




Biodiesel

Basics, Technical Aspects, and Issues for Mining Operations - Biodiesel and diesel particulate matter reductions

Mining Diesel Emissions Council (MDEC) Conference

Toronto, Canada
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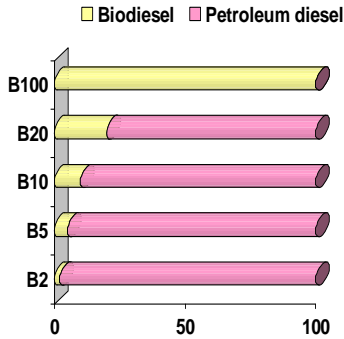
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General Definition and Concepts


- 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 can be used in any concentration with petroleum-based diesel fuel in existing diesel engines with little or no modification.
- **Biodiesel is *not* raw vegetable oil!**
 - Biodiesel *must* be produced by a chemical process that removes glycerin from the oil.

■ Biodiesel ■ Petroleum diesel




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.







B100 Properties

- High Cetane (averages >50)
- High Lubricity (<300 HFRR) – (HFRR, High Frequency Reciprocating Rig, accepted ASTM test standard)
- BTU Content (7-9% lower than #2)
 - Some users see better fuel economy with B20
 - this is most likely due to the cleaning effect of B20
- Cold Flow (3-10° F > for soy-based B20)
- Flash Point (>260°F vs 117° F)
- No nitrogen or aromatics
- Biodegradable, non-toxic, renewable and sustainable
- 78% Life Cycle CO2 Reduction and high energy balance (3.2 to 1)









AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL

<u>Emission Type</u>	<u>B100</u>	<u>B20</u>
<u>Regulated</u>		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
NO _x	+10%	+2%
to-2%		
<u>Non-Regulated</u>		
Sulfates	-100%	-20%
PAH (Polycyclic Aromatic Hydrocarbons)	-80%	-13%
nPAH (nitrated PAH's)	-90%	-50%
Ozone potential of speciated HC	-50%	-10%



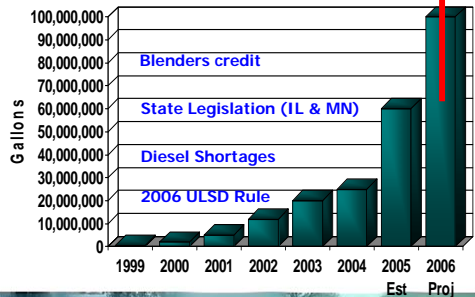


Biodiesel Markets & Drivers


- B20** – EPACT, municipal, school buses
 - Currently over 500 fleets using B20
- B2 to B5** – Ag fuels, premium diesel fuels, lubricity component for ULSD, potential RFS option
 - Low blend is now an important strategy to Clean Cities
- B100** – Niche markets: sensitive areas, mining, power generation, garbage truck fleets


Near-term Growth Markets

- On-highway
 - 37 billion gallons per year (2004 USDOE EIA)
 - ULSD compliance
- Mining (? BGY), Electric Power Generation (~1 BGY), & Railroads (~3 BGY)
 - Market analyses presently being conducted, but definite need for biodiesel
 - ULSD aspects at later dates
 - Emissions/Air Quality Benefits**
 - Possible Renewable Portfolio Standard (RPS) mandates



Year	Production (Gallons)
1999	~5,000,000
2000	~10,000,000
2001	~15,000,000
2002	~25,000,000
2003	~35,000,000
2004	~45,000,000
2005	~60,000,000
2006	~150,000,000 (Proj)






ASTM D 6751 – Biodiesel Fuel Specification & BQ-9000 - Biodiesel Production QC Measure

ASTM D 6751

specification for **biodiesel** fuels irrespective of the feedstock source and/or processing method. Standard ensures **safe operation in a compression ignition engine.**

BQ-9000 www.BQ-9000.org

- To **promote** the commercial success and public acceptance of biodiesel
- To help **guarantee** that biodiesel fuel is produced and maintained at ASTM D 6751 levels
- To **provide** a mechanism to track biodiesel in the distribution system, identifying biodiesel which meets ASTM standards.





ASTM International Specification
D6751: Standard Specification for Biodiesel Fuel


In 2002, ASTM International issued a standard specification for biodiesel fuel called D6751. This specification states that the only form of biodiesel that can be legally resold for commercial operations must meet ASTM specifications.

TABLE 1: Detailed Requirements for Biodiesel (B100)

Property	Test Method	Limits	Units
Flash point (closed cup)	D 93	130.0 min	°C
Water and sediment	D 2709	0.050 max	% volume
Kinematic viscosity, 40°C	D 445	1.9-6.0	mm ² /s
Sulfated ash	D 874	0.020 max	% mass
Sulfur	D 5453	0.05 max	% mass
Copper strip corrosion	D 130	No. 3 max	N/A
Crystallinity	D 611	≤7 min	N/A
°C cloud point	D 2500	Report to customer*	°C
Carbon residue	D 4510	0.050 max	% mass
Acid number	D 664	0.80 max	mg KOH/g
Free glycerin	D 6584	0.020	% mass
Total glycerin	D 6584	0.240	% mass
Phosphorus content	D 4951	0.001 max	% mass
Distillation temperature, atmospheric equiv. temp	D 1160	360 max	°C










Cold Flow Properties & Handling

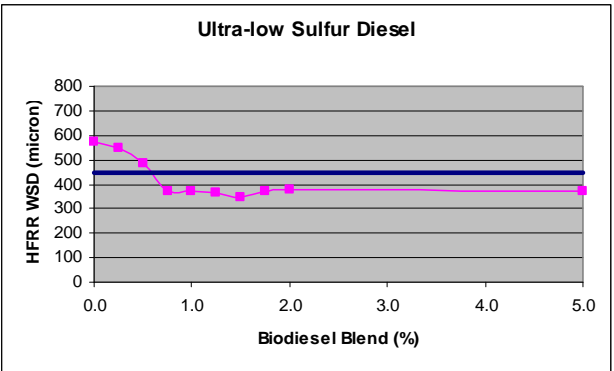
- B100 freezes faster than most petrodiesel; no additives for B100 handling
- Maintain B100 at a minimum of 50°F to 55°F (underground or heated storage) and pay attention to biodiesel arrival and flow on-site
- Untreated B20 freezes about 3-10° F faster than petrodiesel, depending on:
 - the cold flow properties of the biodiesel
 - the cold flow properties of the petrodiesel
- B2 properties are similar to diesel fuel
- Traditional cold weather options for diesel work well with biodiesel and blends
 - Blend with kerosene or use of additive packages
 - Block and filter heaters
 - Indoor vehicle storage




Lubricity & USEPA 2006 ULSD Rule

The purpose of the "Rule" is to reduce emissions of nitrogen oxides (NOx) and particulate matter (PM) by >90% from vehicles that use diesel fuel. However, these reductions require "after treatment" devices which are harmed by the presence of sulfur in the diesel fuel.



Biodiesel Blend (%)	HFRR WSD (micron)
0.0	600
0.2	550
0.4	500
0.6	450
0.8	400
1.0	380
1.2	380
1.4	350
1.6	380
1.8	380
2.0	380
5.0	380

- Testing confirms biodiesel's ability at low levels to provide sufficient lubricity
- 2% biodiesel used as a lubricity additive in 38 billion gallons of on-road fuel = 760 million gallons of biodiesel



BIO DIESEL Biodiesel and Gaseous Emissions
TM by the National Biodiesel Board


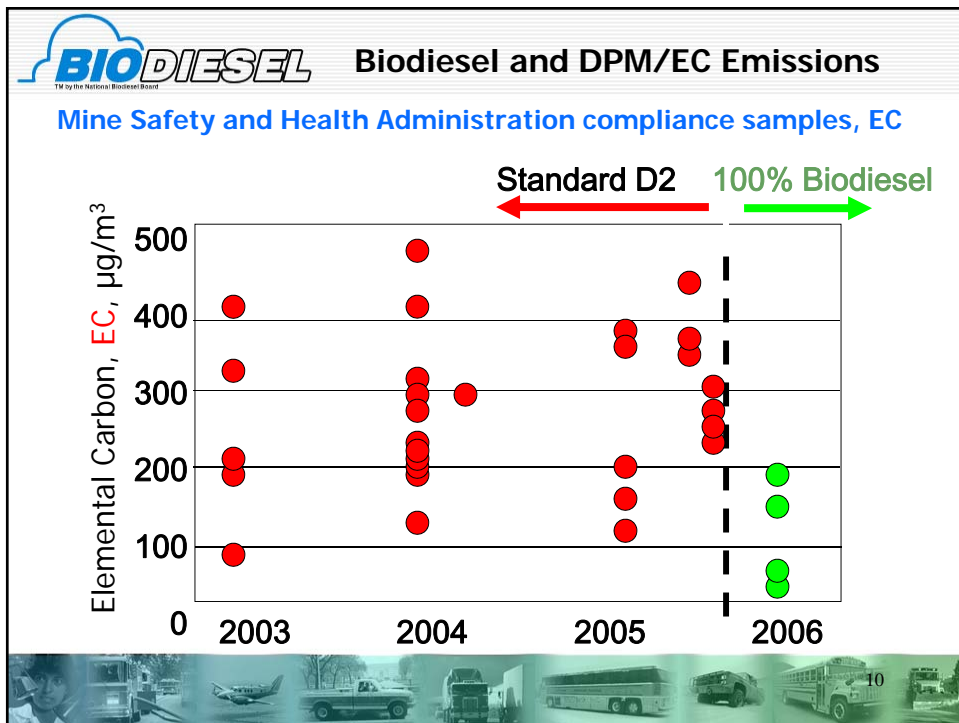
NIOSH PRL isolated zone study, Stillwater mine at Nye, MT

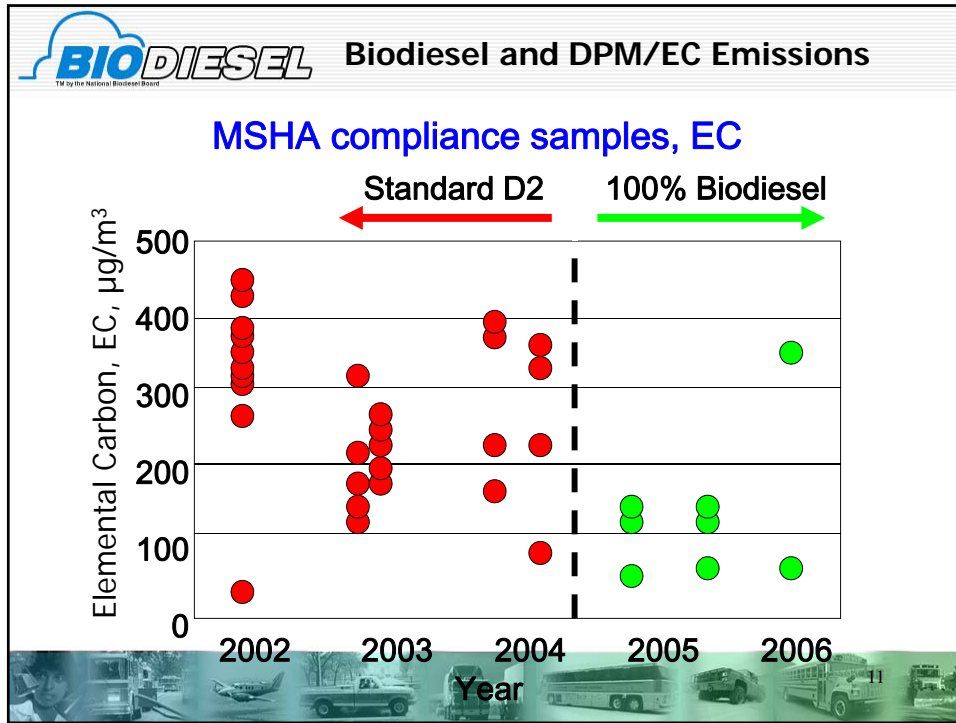
B20 w/OCC vs. #2 diesel w/OCC

- CO no change (both were zero)
- CO₂ no change
- NO - 5.8%
- NO₂ - 5.5%

B50 w/OCC vs. #2 diesel w/OCC

- CO no change (both were zero)
- CO₂ no change
- NO + 4.4%
- NO₂ + 5.5%




Biodiesel 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 OEM's

OEM Warranty Statements and Use of Biodiesel Blends Above B5
http://www.biodiesel.org/pdf_files/B5_warranty_statement_32206.pdf

NBB Guidance on Use of Biodiesel Blends Above B20
http://www.biodiesel.org/pdf_files/Biodiesel_Blends_Above%20_20_Final.pdf








OEMs Positions on Biodiesel



OEMs:

- B100 Must Meet ASTM D 6751
- Most OEM HQs have B20 experience:
 - Won't void warranty, but
 - *Problems caused by the fuel are the responsibility of the fuel supplier*
 - OEMs want to see additional experience in the field
- Higher blends OK'd based on experience of OEM and their technology

OEM's Don't Make Fuel and OEM's Don't Warranty Fuel



NBB Resources

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

Other web sites:

www.nationalbiodieseleducation.org

www.nationalcleancities.org







