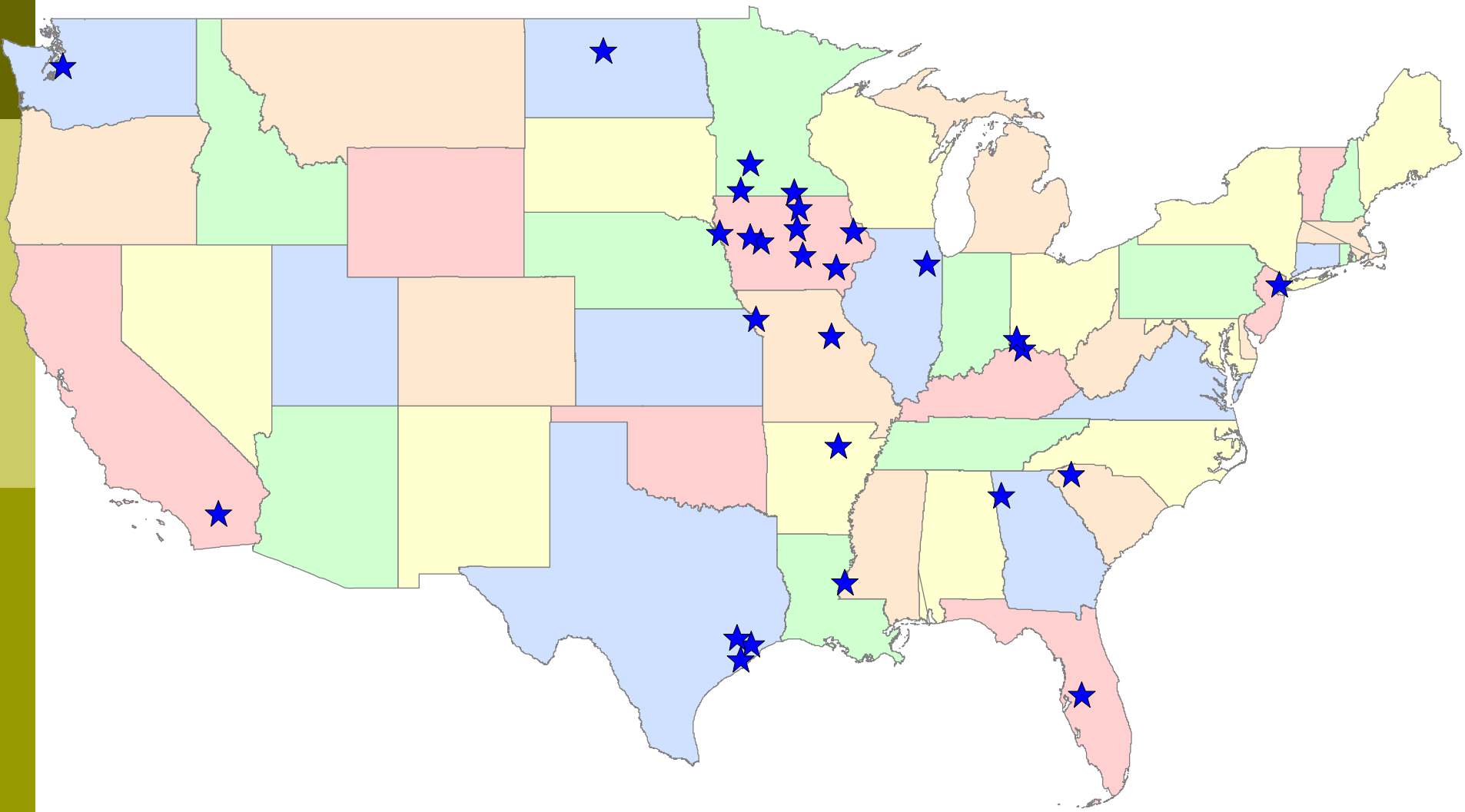
BQ-9000 Certification Program

- To promote the commercial success and public acceptance of biodiesel
- To help assure that biodiesel fuel is produced to and maintained at the industry standard, ASTM D 6751

BQ-9000 Producer Focus

- **To outline a system for monitoring the production of biodiesel to the ASTM D 6751 specification.**
  - **Sampling**
  - **Testing**
  - **Storage**
  - **Retain Samples**
  - **Shipping**

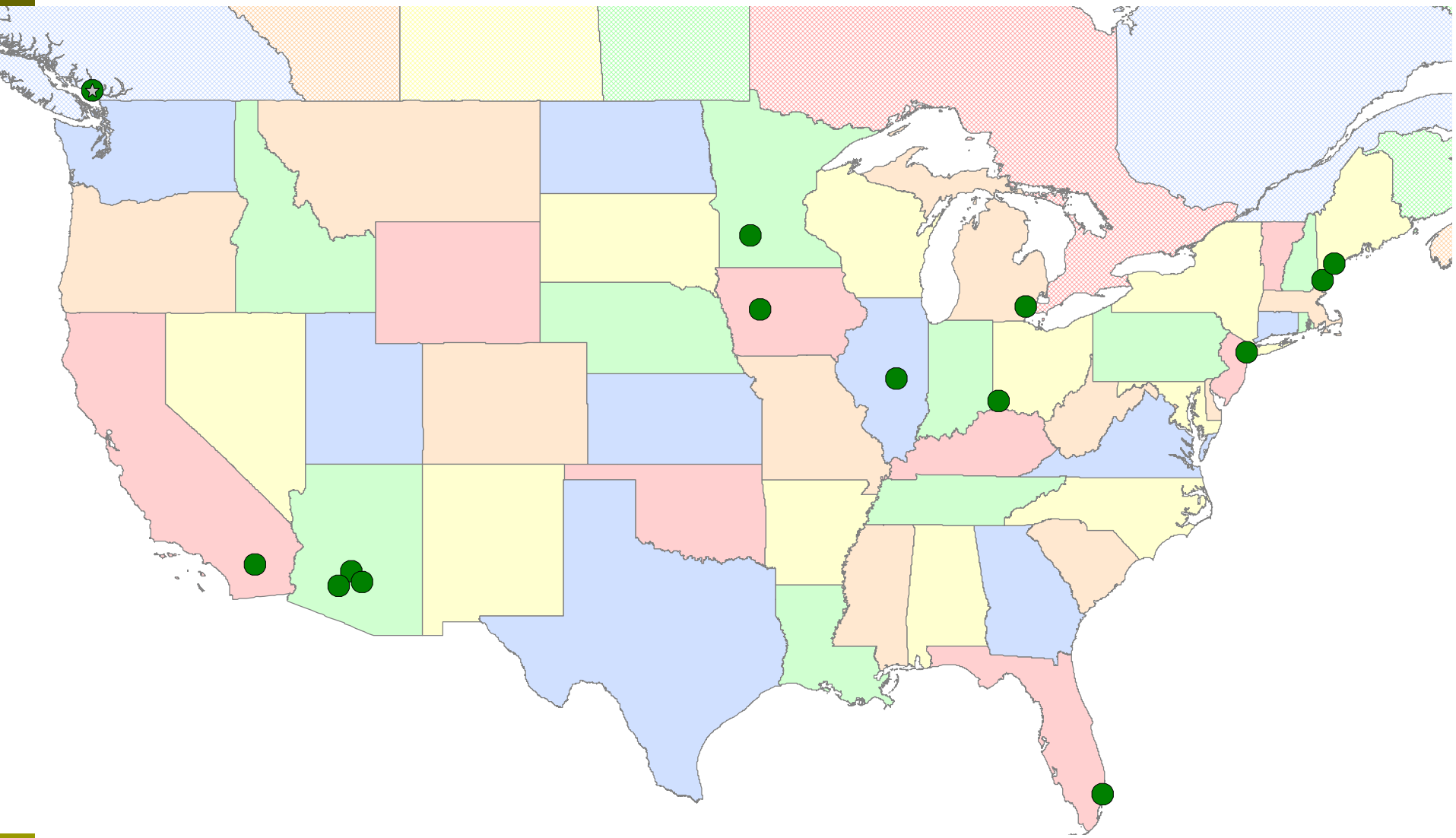
BQ-9000 Producers (29)



BQ-9000 Marketer Focus

- **To outline a system for the handling and distribution of biodiesel that maintains the fuel properties at the ASTM D 6751 specification.**
  - **Sampling**
  - **Testing**
  - **Storage**
  - **Retain Samples**
  - **Blending**
  - **Shipping**

BQ-9000 Marketers (14)



www.bq9000.com

Biodiesel Specifications

ASTM Current Status

- ASTM D6751 is the approved standard for B100 for blending up to B20 in the US
  - Feedstock and Process Neutral
  - ASTM has approved D6751 for B100 use only for up to B20 in the final blend
  - Higher blends upon consultation with the OEM
- D6751 was not designed for higher levels than B20
- European EN14214 specs are for neat B100 use
  - Not feedstock neutral, based on rapeseed only
- This is why D6751 has different limits for some properties compared to the European Specs
  - i.e. D6751 stability is 3 hours, EN14214 is 6 hours

Biodiesel ASTM D 6751-07b$^{\varepsilon 1}$

Property	Test Method	Limits	Units
Phosphorous content	D 4951	0.001 max	% mass
Flash Point	D 93	130 min.	Degrees C
Kinematic Viscosity, 40C	D 445	1.9 - 6.0	mm²/sec.
Sulfated Ash	D 874	0.020 max	% mass
Copper Strip Corrosion	D 130	No. 3 max	
Cetane number	D 613	47 min	
Carbon Residue	D 4530	0.050 max.	% mass
Distillation, T90 AET	D 1160	360 max	Degrees C
Calcium & Magnesium, combined	EN 14538	5 max	ppm (ug/g)
Sodium & Potassium, combined	EN 14538	5 max	ppm (ug/g)

ε1 NOTE—Corrected EN 14110 mass percent in Table 1 editorially in March 2008.

Biodiesel ASTM D 6751-07b$^{\varepsilon 1}$ cont.

Property	Test Method	Limits	Units
Alcohol Content, one of the following			
Methanol Content	EN 14110	0.2 max	% mass
Flash Point	D 93	130 min.	Degrees C
Water & Sediment	D 2709	0.050 max.	% Volume
Sulfur S500	D 5453	0.05 max (500)	% mass (ppm)
S15	D 5453	0.0015 max (15)	% mass (ppm)
Cloud Point	D 2500	Report	Degrees C
Acid Number	D 664	0.50 max.	mg KOH/g
Free Glycerin	D 6854	0.020	% mass
Total Glycerin	D 6854	0.240	% mass
Oxidation Stability	EN 14112	3 min	Hours

BQ-9000 Critical Specification Testing Once Production Process is Under Control

Recent ASTM Activities

- **The past 9 months have seen the highest activity on ASTM biodiesel standards ever**
- **4 major ballots were issued, voted on and passed both the ASTM subcommittee and main committee as of June 2008:**
  - **Changes to B100 Blends Stock, ASTM D6751**
  - **Add up to 5% biodiesel in Petrodiesel, D975**
  - **Add up to 5% biodiesel in Heating Oil, D396**
  - **New standard for on/off road blends B6 to B20**

Cold Soak Filtration Test (CSFT)

- Purpose is to insure cloud point is still an accurate measurement for B20 and lower blends
  - This test has nothing to do with the actual cold flow properties of the B100 or its blends
  - Results are independent of the cloud point of the B100
  - The test has no meaning for blends of biodiesel and diesel fuel
- 300 ml of B100, chilled to 40F for 16 hours, allowed to warm to room temp, filtered under vacuum using 0.7 micron glass fiber filter with stainless steel support
  - Two limits:
    - 360 seconds filtration time for all times of the year
    - 200 seconds if the seller claims the B100 is fit for purpose to use in blends in temperatures below -12 C (~10 F)

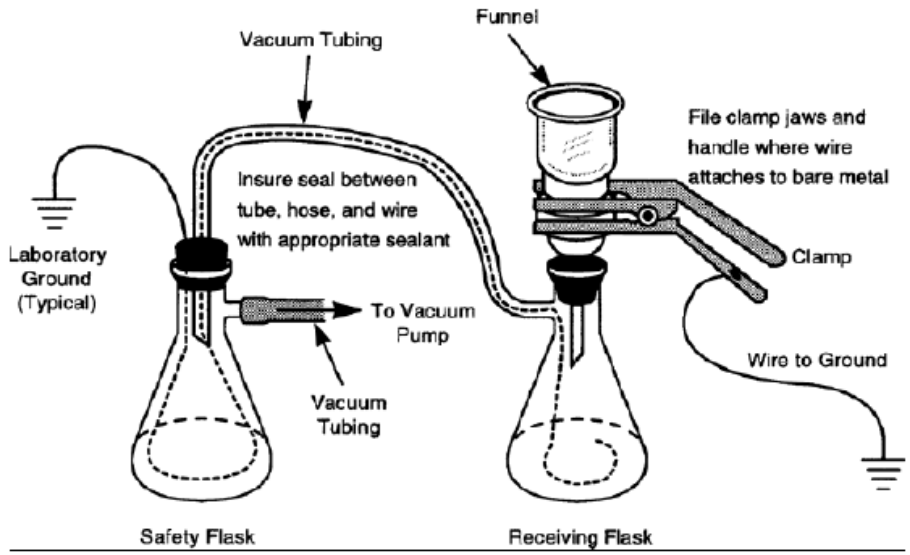


FIG. A1.1 Schematic of Filtration System

B5 Blends

- **B5 ballot into the petrodiesel specifications: D975, D396 (heating oil) passed D02 main.**
  - **No changes to properties in table 1 of D975 and D396**
  - **B100 must meet D6751 prior to blending**
  - **Ballot was linked to the satisfactory resolution of the cold soak filtration test in D6751**

B6 to B20 Blends

- **B6 to B20 for on/off road diesel engines will be a stand alone specification, passed D02 main**
- **Designed so that if B100 meets D6751 and petrodiesel meets D975, B6 to B20 will meet its specification:**
  - **Widest of #1/#2 specifications**
  - **Allow T-90 to be 5 degrees C higher**
  - **Add stability (induction period 6 hours min.)**
  - **Add acid number of 0.3 maximum**
- **Ballot was linked to the satisfactory resolution of the cold soak filtration test in D6751**

Impact of Blended Specs

- **Large fleets have stated they will begin using B20**
- **Several OEM's have stated they will issue B20 support to their customers**
- **Biodiesel blends will be the only non-petroleum diesel substitute to have officially sanctioned ASTM specifications!**
- **Quality will be further improved, fuel specs can be enforced by regulatory bodies (supported by NBB)**
- **Some biodiesel companies will need to make process changes in order to meet D6751**

ASTM Effective Date

- All D02 main ballots go through ASTM Committee on Standards and ASTM Editorial after voting
- Committee on Standards (COS): review handling of negatives and allows for appeal by negative voter if improperly handled
- ASTM Editorial: ensure proper form/style
- Specs officially ‘in effect’ from ASTM after COS and Editorial review, and publishing on the ASTM web site
- Expected in September/October of 2008

Engine Warranties

GSA Letter – February 23, 2007

- “GSA Fleet supports your efforts to meet government mandates through the use of alternative fuels such as B20. However, the manufacturers may not honor warranty repairs that are linked to problems caused by the use of JP8, fuel additives, or fuels containing greater than 5% BioDiesel. If you opt to utilize these fuels and the vendor refuses to honor the vehicle warranty, GSA Fleet will contact the manufacturer and attempt to obtain warranty coverage. If they will not pay, we have no choice but to bill your agency for the cost of those repairs. We hope that this is not necessary and support your efforts to reduce our reliance on foreign oil. If you choose to use BioDiesel in any blend, we suggest you use fuel companies certified under the voluntary BQ9000 quality program.”

OEMs Positions on Biodiesel

- **Engine Warrantees:**
  - **Parts and Workmanship**
  - **OEM's Don't Make Fuel**
  - **OEM's Don't Warrantee Fuel**
  - **As with diesel--problems caused by the fuel are the responsibility of the fuel supplier**

www.biodiesel.org/resources/fuelfactsheets/standards_and_warranties.shtm

Case IH

- **Blend Level**
  - **B100 -** Approved for nearly half of the Case IH models sold globally
  - **B20 -** Approved for more than 90% of Case IH models sold in US and Europe
  - **B5 -** Approved for every Case IH engine sold globally
- **Notes**
  - Visit www.caseih.com for biodiesel approval levels onspecific products and equipment by model
- **Reference**
  - http://www.caseih.com/highlights/highlights.aspx?navid=121&recordid=193&RL=ENNA
- **Last Updated**
  - 1/24/08

Caterpillar

- **Blend Level**
  - **B30**
  - **B20**
  - **B5**
- **Notes**
  - Tiered biodiesel blend approval structure based on equipment type and model.
  - On-Highway Truck Engines (SEBU6385-07) - **See page 31** for biodiesel recommendations
  - Caterpillar Commercial Diesel Engines Fluids Recommendations (SEBU6251-10) - **See page 38** for biodiesel recommendations
- **Reference**
  - http://www.cat.com/cda/components/fullArticle?m=37675&x=7&id=149474
- **Last Updated**
  - 6/1/07

Cummins

- **Blend Level**
  - **B20 –** Approval is for 2002 and later emissions-compliant On-Highway ISX, ISM, ISL, ISC and ISB engines. B20 is also approved for Off-Highway engines including: QSX, QSM, QSL, QSC, QSB6.7, QSB4.5, QSM Marine, QSM G-Drive.
  - **B5 –** All other Cummins engines not listed are approved.
- **Notes**
  - B100 must meet ASTM D6751 spec
  - B20 must conform to EMA Test Specification for B20.
  - Cummins requires use of biodiesel sourced from BQ-9000 Certified Marketers and Producers for the U.S. and Canada.
- **Reference**
  - http://www.everytime.cummins.com/every/customer/faq_biodiesel.jsp
- **Last Updated**
  - 12/9/07

Chrysler LLC

- **Blend Level**
  - **B20 -** 2007 Dodge Ram – Approved Government, Military and Commercial Fleets
  - **B5 -** All other diesels
- **Notes**
  - Biodiesel fuel must meet ASTM D6751 as well as Military Spec requirements stating fuel must be used within 6 months of production
- **Reference**
  - http://blog.chryslerllc.com/blog.do?id=247&p=entry
  - http://www.chryslerllc.com/en/environment/green_fuels/
- **Last Updated**
  - 1/10/08

General Motors

- **Blend Level**
  - **B20 -** Available as a Special Equipment Option (SEO) on the 2008 Chevy Silverado and GMC Sierra for approved fleets
  - **B5 -** All other GM diesel vehicles
- **Notes**
  - B20 SEO available to fleets on the 6.6L Duramax diesel engine in the 2008 Chevy Silverado Heavy Duty, and GM Sierra Heavy Duty One Ton Pickup.
- **Reference**
  - http://media.gm.com/us/gmc/en/product_services/r_cars/r_c_sierra/index%20HD.html
  - http://media.gm.com/us/chevrolet/en/product_services/r_trucks/r_c_silverado/index%20HD.html
  - http://www.gm.com/corporate/responsibility/environment/news/2006/epa_smartway_102706.jsp
- **Last Updated**
  - 8/1/07

John Deere

- **Blend Level**
  - **B20**
- **Notes**
  - While 5 percent blends (B5) are preferred, biodiesel concentrations up to a 20 percent blend (B20) in petroleum diesel fuel can be used in John Deere engines through Tier 3/Stage III A models, including all non-emissions-certified engines.
  - Biodiesel must meet ASTM D6751 and petroleum diesel content must meet ASTM D975.
  - John Deere recommends use of a BQ-9000 certified supplier for the biodiesel.
- Reference
  - http://www.deere.com/en_US/rg/infocenter/infoevents/pr/2007/biodiesel.html
- Last Updated
  - 11/12/07

New Holland

- **Blend Level**
  - **B100**
- **Notes**
  - New Holland supports the use of B100 biodiesel in all equipment with New Holland-manufactured diesel engines, including electronic injection engines with common rail technology.
  - A listing of all the New Holland models that can be run on B100 can be found at: http://www.newholland.com/na/biodiesel/NHBiodiesel.pdf
- **Reference**
  - http://www.newholland.com/na/biodiesel/
  - http://www.newholland.com/na/biodiesel/NHBiodiesel.pdf
- **Last Updated**
  - 11/8/07

Cold Weather Operability

Three Important Cold Weather Parameters that Define Operability for Diesel Fuels & Biodiesel

Cloud Point

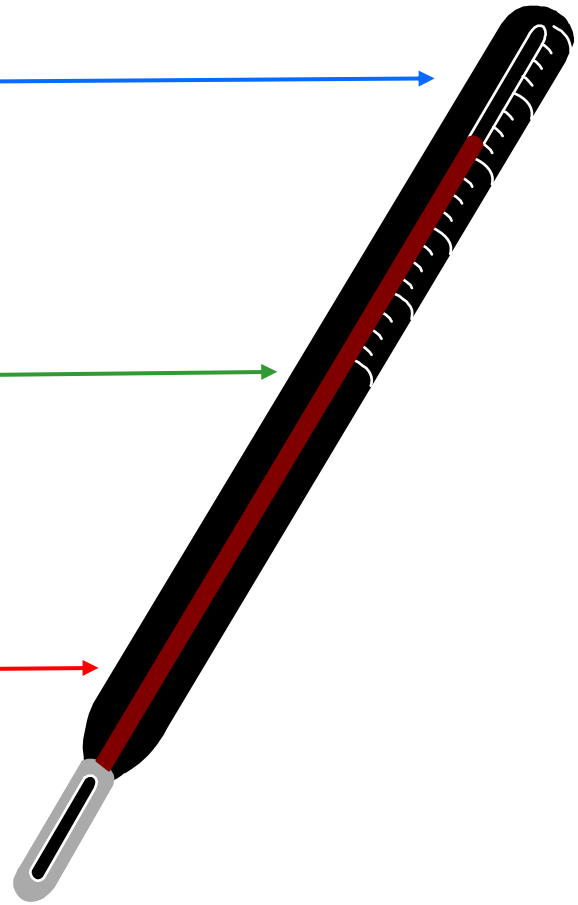
Temperature where crystals first appear

Cold Filter Plugging Point

The lowest operating temperature a vehicle will operate

Pour Point

Lowest temperature where fuel is observed to flow

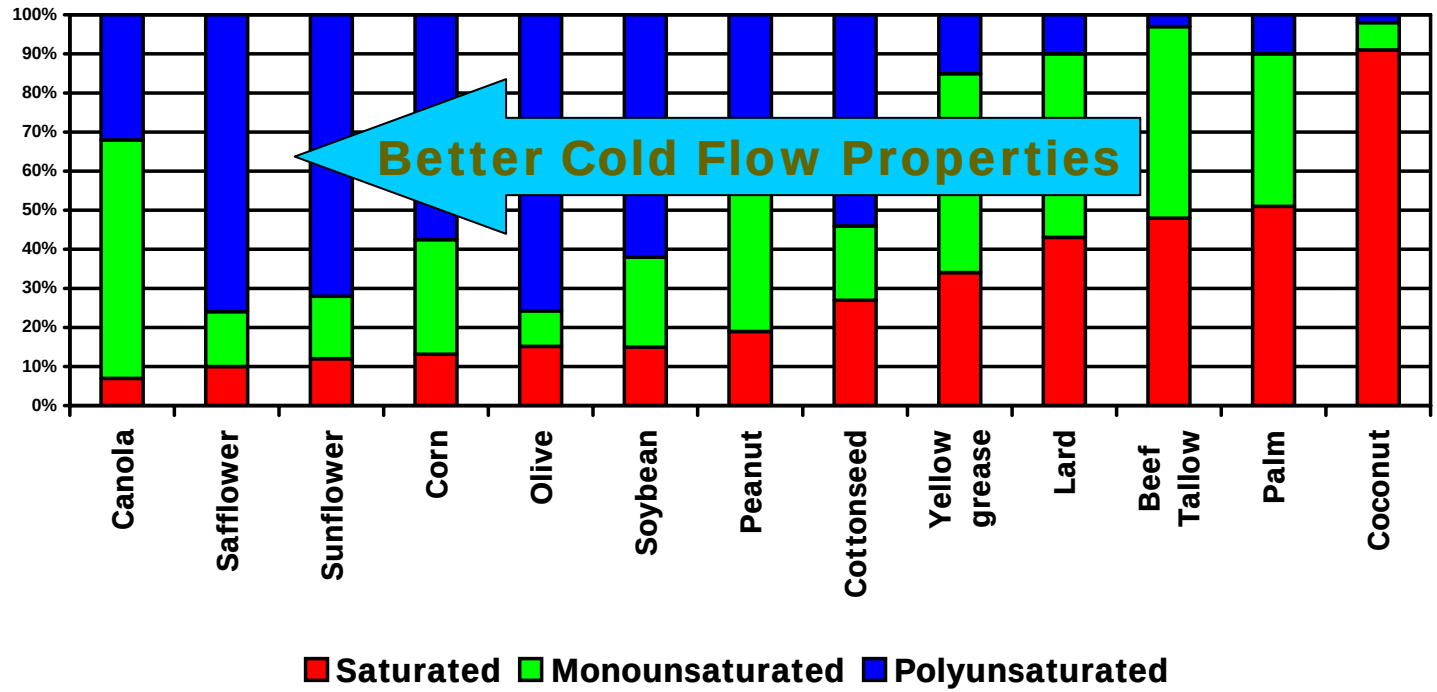


Cold Flow Properties

- Biodiesel (B100) freezes faster than most petrodiesel
- Untreated B20 freezes about 3-10º F faster than petrodiesel, depending on:
  - the cold flow properties of the biodiesel
  - the cold flow properties of the petrodiesel
- B5 differences are imperceptible
- Traditional cold weather options for diesel work well with biodiesel and blends
  - Blend with kerosene, use of additives
  - Block and filter heaters
  - Indoor vehicle storage

Biodiesel Feedstock Composition and Cold Weather Operability

- The cold flow properties of biodiesel fuels are dependant on the feedstock (specific type of oil, fat or grease) from which they are made, and are a strong function of the level of saturated fat.
- Animal fats, palm, coconut oils are more highly saturated



Cold Weather Performance with Biodiesel

- **Establish a benchmark for cold flow protection based on the ASTM D975 "Tenth Percentile Minimum Ambient Air Temperature"**

the lowest ambient air temperature which will not go lower on average more that 10% of the time

- **Make sure the petroleum distributor is aware of this and incorporates it into his blending operations**

Fuel Stability

Storing Biodiesel

- **Consider stabilizing B100 and biodiesel blends being stored in excess of six months.**
- **Pay attention to fuel contaminants in general, air, water and fuel.**

Oxidation on Biodiesel Fuel

Early Stages

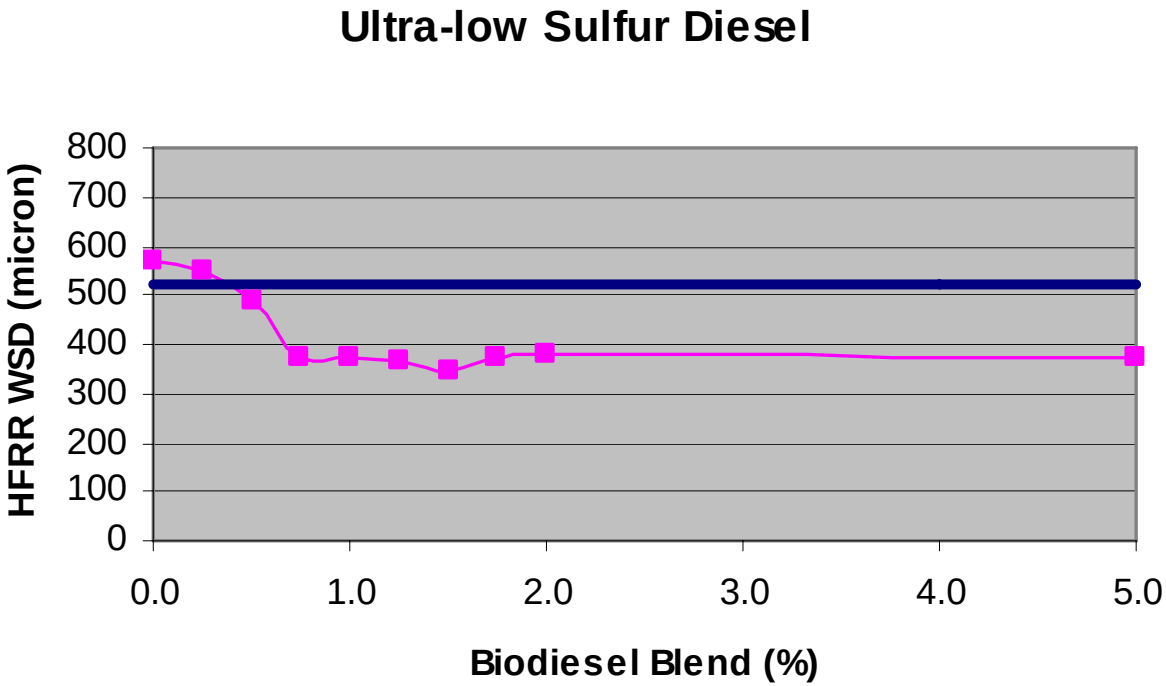
Overall effects on fuel quality are minimal
Slight increases in viscosity, acid value

Extensive Degradation (long-term exposure)

Viscosity, acid value increases exceed maximum limits in ASTM D6751

Degradation of Engine Components

Enhanced Lubricity



- **Equipment benefits**
  - **Superior lubricity**
  - **B2 has up to 66% more lubricity than #2 Diesel**
- **No overdosing concerns**

Material Compatibility

- **Biodiesel and biodiesel blends will form high sediment levels when in contact with brass, bronze, copper, lead, tin and zinc**
- **Biodiesel is compatible with mild and stainless steel, aluminum**

Materials Compatibility

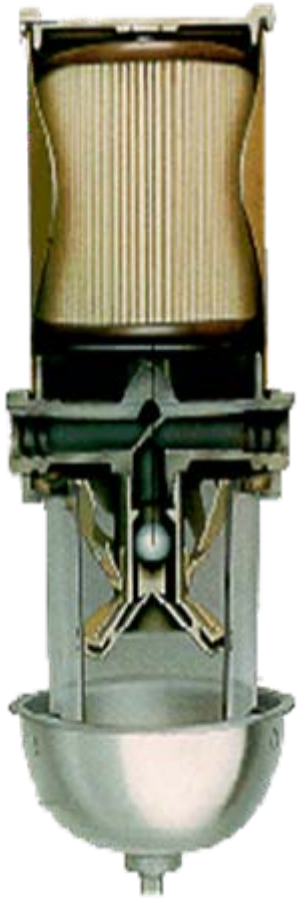
- B100 may adversely affect some elastomers such as natural or nitrile rubbers over time
  - Most elastomers used after 1993 are compatible with B100 (Viton/Teflon)
- Blends (B20) effect is less, or non-existent
- Normal monitoring of hoses and gaskets for leaks is sufficient with B20

Filter Plugging

Fuel Filters and Solvency

B100

- Monitor filters closely
- Strong cleaning effect
- Storage tanks may need to be cleaned, or keep extra filters on hand at start up



B20 & Under

- Monitor filters, less than 2% need to be changed
- Mild cleaning effect
- Maintain housekeeping protocols for generic diesel

Biodiesel Price

Blenders Tax Credit

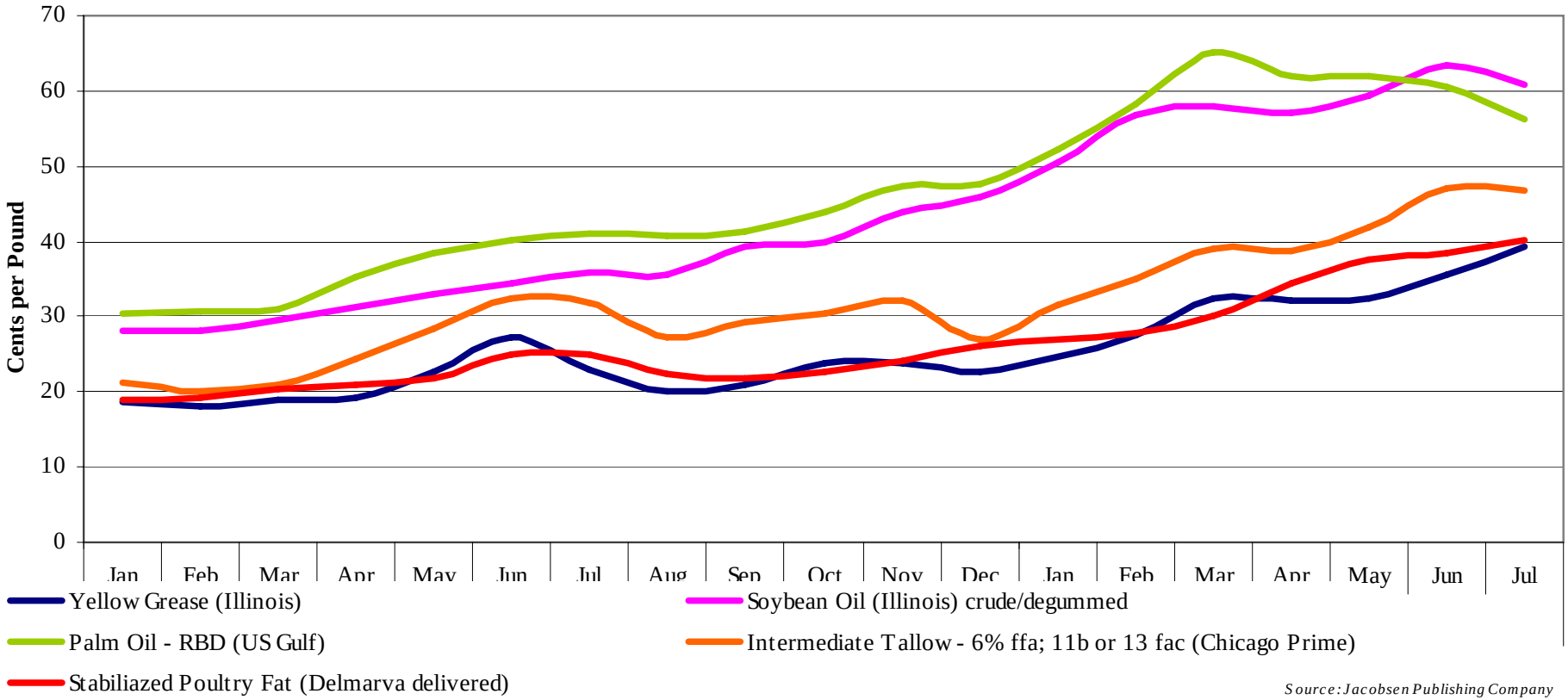
- **Federal Excise Tax Credit**
- **Excise tax credit amounting to ½ cent per % point blend into diesel fuel for biodiesel from recycled cooking oil.**
- **1 cent per % blend for "agri-biodiesel"**
  - **First use vegetable oils and fats**
- **Begins January 1, 2005, ends Dec 31, 2008.**
- **Claims will primarily be made by the blender of record. (i.e. distributors, biodiesel producers)**

B20 vs. Diesel Fuel Price

	B20	Diesel
2/28/08	$3.36	$3.00
3/27/08	$3.60	$3.25
4/17/08	$3.85	$3.55
5/29/08	$4.21	$4.03
6/26/08	$4.08	$3.86
7/25/08	$3.96	$3.70

Source: *Alternative Fuels Index*
published by the Energy Management Institute

Fats & Oils Prices (2007-2008)



Source: Jacobsen Publishing Company

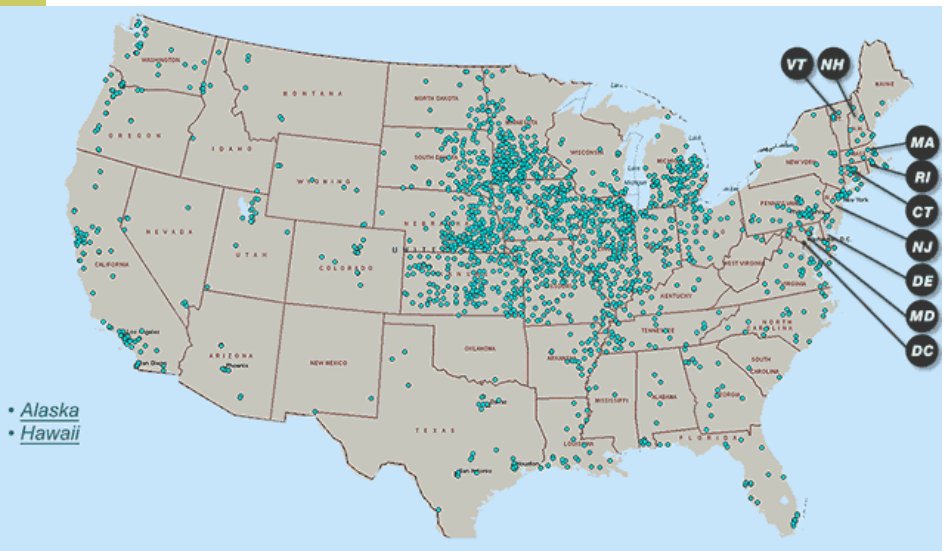
Biodiesel Availability

Fuel Availability

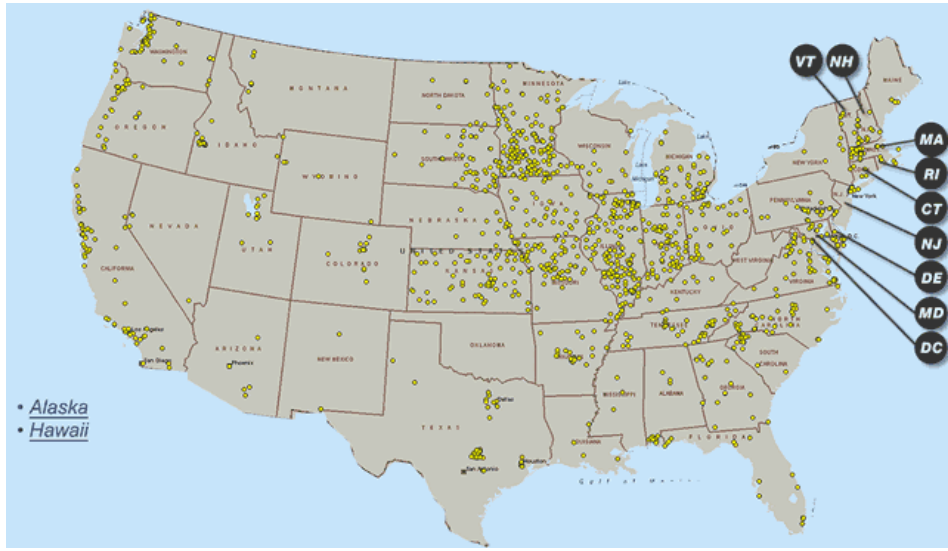
- Fuel available through direct shipment from over 1,977 petroleum distributors nationwide
- Over 1,410 retail filling stations nationwide
- Movement towards biodiesel at the terminal – over 63 terminal nationwide

Interactive Maps on NBB Website

Biodiesel Distributors



Biodiesel Retailers



http://www.biodiesel.org/buyingbiodiesel/distributors/

http://www.biodiesel.org/buyingbiodiesel/retailfuelingsites/

Transitioning to B20 Checklist

Biodiesel Usage Checklist

- ☑ **Only accept ASTM D 6751 biodiesel and ASTM D 975 diesel fuel and periodically take fuel samples**
- ☑ **Look for BQ-9000 Suppliers**
- ☑ **Avoid storage tanks contaminated with water or old fuel; bacterial growth**
- ☑ **Check fuel filters on vehicles and delivery system frequently upon initial biodiesel use and change them as necessary**
- ☑ **Be aware of biodiesel's cold weather properties and take precautions as with #2 petrodiesel use in cold weather.**
- ☑ **Be aware of biodiesel's compatibility with engine components.**
- ☑ **Use stored biodiesel within six months**

GSA B20 Service Recommendations April 19, 2003

- **Site Issues -** The cleanliness of fuel tanks (both bulk storage and fuel vehicle tanks) can impact the necessary service schedule of B20-fueled vehicles. Customers or their fuel vendors should be informed that the mild solvency property of B20 fuel might have a cleansing affect on fuel tanks when first using B20. Storage tanks should be monitored and the frequency of fuel dispenser filter changes may need to be increased in order to counter this effect until the pre-existing debris and material have been removed.
- **Vendor Issues -** The quality of the biodiesel can impact the success of the fuel use. Customers are required to use biodiesel that meets the standard specification ASTM D-6751.

GSA B20 Service Recommendations April 19, 2003

- **Monitor Vehicle Fuel Filters -** On occasion, the B20 fuel should be tested for quality assurance, and during the first month of B20 use, several vehicle fuel filters should be visually inspected for the amount of debris in the filter. These inspections will ensure that no debris has entered the fuel and that fuel filters are serviced before they become clogged.
- **Provide Necessary Fuel Filter Changes -** Provide fuel filter changes for B20-operated vehicles as needed, without creating a different service schedule for these vehicles. The frequency of fuel filter services for B20-operated vehicles depends on the quality of both the fuel and site. We have informed the MCC's that there may be an increase in service frequency as a result of initial B20 use.

GSA B20 Service Recommendations April 19, 2003

- **Manage Operating Costs on a Case-by-Case Basis -** Since service recommendations and fuel costs will vary from site to site, the management of additional costs to be billed back to the customer will be subject to the unique conditions of the site. The method of reimbursement, such as a normal bill back or a cost per mile increase will be at the Fleet Manager's discretion.
- **Contact the GSA Maintenance Control Center (MCC) for any service required at 1-866-400-0411.**

NBB Resources

www.biodiesel.org

- Technical Library
- Biodiesel Bulletin
- Educational Videos Available
- Informational Resources
- Technical Resources
- On-line Database & Spec Sheets