BIODIESEL
TM by the National Biodiesel Board

Biodiesel

Benefits, Issues, & Opportunities for the Mining Industry

Presentation to MinEXPO

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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. It is not raw vegetable oil.*

Official IRS and EPA definition – goes to fuel quality.

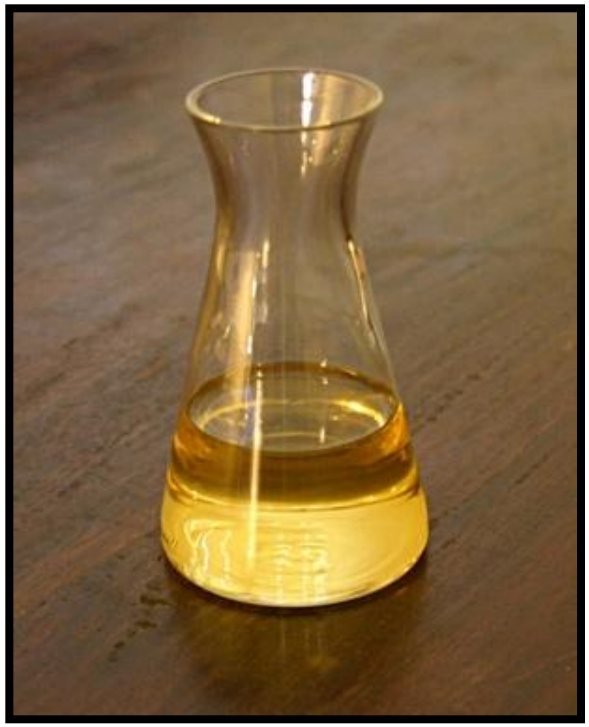
Vegetable Oil

Animal Fat

Used Grease

Biodiesel Attributes

- Integrates into existing petroleum infrastructure; "pour and go"
- High Cetane (>50 vs 42)
- High Lubricity
  - 2% blend biodiesel increases lubricity by up to 65%
- BTU Content of B100 8% less than #2 diesel
- ***Cold Flow Concerns***
- Flash Point (minimum 260°F)
- Virtually Zero Sulfur
  - Meets 2006 ULSD rule



Energy balance of 3.2:1 and 78% life-cycle reduction vs. petrodiesel

Some Quick Perspective – Petroleum & Agriculture

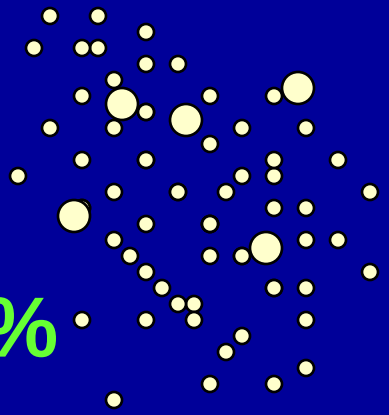
- The oilseed and fat market is only a small fraction of the oil industry

- IF ALL DOMESTIC FEEDSTOCKS WERE CONVERTED TO FUEL, **ONLY 8% OF DIESEL** COULD BE REPLACED

However, we would go very hungry, very quickly

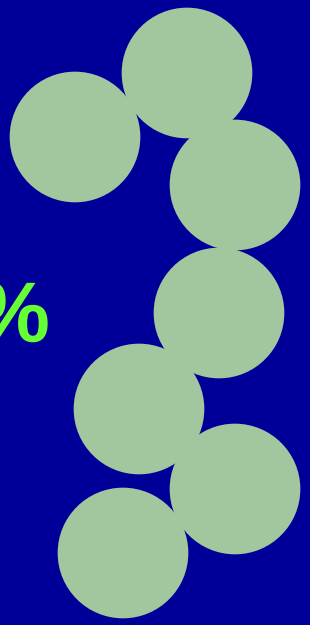
Diesel Particulate Matter (DPM) Carbon Components

OC=23%



Vapor Phase Hydrocarbons (OC)

EC=77%



Elemental Carbon Cores (EC)

77% x 1.3 = 100%

EC x 1.3 = TC

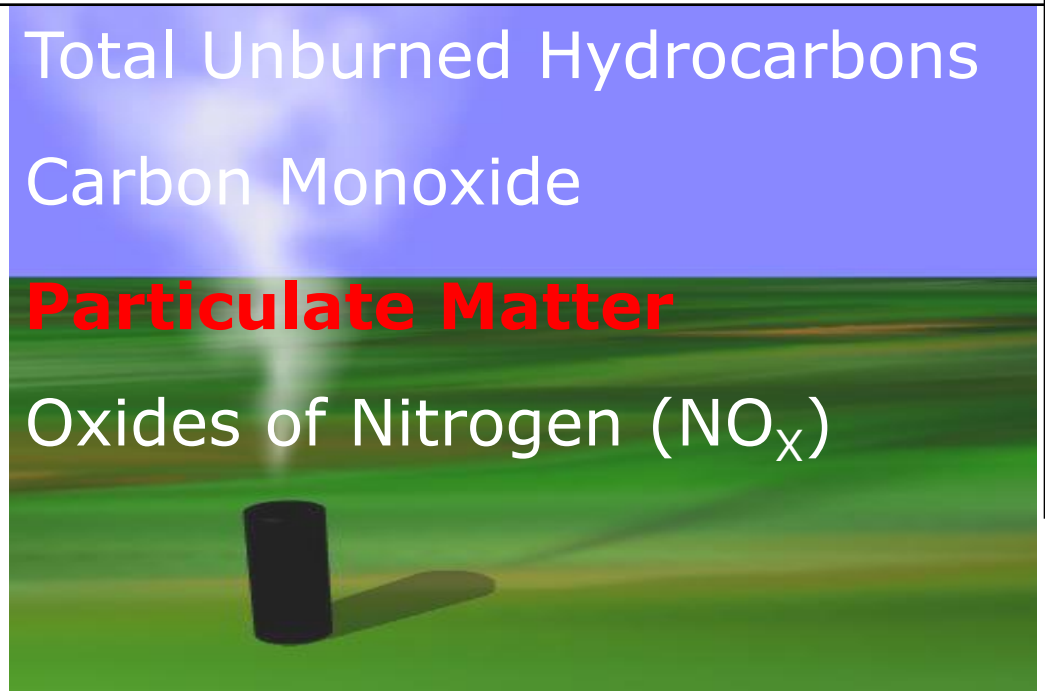
308_{EC} X 1.3 = 400_{TC}

MSHA - May 18, 2006 Final Rule

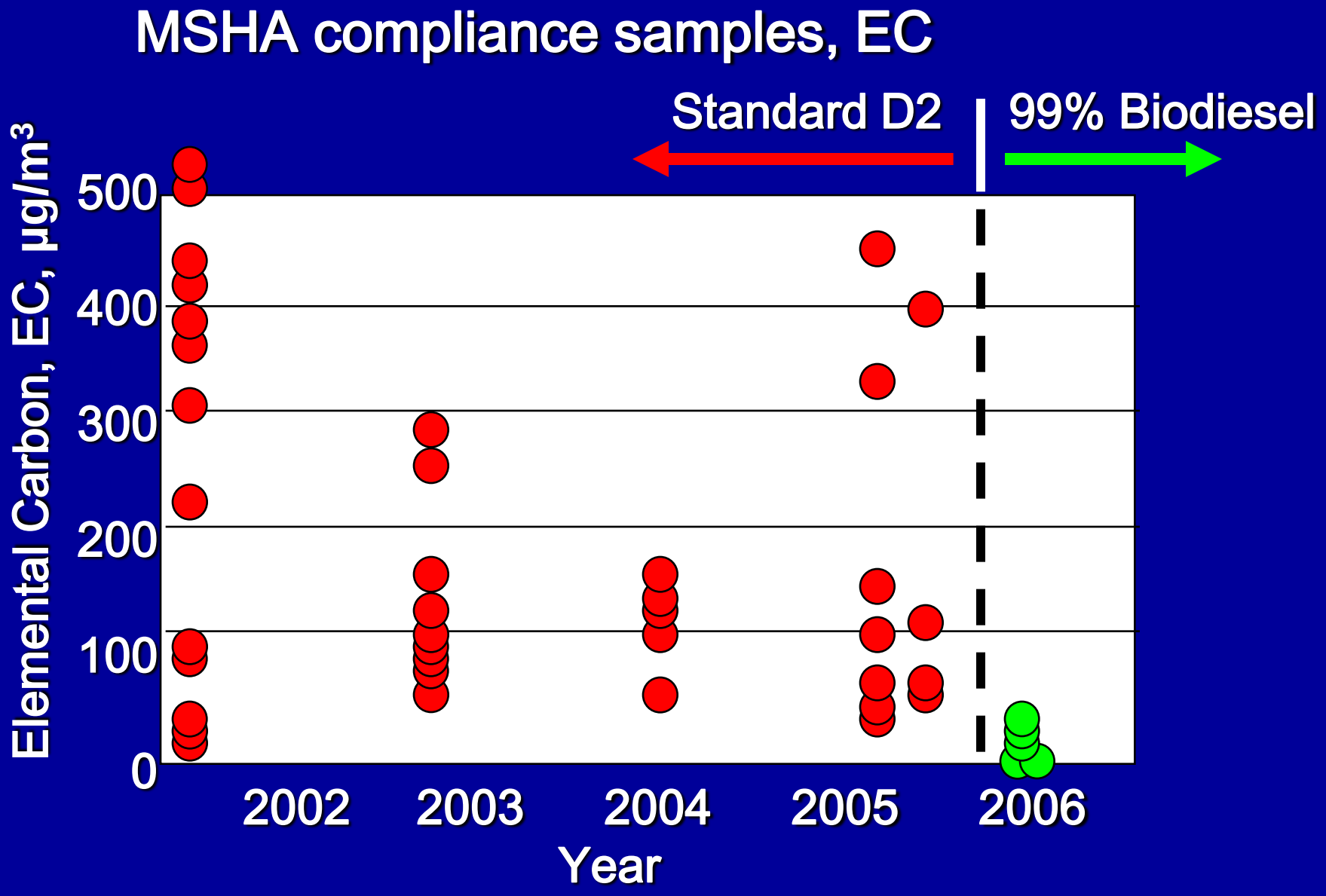
- Phases in final DPM PELs over two years
  - 308_{EC} µg/m^3 - effective May 20, 2006
  - 350_{TC} µg/m^3 - effective January 20, 2007
  - **160_{TC} µg/m^3 - effective May 20, 2008**
- 1st step, 308_{EC} µg/m^3, is an EC limit
- 2nd & 3rd steps are TC limits
- Will use 1.3 conversion factor for 350_{TC} µg/m^3 limit as we did under the Settlement Agreement and use EC to validate
- MSHA will initiate separate rulemaking to convert 160 TC limits to comparable EC limits

Biodiesel lowers emissions

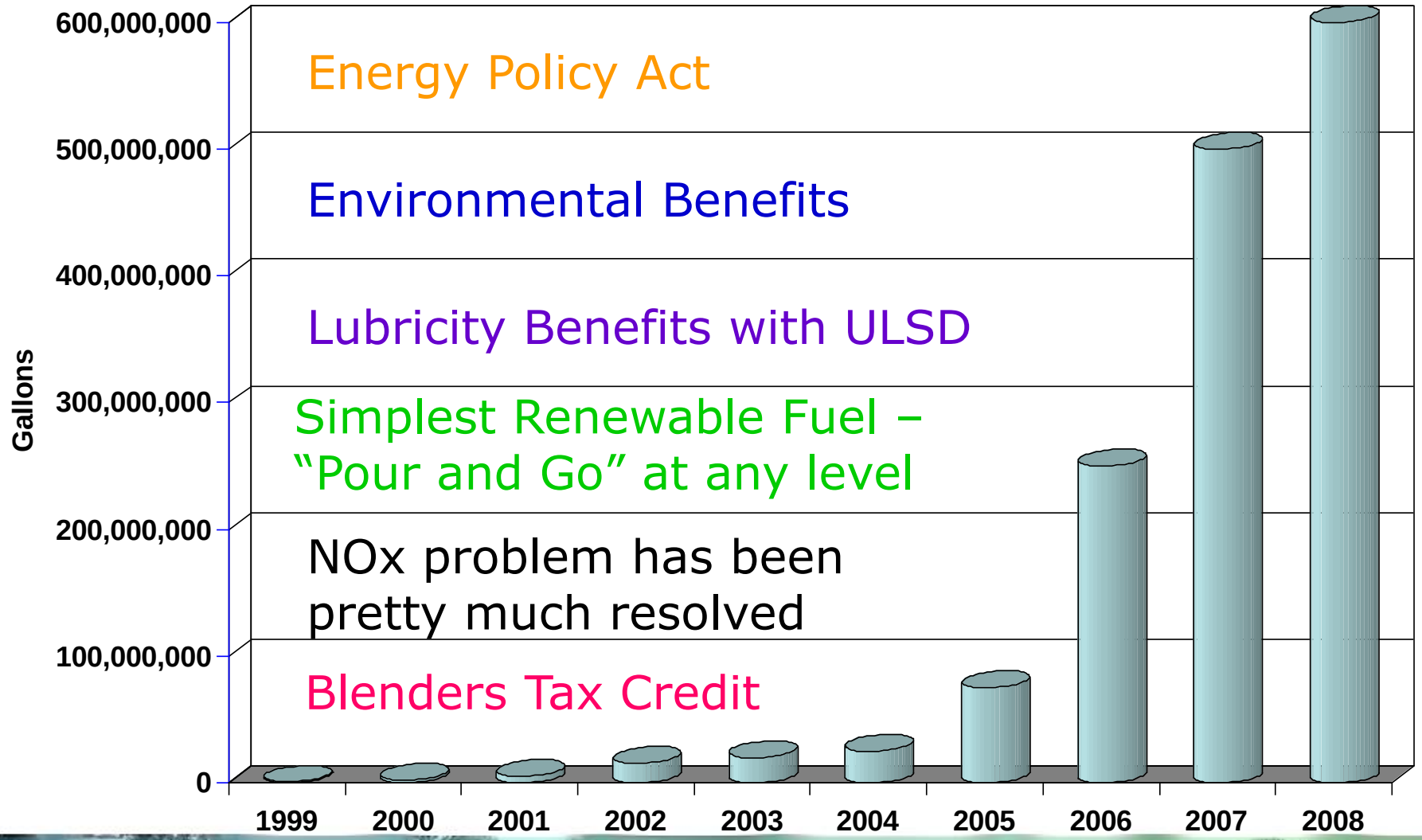
Emission Type	B100	B20	B2
Total Unburned Hydrocarbons	-67%	-20%	-2.2%
Carbon Monoxide	-48%	-12%	-1.3%
Particulate Matter	**-47%**	**-12%**	**-1.3%**
Oxides of Nitrogen (NO_X)	+10%	**+/-2%**	+.2%



Biodiesel and DPM Emissions



US Biodiesel Production



Biodiesel Feedstocks

Oils or Fats

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

High FFA

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







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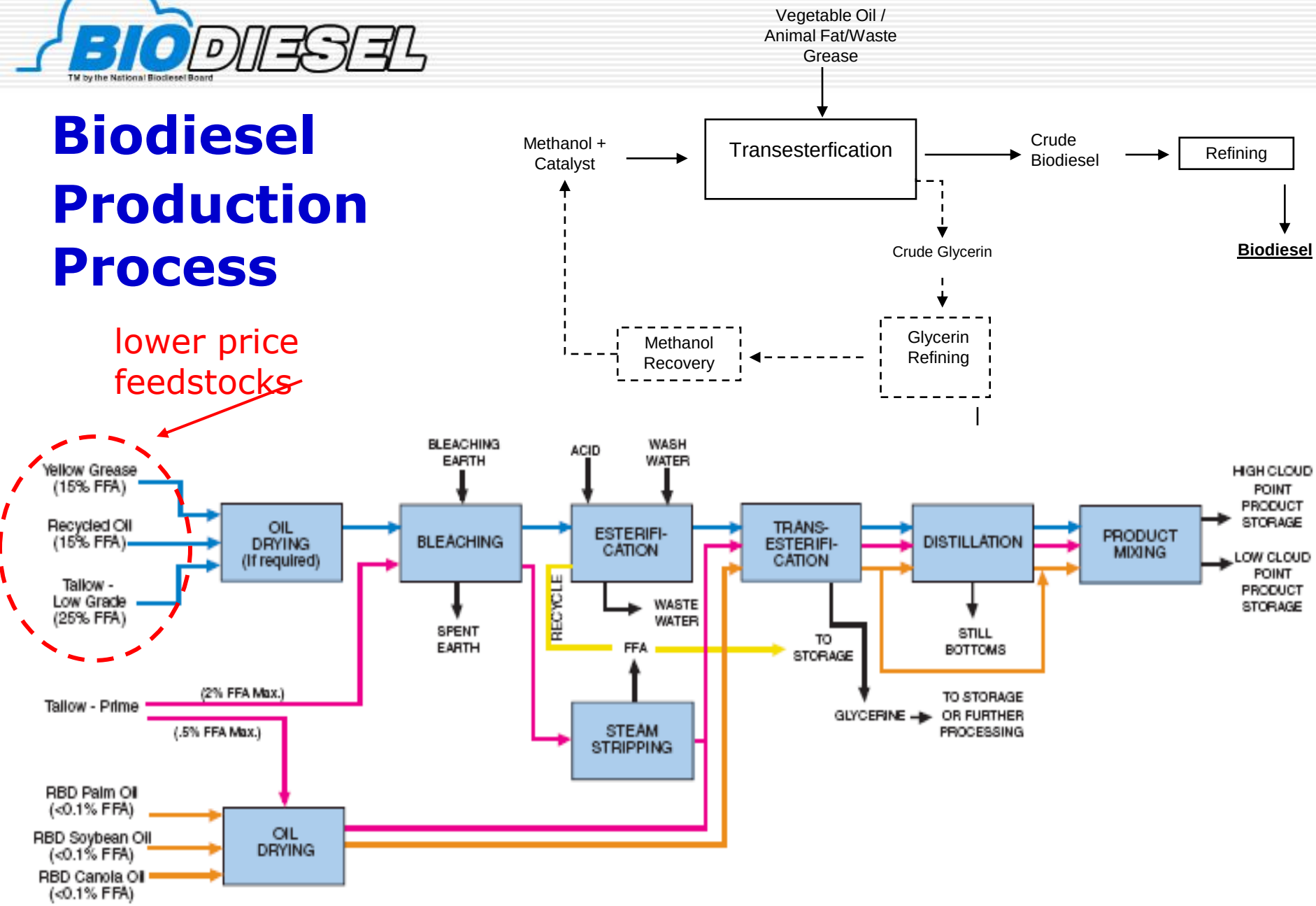
Biodiesel Production Process



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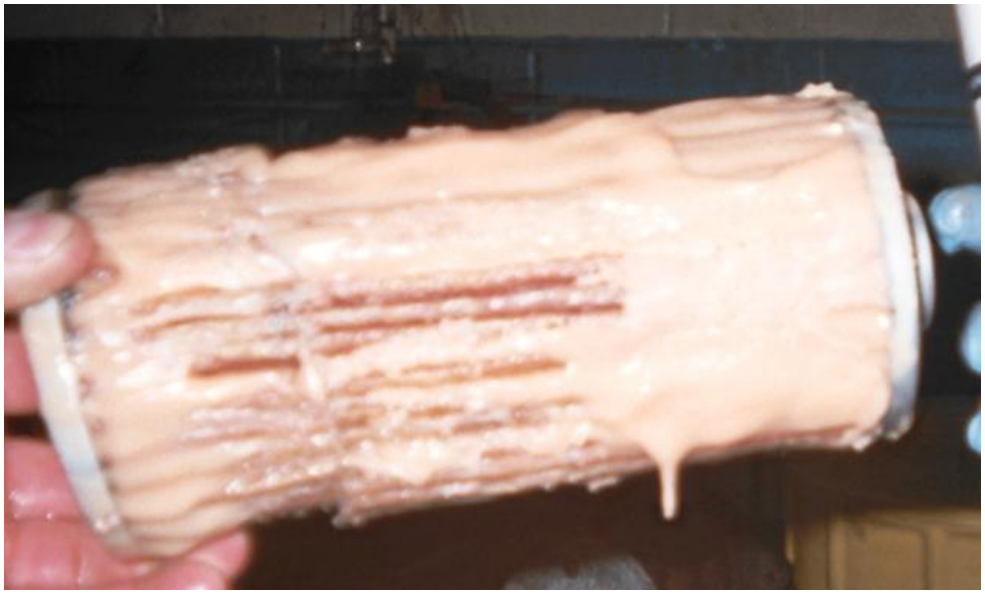
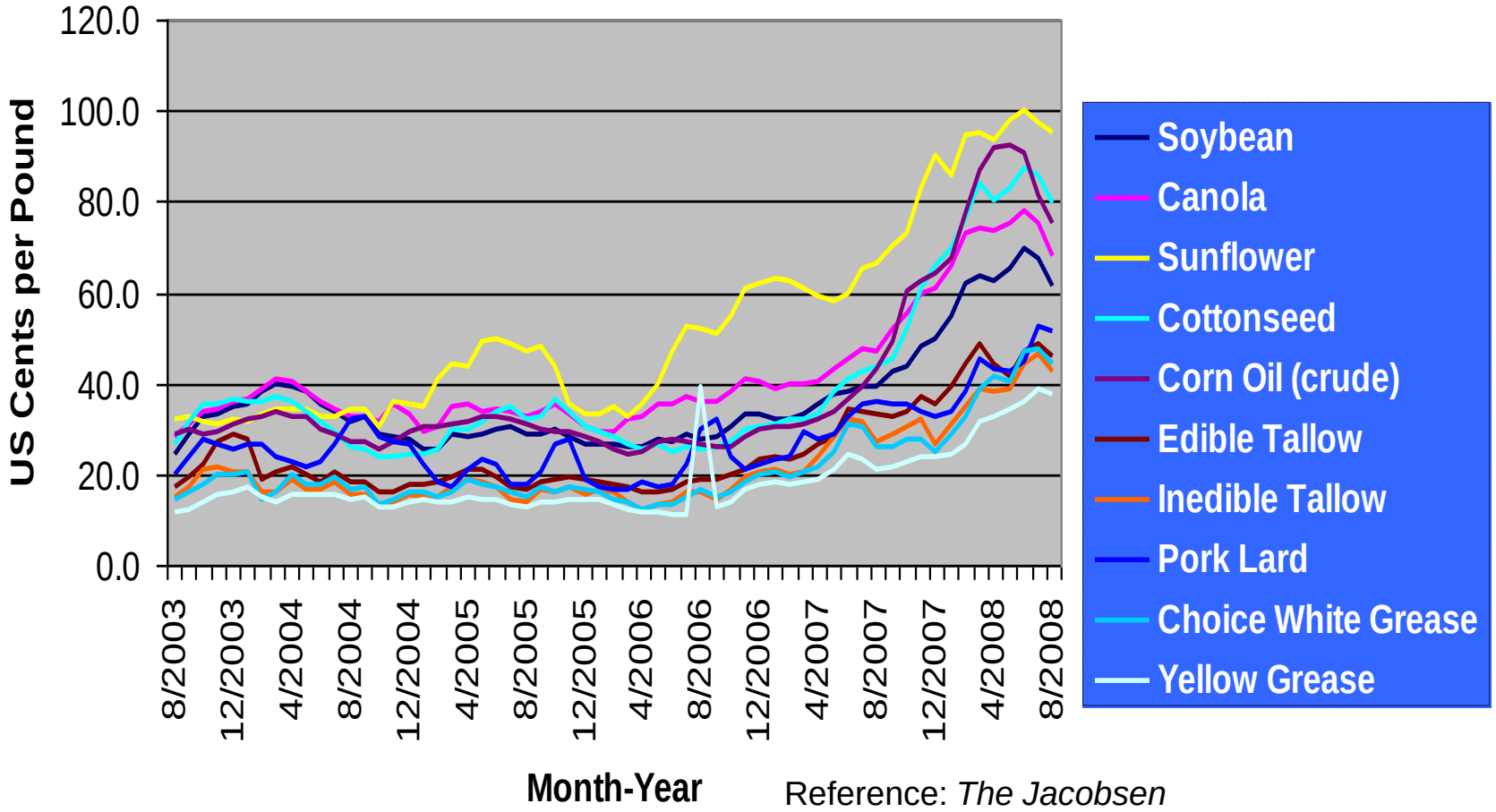


Biodiesel Feedstock Prices (8-03 through 8-08)



Reference: *The Jacobsen*

ASTM D 6751-07b Specifications (Full)

Free Glycerin	ASTM D 6584	Max 0.020 % mass
Total Glycerin	ASTM D 6584	Max 0.240 % mass
Flash Point (Methanol)	ASTM D 93	Min 130 °C (Max 0.2 % vol)
Acid Number	ASTM D 664	Max 0.50 mg KOH/g
Water & Sediment	ASTM D 2709	Max 0.050 % vol
Visual Appearance	ASTM D 4176	Max 2 Haze rating
Oxidative Stability	EN 14112	Min 3.0 hr
Sulfur	ASTM D 5453	Max 15 ppm
Cloud Point	ASTM D 2500	Report °C
Kinematic Viscosity at 40 C	ASTM D 445	1.9 – 6.0 mm^2/sec
Sulfated Ash	ASTM D 874	Max 0.020 % mass
Copper Strip Corrosion	ASTM D 130	Max No. 3
Cetane Number	ASTM D 613	Min 47
Carbon Residue for 100% sample	ASTM D 4530	Max 0.050 % mass
Distillation, 90% recovered	ASTM D 1160	Max 360 °C
Phosphorous Content	ASTM D 4951	Max 0.001 % mass
Relative density at 60 °F	ASTM D 1298	Report
Na and K, combined	EN 14538	Max 5.0 ppm
Ca and Mg, combined	EN 14538	Max 5.0 ppm

ASTM Current Status (summer/fall 2008)

- Changes to B100 Blend Stock, ASTM D6751
  - Better assessment of cold flow properties

- B5 into the petrodiesel and heating oil specifications with no changes to D975 and D396

- *B6 to B20 for on/off road diesel engines will be a stand alone specification*
  - Large fleets have stated they will begin using B20
  - Several OEM's have stated they will issue B20 support to their customers

Supply Chain Management

www.bq-9000.org

Accredited Producer Focus

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

Certified Marketer Focus

- 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

"cradle" → "grave"






Biodiesel adds significant lubricity to Ultra Low Sulfur Diesel (ULSD)

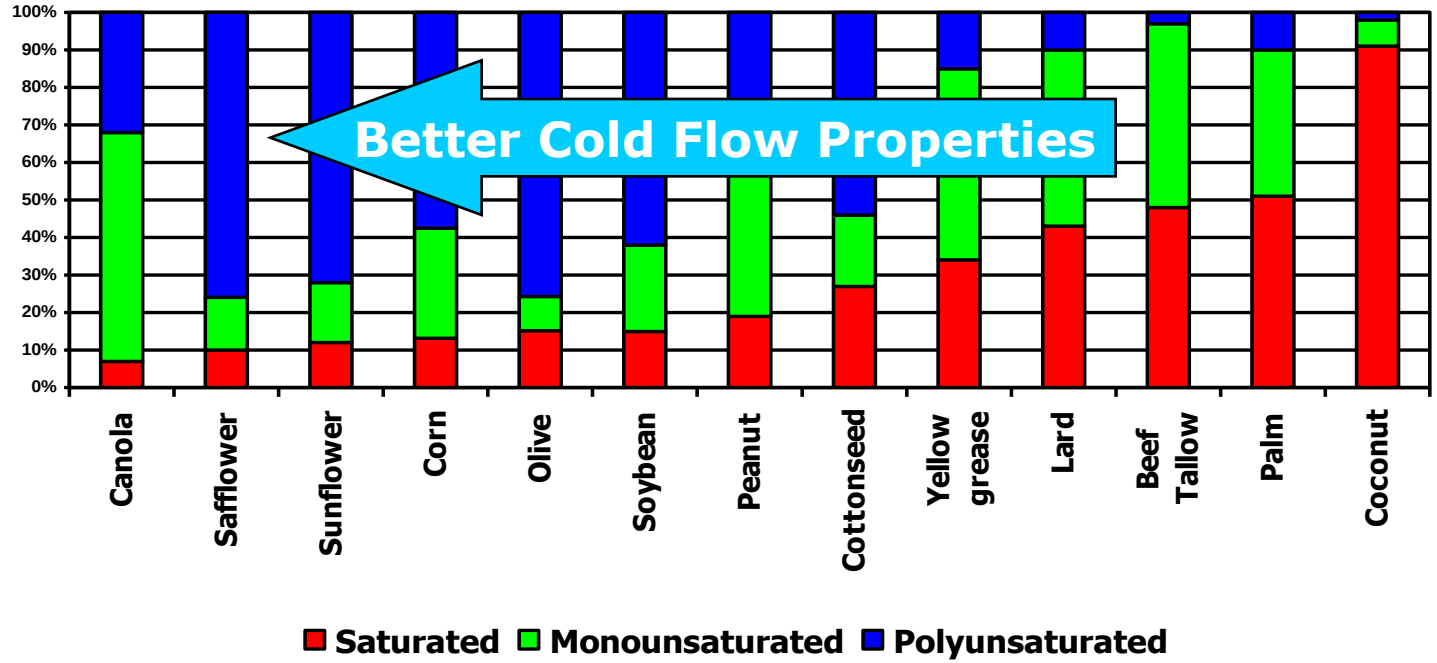
	% Biodiesel	Results (microns)
#2 ULSD	none	580
	B2	278
	B5	260
#1 ULSD	none	680
	B2	380

Minimum Wear = 520 microns

Off-Road ULSD by 2010

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



Biodiesel & New Diesel Technologies

- Biodiesel blends may provide SIGNIFICANT benefits with 2007 PM trap equipped engines
- 2% biodiesel restores the lubricity of the poorest lubricity ULSD petrodiesel
- 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.
  - B20 particles are different than petrodiesel particles

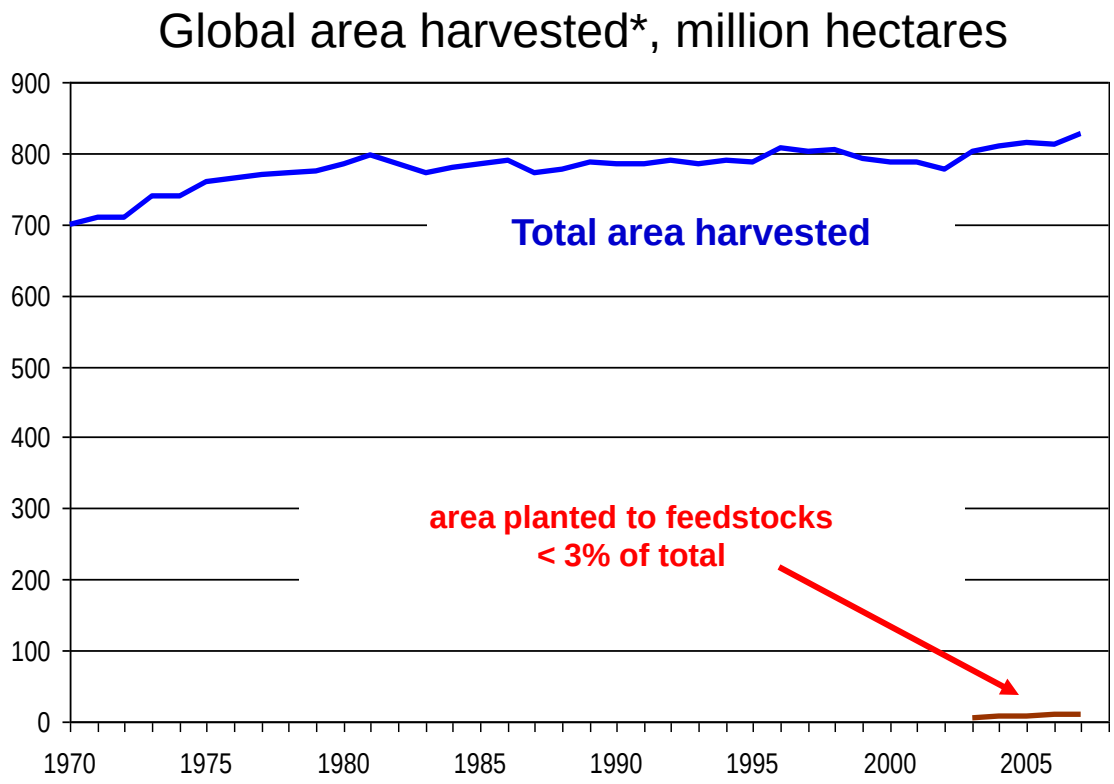
OEMs Positions on Biodiesel

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

OEMs want to see additional experience in the field, but expect new warranty statement with the new ASTM specs

"Food versus Fuel" debate
Biodiesel



* Wheat, Rice, Corn, Barley, Sorghum, Other cereals, Soybeans, Rapeseed, Sunseed, Cotton.

- The Federal Reserve Bank of Kansas City says, ...a 10 percent gain in energy prices could contribute 5.2 percent to retail food prices
- **12% of 2007 soybean production was for biodiesel and 81% was protein**
- **Other sources of feedstock are being used (waste greases, animal fats, corn oil)**

For more info on Biodiesel & Food Prices:

http://www.biodiesel.org/resources/sustainability/pdfs/FoodandFuelFactSheet.pdf