BIODIESEL
TM by the National Biodiesel Board

APWA Educational Session

Biodiesel's Impact on Public Fleet Operability and Economics

September 9, 2007

San Antonio, Texas

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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.

Official IRS and EPA definition – goes to fuel quality.

BIODIESEL ASTM - D6751-07a

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Property	ASTM Method	Limits	Units
Calcium & Magnesium, combined	EN 14538	5 max ppm	(ug/g)
Flash Point (closed cup)	D 93	93 min.	Degrees C
Alcohol Control (One of the following must be met)			
1. Methanol Content	EN14110	0.2 Max	% volume
2. Flash Point	D93	130 Min	Degrees
Water & Sediment	D 2709	0.05 max.	% vol.
Kinematic Viscosity, 40 C	D 445	1.9 - 6.0	mm2/sec.
Sulfated Ash	D 874	0.02 max.	% mass
Sulfur			
S 15 Grade	D 5453	0.0015 max. (15)	% mass (ppm)
S 500 Grade	D 5453	0.05 max. (500)	% mass (ppm)
Copper Strip Corrosion	D 130	No. 3 max.	
Cetane	D 613	47 min.	
Cloud Point	D 2500	Report	Degrees C
Carbon Residue 100% sample	D 4530*	0.05 max.	% mass
Acid Number	D 664	0.50 max.	mg KOH/g
Free Glycerin	D 6584	0.020 max.	% mass
Total Glycerin	D 6584	0.240 max.	% mass
Phosphorus Content	D 4951	0.001 max.	% mass
Distillation, T90 AET	D 1160	360 max.	Degrees C
Sodium/Potassium, combined	EN 14538	5 max	ppm
Oxidation Stability	EN 14112	3 min	hours

Workmanship Free of undissolved water, sediment, & suspended matter

BOLD = BQ-9000 Critical Specification Testing Once Production Process Under Control

BIODIESEL ASTM Current Status

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- ASTM D 6751 is the approved standard for B100 ***to be used for blending in the US***

- If B100 meets D 6751 and petrodiesel meets D 975, the two can be blended up to 20%
  - Similar to how #1 and #2 diesel are managed

The MOST important factor is B100 meeting D 6751 prior to blending!!!

Biodiesel Feedstocks

Oils or Fats

- Soybean (major market share)
- Corn
- Canola
- Cottonseed
- Sunflower
- Beef tallow
- Pork lard
- Used cooking oils
- Palm

Each biodiesel feedstock varies by its free fatty acid content and the different proportions of fatty acids found in each feedstock influence some biodiesel fuel properties

degree of saturation

↓

- Cold flow properties
- Cetane number

ASTM specification intended to alleviate feedstock concerns

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Biodiesel lowers 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%

Fuel Quality

- ASTM spec fuel improperly stored, transported, and/or handled can be affected
- Observed distribution problems could potentially include:
  - Storage tanks contaminated with water or old fuel; bacterial growth
  - Trucks not cleaned; carry-over residues
  - Improper blending techniques
  - Aged fuel – oxidation, precipitates, sediments
  - ULSD occasionally out of spec

BIODIESEL Spec's To Learn & Keep An Eye On

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Biodiesel

- Flash point
- Acid number
- Free glycerin
- Total glycerin
- Water & sediment
- Cloud point

Petrodiesel

- Cetane number/index
- Cloud point
- Pour point
- CFPP
- Water & sediment
- Sulfur

Housekeeping Petrodiesel and Biodiesel - Responsibilities

No matter where you are in the supply chain <u>both you and your staff are responsible</u> for ensuring optimum storage environments for your fuels, diesel and/or biodiesel

Maintaining Fuel Quality Throughout The Supply Chain

- Begin by specifying ASTM designed fuels, D 6751 and D 975. Get it in writing that your supplier will furnish ASTM fuels!

- Reference cold weather performance and other special needs prior to ordering.

Specifics…..

- Review fuel analysis to ensure incoming fuel meets specifications, both biodiesel and generic diesel.
- If either biodiesel or generic diesel fuel fails, notify your fuel supplier immediately.
- Retain samples (quart minimum) should analytical work be required to evaluate future operability issues.
- **Make a friend with an independent testing laboratory.**

The Downstream Distributor Should:

Only accept ASTM D 6751 biodiesel

Understand fuel handling characteristics of both distillate and biodiesel fuel

Become knowledgeable about biodiesel (and diesel) properties as they may affect their operations

Certificate of Analysis (COA) from a Producer to Distributor or End User

Renewable Energy Group
PO Box 128
406 1st Street
Ralston, IA 51459
Phone: 712-667-3380
Fax: 712-667-3599
www.renewable-energy-group.com

Certificate of Analysis

Date Reported:	
Lot Number:	**01BD07…….**
Product Description:	**B100**

Order Number:					
Shipping Date:		**Rail/Truck Number:**			
Customer:		**Attention:**			
Street Number:		**Post Office Box:**			
City:		**State:**		**Zip Code:**	

ASTM D 6751-07a Specification Analysis of Biodiesel

Test Parameter	Results	Limits	Units	ASTM Method
Free Glycerin:		0.020 max.	% Mass	D 6584-07
Total Glycerin:		0.240 max.	% Mass	D 6584-07
Monoglycerides[1]:		n/a	% Mass	D 6584-07
Diglycerides[2]:		n/a	% Mass	D 6584-07
Triglycerides[3]:		n/a	% Mass	D6584-07
Cloud point:		n/a	°C	D 2500-05
Water & Sediment:		0.050 max.	% Volume	D 2709-96(2006)
Acid Number:		0.50 max.	mg KOH/g	D 664-06a
Visual Inspection:		2 max	Haze	D 4176-04e1 Procedure 2
Density @15°C:		none	kg/m^3	D1298-99(2005)
Oxidative Stability:		3 min.	hrs	EN 14112:2003
Flashpoint Option A- PMCC :		130 min.	°C	D 93-06
Flashpoint Option B- PMCC :		93 min.	°C	D 93-06
Option B- Methanol:		.2	% Volume	EN 14110:2003
Moisture[4]:		n/a	% Volume	E203-01
Cold Soak Filtration[5]:		360 max	seconds	D 6217-98(2003)e1 Modified
Sulfur:		0.0015 max.	% Mass	D 5453-06
Phosphorus*:		0.001 max.	% Mass	D 4951-06
Sodium & Potassium Combined*:		5 max	ppm (µg/g)	EN 14538 BS2000-547
Calcium & Magnesium Combined*:		5 max	ppm (ug/g)	EN 14538 BS2000-547
Carbon Residue*:		0.050 max.	% Mass	D 4530-06e1
Sulfated Ash*:		0.020 max.	% Mass	D 874-06
Kinematic Viscosity at 40 °C*:		1.9-6.0	$mm^2/sec.$	D 445-06
Copper Corrosion*:		No. 3 max.	n/a	D 130-04e1
Cetane Number*:		47 min.	n/a	D 613-05
Distillation at 90% Recovered*:		360 max.	°C	D 1160-06

[1,2,3,4,5] **These are not ASTM D 6751-07a specification requirements**
***Typical Results**

Prepared by: _____ *MM/DD/YYYY*
NAME, TITLE, Renewable Energy Group

Please contact Inside Sales of Renewable Energy Group, Inc. at (888)734-8686 for all questions and comments about this product.

Biodiesel Certificate from a distributor to the final end-user

CERTIFICATE FOR BIODIESEL

Certificate Identification Number: **1136**
(To support a claim related to biodiesel or a biodiesel mixture under the Internal Revenue Code)

The undersigned biodiesel producer ("Producer") hereby certifies the following under penalties of perjury:

1. **BioEnergy Of Colorado, LLC., 801 West 56th Ave, Denver, Co. 80216 (34-2012847)**
Producer's name, address, and employer identification number

2. **Bridgman Oil Company. 109 Clay, Hutchison, KS 67501 (48-0896916)**
Name, address, and employer identification number of person buying the biodiesel from Producer

3. **January 8, 2007. Denver, Colorado**
Date and location of sale to buyer

4. This certificate applies to **6698** gallons of biodiesel.

5. Producer certifies that the biodiesel to which this certificate relates is:
100 % Agri-biodiesel (derived solely from virgin oils)
_____ % Biodiesel other than agri-biodiesel

This certificate applies to the following sale:
1136 Invoice or delivery ticket number
6698 Total number of gallons of biodiesel sold under that invoice or delivery Ticket number (including biodiesel not covered by this certificate)

One Total number of certificates issued for that invoice or delivery ticket number

6. _____
Name, address, and employer identification number of reseller to whom certificate is issued (only in the case of certificates reissued to a reseller after the return of the original certificate)

7. _____ Original Certificate Identification Number (only in the case of certificates reissued to a reseller after return of the original certificate)

Producer is registered as a biodiesel producer with registration number **2005-000763AB** Producer's registration has not been suspended or revoked by the Internal Revenue Service.

Producer certifies that the biodiesel to which this certificate relates is monoalkyl esters of long chain fatty acids derived from plant or animal matter that meets the requirements of the American Society of Testing and Materials D6751 and the registration requirements for fuels and fuel additives established by EPA under section 211 of the Clean Air Act (42 U.S.C. 7545).

Producer understands that the fraudulent use of this certificate may subject Producer and all parties making any fraudulent use of this certificate to a fine or imprisonment, or both, together with the costs of prosecution.

Printed or typed name of person signing this certificate
Mr. Thomas A. Davanzo
Title of person signing
Managing Member
Signature and date signed _____ January 8, 2007

Qualified Laboratories

http://www.biodiesel.org/resources/fuelqualityguide/testinglabs.shtm

- Ask the lab if it can/has tested for ASTM parameters
- Ask if the lab has applied for and has participated in the ASTM "Round Robin"
- Ask who their clients currently are that are testing for the ASTM specification (this may be proprietary)
- Ask if it "farms" out any parameter work to other labs and who those labs are
- Ask to see a sample sheet of the ASTM parameter data they will provide

Microbial Contamination in Biodiesel

- Biodiesel already has an ultra-low sulfur content
- Some people think that biodiesel is a "food source" for microorganisms
- Expect future problems with ULSD as have been seen in biodiesel blends.

It's more likely the lack of sulfur in biodiesel makes microbial growth easier

Biodiesel Fuel Stability

- Fuel stabilizers generally are not needed in biodiesel blended fuel used on a frequent basis

- When using biodiesel in vehicles that sit unused for 6 months or longer, a stability additive added to the storage tank can help ensure trouble-free use

Effects of Oxidation on Biodiesel Fuel Quality

Early Stages

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

Extensive Degradation (long-term exposure e.g, 6 months)

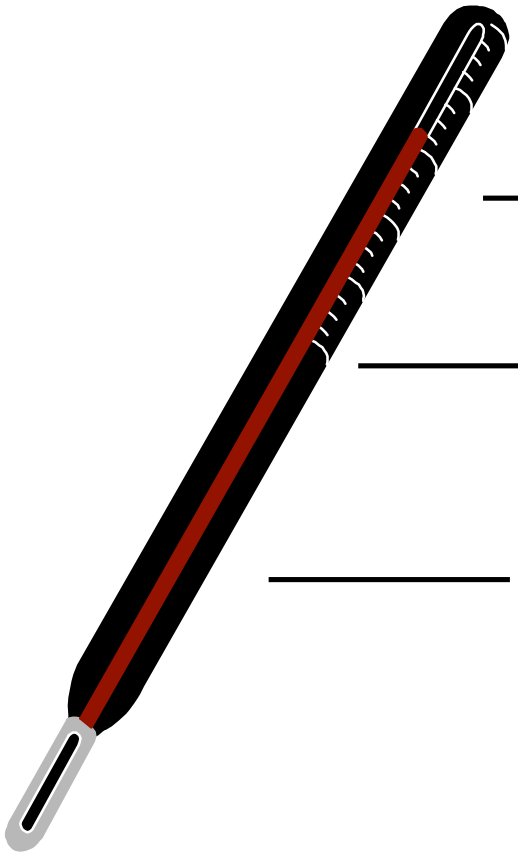
- **Viscosity, acid value increases exceed maximum limits in ASTM D6751**

Cold Weather Performance

- Wax in a vehicle fuel system is a potential source of operational snafus
- A fuels Cold Filter Plugging Point (CFPP), cloud point and pour point require your attention
- 20% blends of biodiesel will impact cold weather operability in direct relationship to the independent base analysis of each fuel
- Pour and cloud can be addressed with kerosene blending

Cold Weather Operability

Understanding Cloud, Pour, and Cold Filter Plugging Point (CFPP)



Cloud — Temperature at which wax is first visible when fuel is cooled

CFPP — Max temperature which wax separating out of the fuel can inhibit fuel flow through a filter

Pour — Temperature at which wax out of solution is sufficient to gel the fuel

Biodiesel Winter Weather Advisory

- **The NBB and PMAA advised members to take the following precautions:**
  - Work with a reputable producer/supplier who you have a good relationship with who will stand behind the product.
  - Require an actual certificate of analysis on every load.
  - Know cold flow properties of both the ULSD and biodiesel before blending.
  - Observe all proper handling and storage procedures, and carefully review the materials available online. Those materials include:
    - B20 Fleet Evaluation Team Guidance
    - Fuel Quality and Performance Guide
    - Biodiesel Handling and Use Guidelines
    - Fuel Handling Training Video

Biodiesel cleaning effect

- B20 has a cleaning effect on tanks and fuel systems when first used.
  - Fuel filters may need to be changed when switching to B20 for the first time. This happens about 2% of the time. After the system is clean, filter changes go back to normal
- B2 has not exhibited this cleaning effect
- The cleaning effect is more dramatic as the blend level goes up

Going over B20 requires caution

- Cold flow
- Materials compatibility
- Cleaning effect
- Fuel Stability a bigger concern
- Lower BTU content becomes noticeable
- Engine oil may become diluted with fuel
- Not supported by most OEM's

http://www.biodiesel.org/pdf_files/Biodiesel_Blends_Above%20_20_Final.pdf

Material Compatibility (tanks)

- 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

Biodiesel adds significant lubricity to ULSD

	% Biodiesel	Results (microns)
#2 ULSD	none	580
	B2	278
	B5	260
#1 ULSD	none	680
	B2	380

Results obtained by ASTM 6079, HFRR lubricity test (520 micron maximum)

Impact of Kerosene Blending with Biodiesel

- Kerosene blending 20% - 40% depending on your region
- 20% kerosene in conjunction with competent chemistry provides most cost effective cold weather protection for generic diesel products
- Adding 10% kerosene reduces fuels BTU value (power & economy) by 1,500 BTU
- Biodiesel blends enhance lubricity, eliminates lubricity issues that kerosene causes
- Kerosene remains to be both economically unstable as well the first distillate grade to evaporate in tight supply markets

Major OEMs' Biodiesel Positions

Arctic Cat	Accepts up to B20 for use in its twin cylinder ATV
CNH	Accepts up to B20 in both Case IH & New Holland brands for most equipment; nearly half of all Case IH equipment also approved for B100
Caterpillar	Accepts up to B30 in most equipment; B5 for remainder
Chrysler Group	Accepts up to B5 in most vehicles; B5 factory fill in Jeep Grand Cherokee and Dodge Ram; B20 approved for fleet use in Dodge Ram
Cummins	Accepts up to B20 in ISX, ISM, ISL, ISC and ISB engines, including new 2007 products

Major OEMs' Biodiesel Positions

Detroit Diesel	Accepts up to B5
Ford	Accepts up to B5; working toward B20
General Motors	Accepts up to B5; B20 offered as SEO for fleets
International	Accepts up to B5
John Deere	Accepts up to B5; B2 factory fill for all US diesels
Mack/Volvo	Accepts up to B5
Mercedes	Accepts up to B5; 4 new diesels for 2007
VW	Accepts up to B5; working toward B20

New Diesel Engines

- Biodiesel blends may provide SIGNIFICANT benefits with 2007 PM trap equipped engines
- 2% biodiesel restores the lubricity of the poorest lubricity ULSD petrodiesel
- Although similar in size/distribution, B20 particles are different than petrodiesel particles
- Break Even Temperature of PM Traps reduced which may increase fuel economy and lengthen PM trap life
  - Use of B20 lowered the balance point temperature by 110°C, and B100 by 230°C.

BQ-9000 Accreditations

- Two accreditations possible for companies:
  - BQ-9000 Accredited Producer
  - BQ-9000 Certified Marketer
- BQ-9000 accredits companies, not fuel
  - There is no such thing as 'BQ-9000 Biodiesel'
  - BQ-9000 does, however, help insure that biodiesel produced and sold will meet D 6751

www.bq-9000.org

Educational Resources

BEN: Biodiesel Education Network

- Web-based resource specifically for petroleum marketers
- Partnership between NBB/PMAA

www.pmaa.org

www.biodiesel.org