

Biodiesel at the Fleet Level

Enviro-Fleets Workshop

November 16, 2010

Presented by Ken Fryer



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Ken Fryer

- CPP, AST, Motive Power Technician, Machinist, Diesel Engine Specialist, Ontario Diesel Endorsement
- Accredited ISO/TS Lead Auditor
- National Biodiesel Board Commission – BQ-9000 Lead Auditor
- CRFA 2005 National Fleet Manager of the Year
- Pioneering Biodiesel in Western Canada
- E3 Fleet Program – Lead Auditor
- Director - Alberta and BC Biodiesel Association
- 4Refuel – Internal QSE Lead Auditor
- GHG Inventory analyst
- Fleet Manager and Superintendent for various Public and Private Fleet Operations



Today's Session – Full Meal Deal

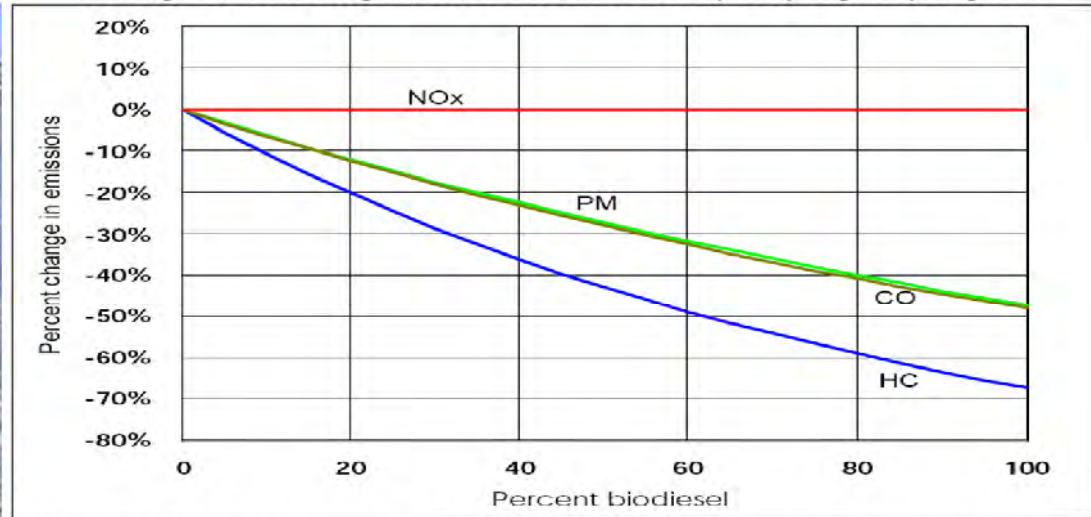
- Biodiesel Attributes
- Feedstocks
- Chemistry
- ASTM Standards
- Biodiesel – WHY NOW?
- Warranties
- Global perspective
- Quality – Procurement
- Handling, storage, distribution
- Winter Operations
- Learning's
- 8 Step Action Plan



Why Biodiesel?



Average emission impacts of biodiesel for heavy-duty highway engines



From EPA420-P-02-001 October 2002

A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions, Draft Technical Report (NOx removed)

NOx neutrality from NREL/MP-540-40554, October 2006, Effects of Biodiesel Blends on Vehicle Emissions



Why Biodiesel?

- **Biodiesel is one of the most cost effective methods to reduce air pollution**
- **Reduces Greenhouse Gas Emissions (GHG), black smoke, air toxins, odour**
- **Enhanced performance characteristics;**
 - **- higher cetane = smoother & quieter engine operation**
 - **- increased lubricity = longer injector life, fewer oil changes,**
- **Higher flashpoint – safe product to use & store**
- **Adding lubricity back to the ULSD**
- **Community/Public Relations**
- **Protect the Environment/Employees**
- **Easy to use, biodiesel is ready for use in all modern vehicles without**
- **modifications**





Biodiesel – A New Fuel?

- 1895**

- Rudolf Diesel designed the "diesel-cycle" engine

- First fuel?**

- Biodiesel - Peanut oil
- **Supplanted by Petro-diesel**
- Due to availability, distribution, consistent quality, pricing





Made From Renewable Feedstocks

- **Plant oils**

- Canola, soy, mustard, jatropha, camolina, palm, algae, hemp



- **Other oils**

- Fish oil

- **Animal fats**

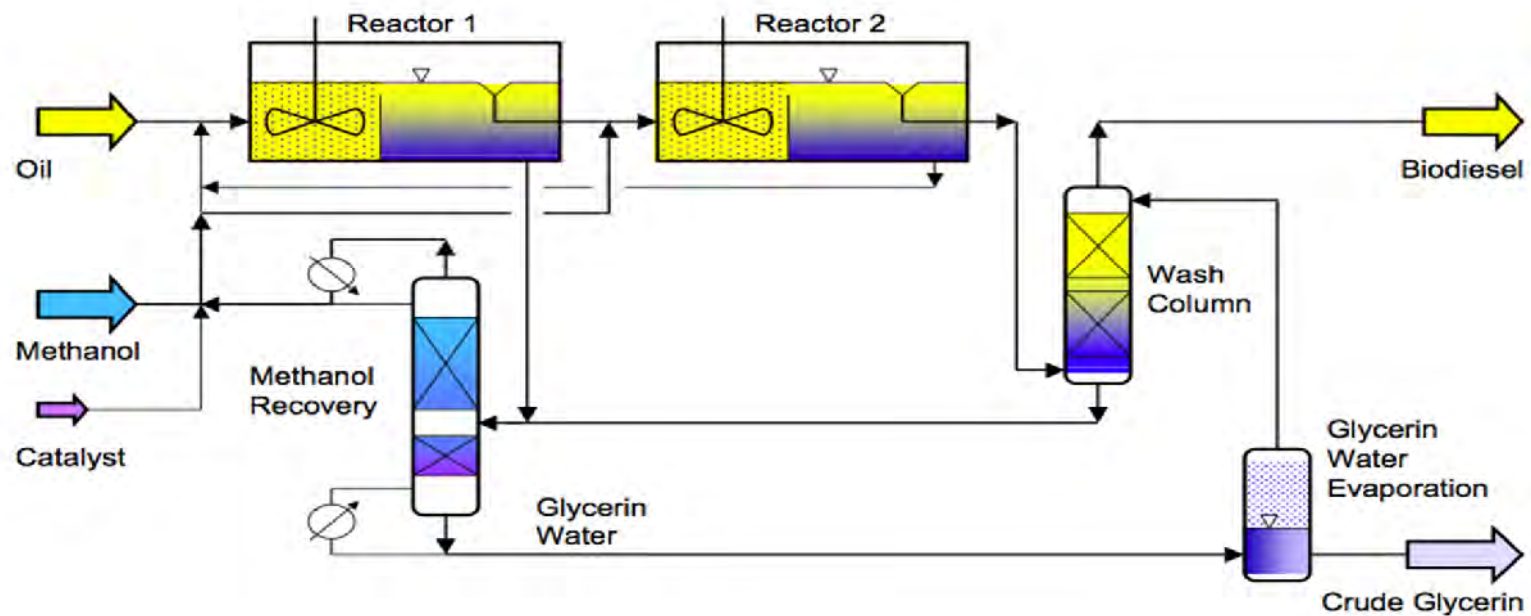
- beef tallow, sheep tallow, pork lard, poultry fats

- **Recycled waste grease**

- yellow and trap greases

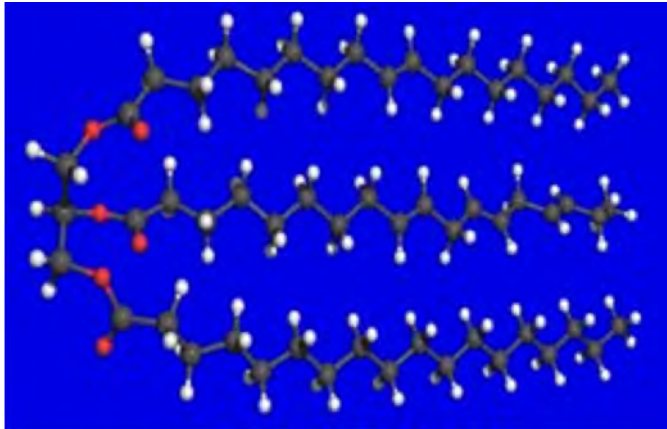


Basic Biodiesel Process-Transesterification





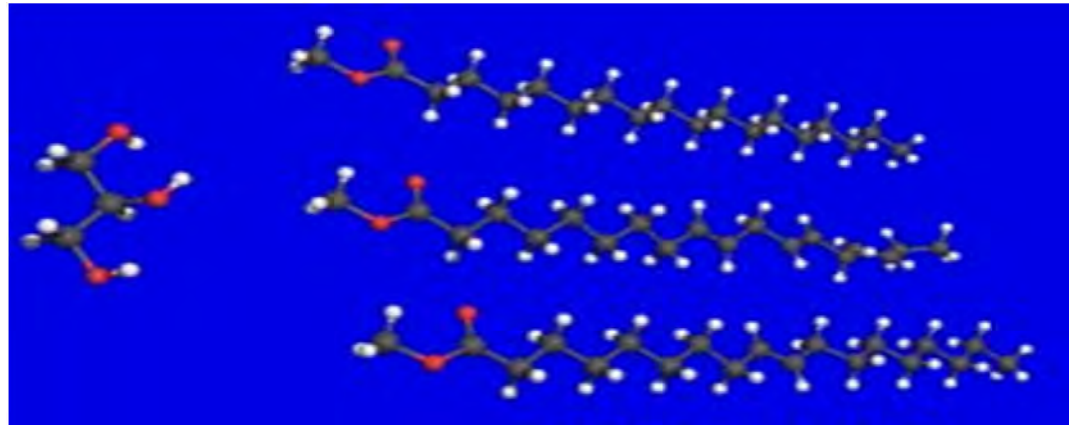
It's The Molecules!



Triglyceride: Fat or Oil molecule

Biodiesel molecules-FAME

Glycerin molecule >>>>





It's The Chemistry!

Diesel vs. Biodiesel Molecule

CH₃CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₃

CH₃CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂CH₂COCH₃

Molecules are very similar

Ease of blending is what makes biodiesel so attractive to users



Biodiesel: Strict Definition

Biodiesel MUST meet fuel quality standards

B100 - ASTM D6751 or European EN14214

Blends – CGSB 3.520 (B1-B5) standard

– CGSB (B6-B12) under review.

Biodiesel is not:

Raw or refined vegetable oils, or recycled greases that have not undergone chemical processing

ALL Engine Manufacturers require that biodiesel must meet ASTM D6751 standards for warranty purposes



ASTM D6751



SPECIFICATION FOR BIODIESEL (B100) – ASTM D6751-07a

March 2007

Biodiesel is defined as the mono alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, for use in compression-ignition (diesel) engines. This specification is for pure (100%) biodiesel prior to use or blending with diesel fuel. #

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 C
Water & Sediment	D 2709	0.05 max.	% vol.
Kinematic Viscosity, 40 C	D 445	1.9 - 6.0	mm ² /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

* The carbon residue shall be run on the 100% sample.

A considerable amount of experience exists in the US with a 20% blend of biodiesel with 80% diesel fuel (B20). Although biodiesel (B100) can be used, blends of over 20% biodiesel with diesel fuel should be evaluated on a case-by-case basis until further experience is available.





Biodiesel – Why Now?

Lower Environmental Impacts

Smog & Greenhouse Gases

Non toxic and biodegradable

Markets for commodities & local industry

Growing Supply in Canada and USA

Engine Warranties & Performance

World Market perspective



Environment

Greenhouse Gas Reductions Rule of thumb

B20 = 15% reduction in GHG's

Federal Mandate = 2% 2012

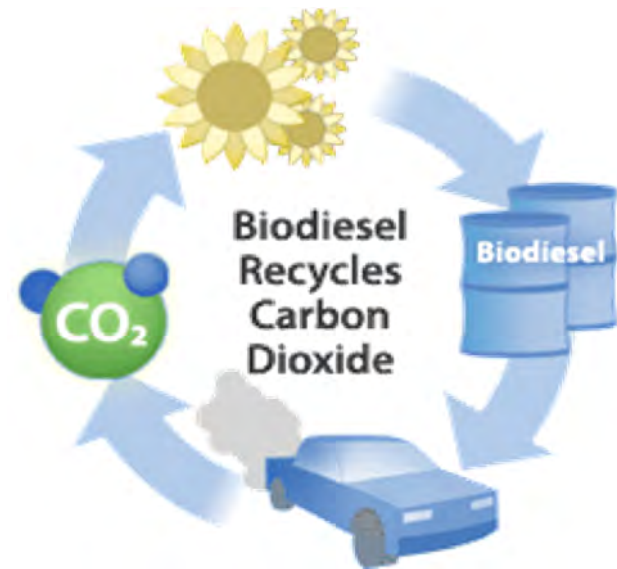
Alberta Mandate = 2% 2011

Manitoba Mandate = 2% 2009

BC Mandate = 5% 2010 (3% initially)

Renewable Fuel Standard

Good Corporate Citizenship





Greenhouse Gases

Global Climate Exchange

Greenhouse Gas that contribute to the Greenhouse effect as defined by;

- Carbon Dioxide (CO₂)
- Methane (CH₄)
- Nitrous Oxide (N₂O)
- Sulphur Hexafluoride (SF₆) – Insulation on wires (substations)
- CFC's – **Chlorofluorocarbons – Global Warming Potentials**
 - Hydrofluorocarbons (HFC's) - Freon
 - Perfluorocarbons (PFC's) – Industrial, LCD screens, aluminum production.
- Water vapour (H₂O) and others stays in atmosphere for up to 100 years



Environment

Toxicity and Biodegradability Marine/Construction Environments

- Biodiesel degrades four times more quickly
- US NIOSH National Industrial Occupational Safety and Health deems biodiesel to have no toxic effects on fish





Health & Safety / Safer Alternative

Biodiesel is a safer choice

Higher Flash Point

Biodiesel is safer to use than petroleum diesel. B100 or Pure biodiesel has a flash point of ~ 239 degrees F compared to ~95 degrees F compared to petroleum diesel.

Non-toxic

Biodiesel is non-toxic: acute oral LD50 (lethal dose) is greater than 17.4g/Kg body weight – table salt (NaCL) is nearly 10 times more toxic.

24-hr human patch test – biodiesel produces very mild irritation – less than a 4% soap and water solution



Fuel Prices

Biodiesel vs. Diesel Prices

Biodiesel blends have been competitive with diesel

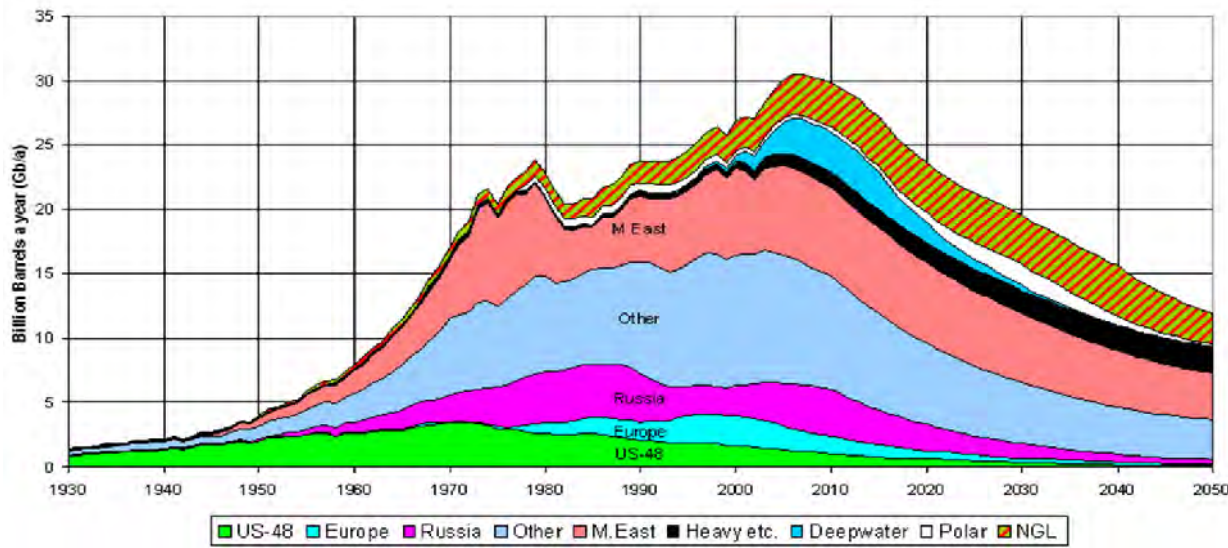
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Security

OIL AND GAS LIQUIDS
2004 Scenario





Security

US Gas Station, Omaha NB





Warranty Statements

The standard engine warranty issued by all OEM's contain a statement to the effect that:

➤ The OEM is not in a position to evaluate the many variations of Biodiesel fuels or other additives. The use of Biodiesel DOES NOT affect the OEM's Material and Workmanship Warranty. Failures resulting from the use of any fuel or additive are not OEM defects and therefore the cost of repair would not be covered by warranty.



Warranty Issues

- B5 is acceptable by OEM's
- Detroit Diesel ~ B5
- CAT B5 ~ Specific applications- B30 current
- Ford 6L ~ (B5)
- Jeep Liberty ~ B5 ~ Factory fill (2005)
- John Deere ~ B2 ~ Factory fill (2005)
- Cummins ~ B5, B20 (2007)

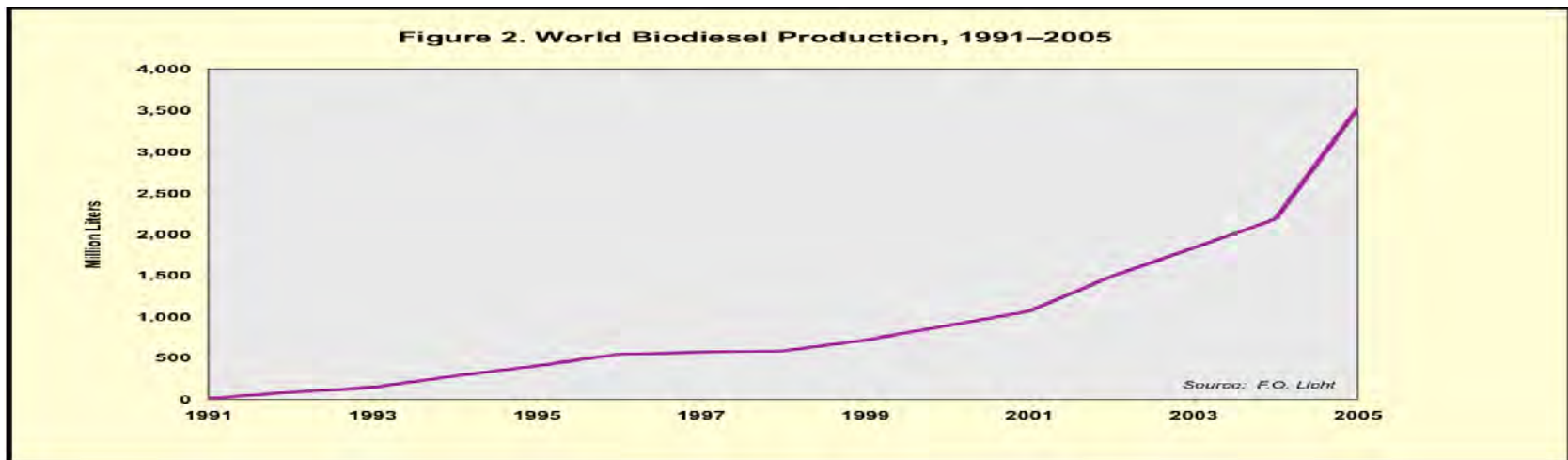




World Markets Today

Biodiesel – A Very Big Business
15 Years ago the fuel was not being sold
anywhere

Today, a multi-billion dollar industry

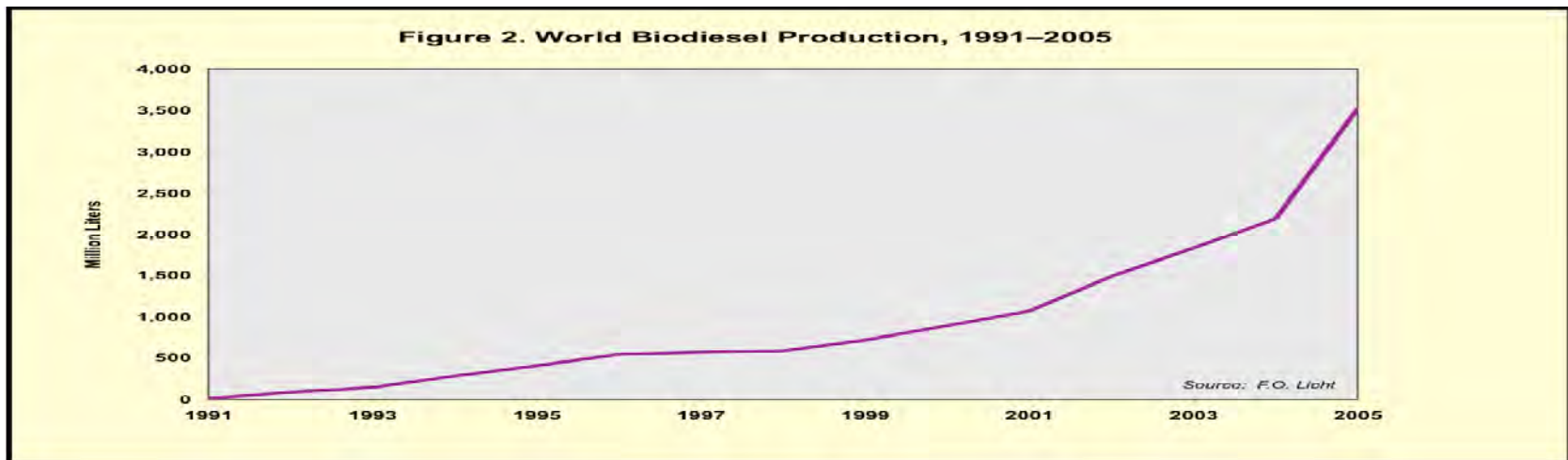




World Markets Today

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Europe – 15 Years Ahead

**1,900 Retail Stations in Germany sell Biodiesel
Ullrich Group: largest independent trucker in
Germany**

1000 trucks, 700 million Km on B100 over 10
years!





UK Users

Tesco Supermarkets – 2000 trucks on B50

Radio Taxi – 3000 Cabs using B30

McDonald's – 150 trucks

Feedstock - its own French fry oil

Virgin Trains using B20





Biodiesel in the USA

**Massive Increase in Production Capacity
By End of 2007: ~ 3 + billion L/yr**





US Users

Chicago School Board buses

Seattle Transit (1200 Buses)

Port of Seattle

MN Prairie Rail Line (B10)

US Military B20 Mandate

Non-combat vehicles

State Mandates (millions of vehicles)

Minnesota – B2 Blend all diesel

Illinois – B2 Blend all public vehicles

WA – B2 mandate 2008

Many other states





Agriculture

Farm equipment manufacturers shipping with “factory fill”

Testing up to 100% blends

Wide spread use across mid-west and Canada

Iowa - 192 Communities where you can bulk purchase Biodiesel





Canada – Just Starting

Canada - Biodiesel Production

2006: 100 Million L
95% exported

Major Canadian Producers

Rothsay (Quebec)
Biox Corporation (Ontario) – BQ9000
Miligan (Sask)- 2% additive
Canadian Green Fuels (Sask)
Manitoba 2 plants this fall
City-Farm Biodiesel - BC
CBEC (pending)
Bfuel Canada (pending)
Kyoto Biodiesel (pending)





Growing Biodiesel Users – Canada

**Toronto Hydro, City of Vancouver,
Toronto Transit, City of Richmond,
Manitoba Hydro, Township of Langley,
Sask. Transportation Bus, BC Hydro,
Calgary Landfill, Resort Muni of Whistler,
(RFQ) Coast Mountain and BC Transit.**

YOU could be Next





Biodiesel in Canada

- Massive Increase in Production Capacity
 - By 2012: 1.5 billion L/yr





Can You Make Biodiesel? Yes.

- \$2500 and its yours!
- But Remember,
 - You will need permits
 - Fire Department will visit
 - Be careful – flammable liquids!
 - Your Insurance may be voided
 - Where and how will you dispose of the waste?
 - This is chemistry – do you really know what you are doing?
 - Are you prepared to risk your vehicle's engine warranty or components?





Procurement – Before You Buy

- **Quality Control**

- Supplier must deliver ASTM D6751 Standard fuel
- Quality control (BQ-9000) Producer/Distributor
- Chain-of-custody-delivery of blended fuel from Production-distribution-transporting-secondary storage, intermediate delivery (resellers) to End-use.
- Supplier/Distributor to provide:
 - Guarantee in writing that fuel meets ASTM
 - **Certificate of Analysis** COA for each batch delivered





Procurement - Before you Buy (Cont.)

- **Considerations related to QUALITY Fuel**
 - Desired Blend
 - Delivery method and frequency
 - Storage
 - Logistics – transportation
 - Colder Climate – Cloud Point – Pour Point
 - Pricing and Mechanisms
 - Terms and Conditions



Handling

- Treat as fuel (WHMIS, safety, etc)
- Mixing / Splash blending (B20/Fuel)
- “Cleaning” / solvent effect (filters, tanks, hoses)
- Cold weather considerations, #2 Diesel Cloud Point -19C, B20 Cloud Point -16C
- Storage – Moisture – “THE ENEMY”- Solution
- Desiccant filters on tank vents
- Fuel management- Biocides “BUGS”
- Long Term Storage – 6-9 months



Fuel Quality/Infrastructure

- ASTM standard is being tightened – Enhanced testing/COA
- Petroleum infrastructure has its advantages and risks
- Certified Marketers and Brokers; be assured of source, and have source documentation
- Understand dispute resolution
- Marketers/Distributors need to implement properly
- Work closely with regional partners and competitors





Fuel Blending

- **Best performance from well blended fuel**
 - In-line blending at the rack
 - Splash blending in the tanker truck – cycled tank chambers
 - Splash blending in the storage tank
 - During splash blending both the biodiesel and petroleum diesel temperatures must be closely monitored to ensure complete blending
 - Must avoid cold temp “shock”
 - Warm biodiesel being poured into cold petro diesel



Tank Maintenance

- **Tank Maintenance Tips**

- Biodiesel should be properly blended prior to being introduced into the tank
- Check tank regularly – test for water, contaminants and acid content. Remove as required and properly dispose of it.
- Some local Fire Codes requires tanks to be dipped every 7 days
- Recommend testing for tank integrity per local regulations. (2 year minimum)
- Ensure regular turnover of fuel





Learnings – Hoses

- **Hoses**

- Delivery truck fuel lines should be checked as part of regular maintenance- Viton/Neoprene
- Natural rubber hoses and seals may deteriorate and cause leaks with B100 and contaminate fuel
- B20 data indicates no problems with natural rubber components



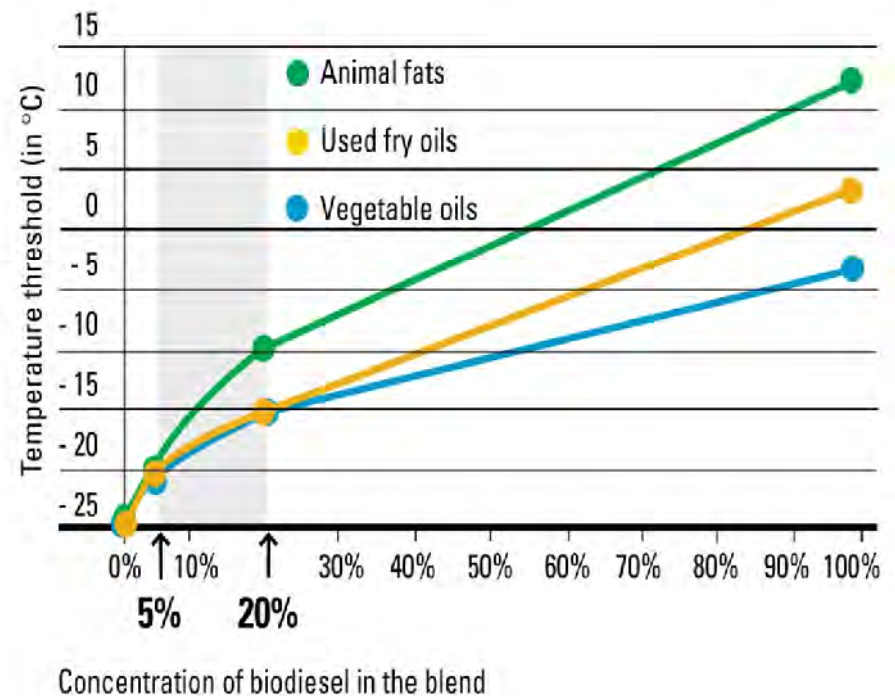


Learnings – Winter Operations

- Biodiesel has a higher cloud point than #2 diesel
- Can lead to cold flow problems
- Biodiesel blending must be carefully managed when using blends above B5
- B100 must be stored at 6 degrees Celsius above its cloud point
- Seek guidance from other fleets, suppliers with cold weather experience

Cloud Point

(based on ASTM D 2500)





Learnings – Winter Operations

- **Solutions to cold weather operations**
 - Use B20 or less
 - Blend with #1 diesel
 - B5 blend can be treated like #1 diesel
 - Manage fuel storage temperature
 - Indoor parking if possible
 - Use cold flow additives
 - #2 Diesel Cloud Point -19°C ,
B20 C Point -16°C





Desiccant Filter Installation





Bulk Delivery-Custody





Intermediate Storage





Recommendations **4Refuel**

- **Cleaning:** Prior to loading Biodiesel into a storage unit, the storage tank must be clean and free of any rust or sediment. For blends of B20 or higher, storage tanks should be cleaned prior to starting a program.
- **Tank Bottom Sampling:** For all tanks, regardless of blend, a sample should be taken from the tank bottom to determine if there are sediments from the existing fuel. (No. 2 diesel fuel tends to form sediments that stick to and accumulate in storage systems, forming layers of sludge or clime in the fuel systems. The older the system, and the poorer the maintenance, the thicker the accumulated sediments become. Biodiesel will dissolve these sediments and carry the dissolved solids into the fuel systems of the vehicles if a filter is not in place on the dispensing unit.)
- **Biocides:** Proactive use of a biocide is recommended if biological growth in the fuel has been a problem in the tank. If biological contamination is a problem, housekeeping needs to be improved and water contamination needs to be reduced since an alga grows in the water and not in the fuel itself. Algae may become an issue in hot conditions where water is present.
- **Desiccant Filters:** Desiccant filters on vents are recommended to reduce moisture and particulate contamination (dirt) if there are particular concerns arising from the tank setup and location. If you don't have a source for filters, you may consider the following local source: National Energy @ 604-942-3810.
- **Materials Compatibility:** Brass, bronze copper, lead, tin and zinc linings should be avoided, as should copper pipes, brass regulators, and copper fittings. The fuel or the fittings tend to change color and sediments may form, resulting in plugged filters. Affected equipment should be replaced with stainless steel or aluminum. Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene, and Teflon. The effect of B20 on vulnerable materials is diluted compared to higher blends and may take longer to materialize.
- **Cloud Point & Pour Point:** Tanks should be equipped to maintain the Biodiesel blend at 10 C above its cloud point. In the lower mainland, B5-B20 blends will not require any special consideration beyond those in place for #2Diesel. For yards in colder climates, please call us if you have any questions regarding the most appropriate cold weather measures. (Generally, B5 will warm the pour point of the diesel between 3C and 5C, depending on whether #1Diesel or #2Diesel. Blended fuels can be stored below ground in most climates. Above ground storage should consider special precautions if temperatures routinely fall below the pour point of the blended fuel. Depending on the pour point of the diesel portion of the blend and the blend ratio, the pour point of the delivered blend will be in the range of 4-7 C below its cloud point.)



Secondary Chain of Custody



- Choose the right handler.



Biodiesel Action Plan

Be Clear – Only use fuel that meets ASTM D6751

- BQ-9000 Accredited Producer;
- BQ-9000 Certified Marketer.

Select Blend - B2-B20? (BQ-9000-Protocols)

- All or some part of your fleet? Timeline?

Assess Suppliers – Certified Marketer (BQ-9000)

- Will current fuel supplier provide a COA for biodiesel blend with each delivery?
- Implementation and dispute resolution



Biodiesel Action Plan

Confirm Technical Specifications

- Ensure biodiesel meets ASTM D6751 Standard
- Obtain biodiesel supplier fuel quality guarantees, COA. through the complete custody chain.
- Cross-check engine warranty issues

Plan Fleet Use

- Are any vehicles using a biodiesel blend travelling to areas where cold temperatures will be a factor?
- Refuelling outside biodiesel supply area



Biodiesel Action Plan - final

Decide on Operational Issues

- Where will biodiesel be stored? (B5 treat just like diesel; other blends depend on Cloud Point of biodiesel and diesel)
- How will biodiesel be blended with diesel? Temperatures?
- Preparation of tanks and vehicles?
- Filter replacement scheduling?
- Staff training and education?

Monitor Use

- Performance and maintenance

Review Overall Program

- Change or expand biodiesel program as needed



Thank You!

