

Biodiesel Future Direction

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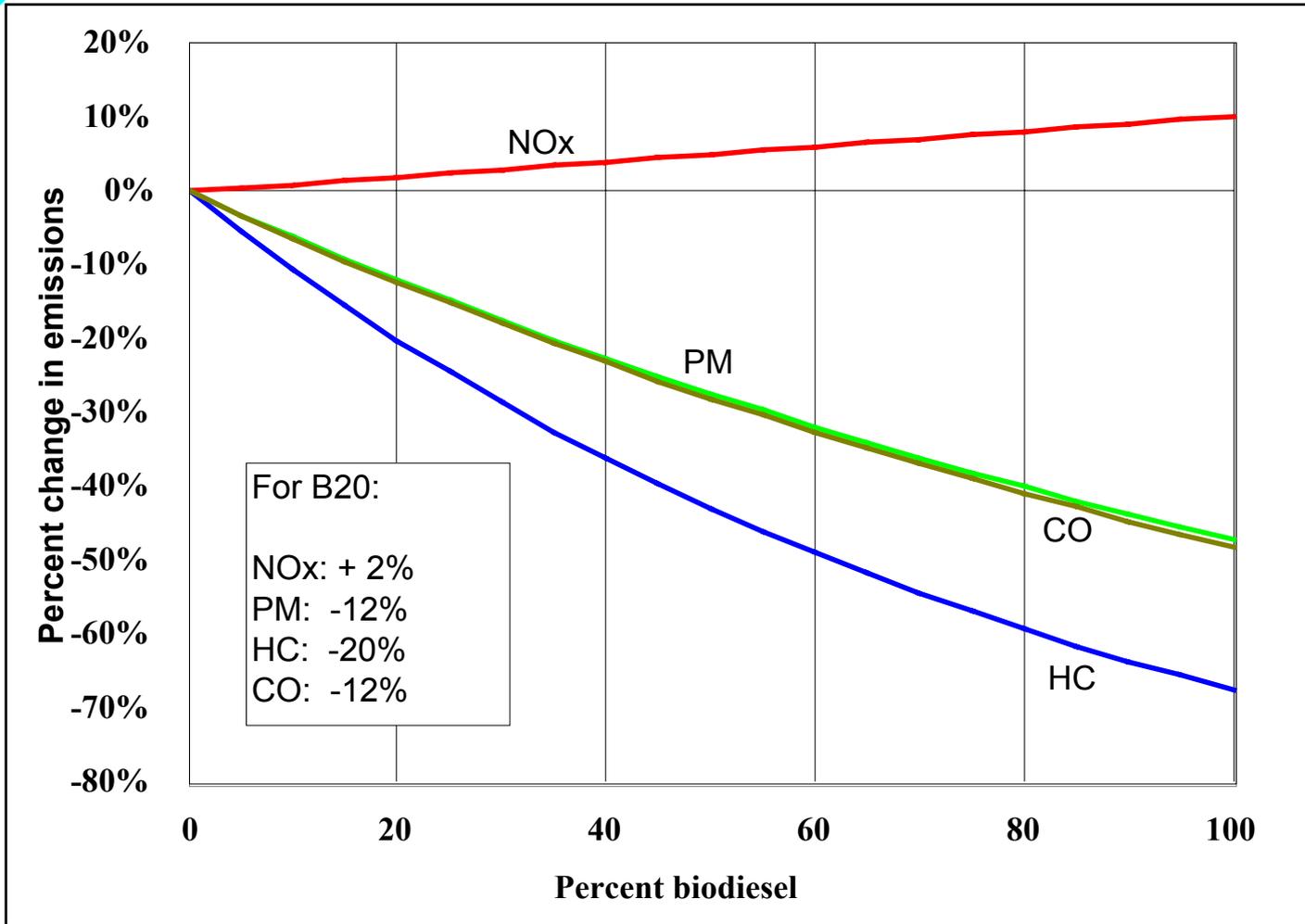


Biodiesel--Driving Forces

- ❖ Excess supply of fats and oils
- ❖ Desire to use cleaner burning fuels
- ❖ Desire to reduce dependence on imported crude oil and petrodiesel
- ❖ Desire to increase homeland security
- ❖ Performance advantages (lubricity, cetane)
- ❖ Ease of use, customers/mechanics like it
- ❖ Safety and handling (flash, biodegradable)



Basic emissions effects--EPA



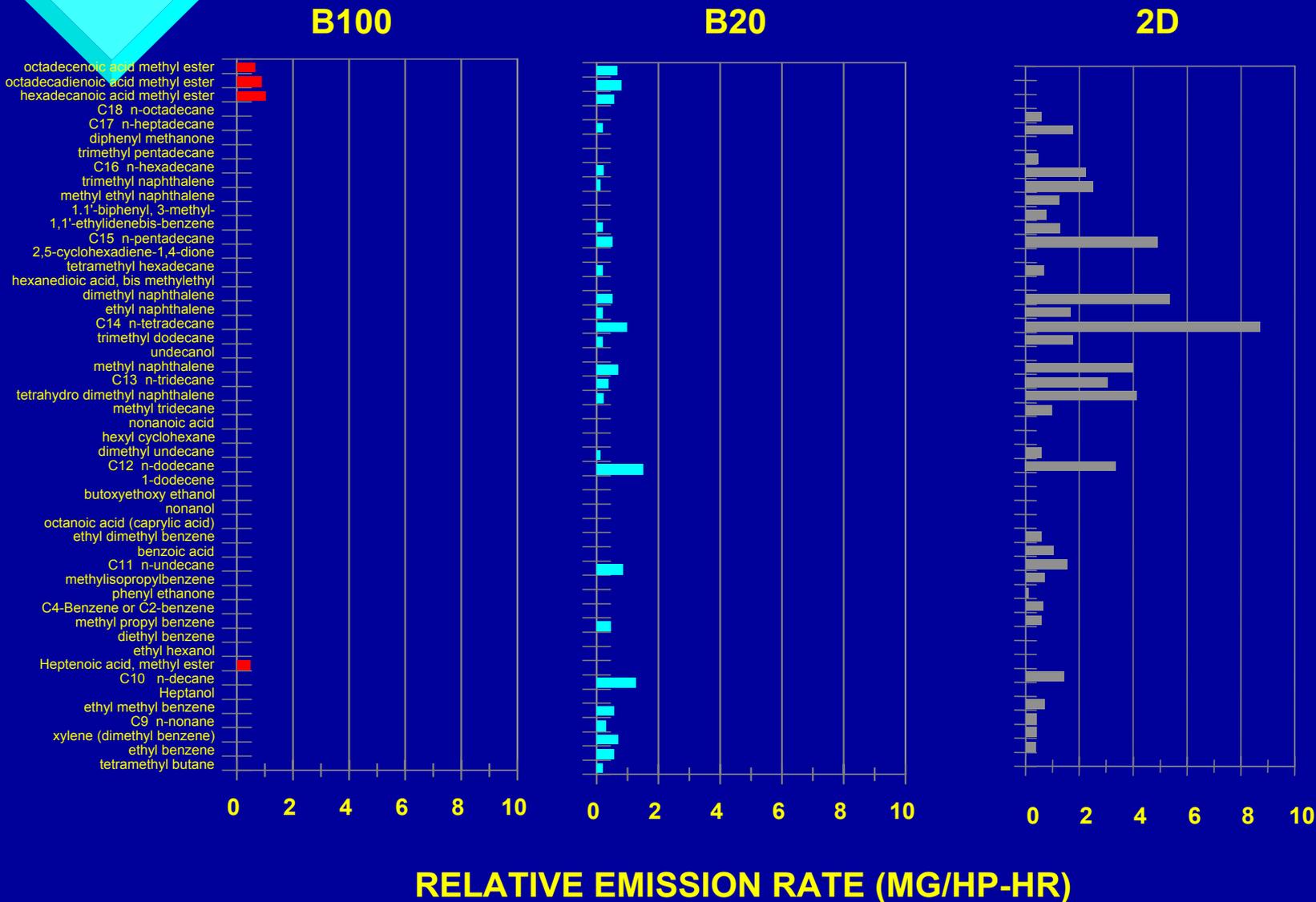


Tier 1 Biodiesel Speciation Papers

❖ SAE 2000-01-1967

❖ SAE 2000-01-1968

HEAVY HC SPECIATION - CUMMINS N14 ENGINE



RELATIVE EMISSION RATE (MG/HP-HR)



Biodiesel Tier 2 Background

- ❖ National Biodiesel Board Contracted with Lovelace Respiratory Research Institute (LRRI)
- ❖ Work Conducted at LRRI Jan-June, 1999
- ❖ Exposed 10 wk old F & M F344 rats
 - 6 hrs/day, 5 days/wk for 13 weeks
 - Whole diluted emissions, 1998 Cummins B5.9
 - 100 % biodiesel produced from soybean oil
 - 3 levels (H, M, L) plus negative control



LRRI-Biodiesel Tier 2 Results

- ❖ No Significant Exposure-Related Effects at ANY Concentration On:
 - Feed Consumption
 - Clinical Condition
 - Mortality
 - Ophthalmology
 - DNA (Micro-nucleus, Sister Chromatid)
 - Neural Parameters
 - Reproduction (Fertility, Teratology)



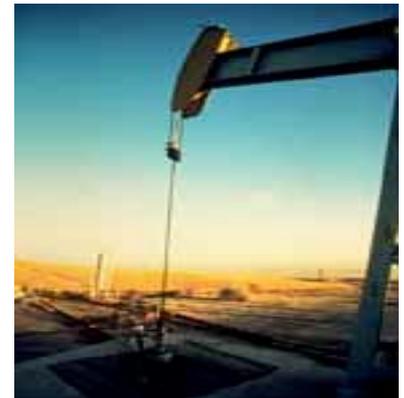
LRRI Biodiesel Tier 2 Conclusions

- ❖ Only Biologically Significant Biodiesel Exhaust Exposure Effect was a Small Effect in Lungs at the High Exposure Level:
 - Increased macrophages in M & F
 - Slight increase in F lung weight
 - Cellular changes in a few F

- ❖ Based on this, the No Observable Adverse Effects Level (NOAEL) was the Medium Level

Biodiesel and Energy Security

- ❖ Biodiesel is **MADE IN THE USA**
 - using USA produced fats and oils
- ❖ Don't have to send troops overseas to protect our biodiesel supply
- ❖ Biodiesel gives you 3.24 times as much energy out as you put in
 - Best of ANY liquid fuel
 - SOLAR energy--in a liquid form!



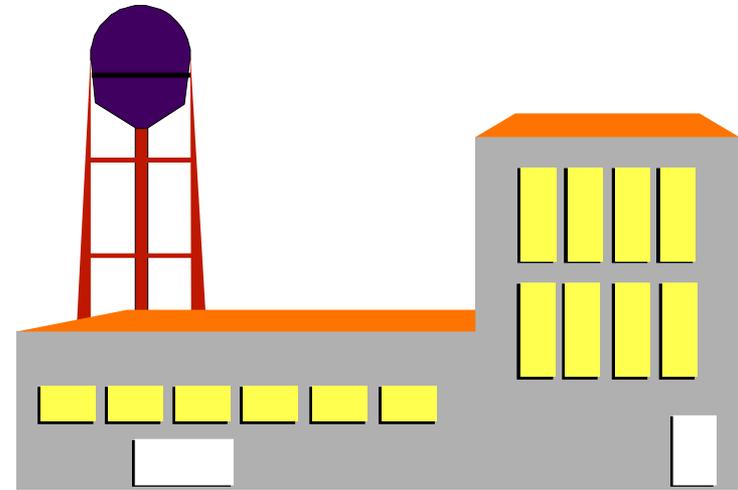


Biodiesel and Energy Policy

- ❖ **Local, Renewable, Sustainable Resource**
 - Can extend supplies of fossil fuels
 - Stable and reliable energy source
 - Highest energy balance of any liquid fuel: 3.24 to 1
- ❖ **Can Implement Blends Immediately**
 - Mixes easily and completely with diesel
 - Existing diesel engines, pumps, etc.
- ❖ **Used in Highest Efficiency Engine:**
 - Diesel engines 30% more efficient than gasoline
 - High biodiesel lubricity can enhance engine life

Biodiesel and Economics

- ❖ Creates Manufacturing Jobs, Enhances Economic Development
 - Most Likely in Rural Areas
- ❖ Reduces Energy Imports
- ❖ Improves Trade Balance
- ❖ Creates Expanded Markets for Agriculture





Biodiesel and Environment

- ❖ B100 is Biodegradable, Non-Toxic
- ❖ Reduces CO, HC, Particulate Matter (PM)
- ❖ No fuel sulfur or aromatics
 - Already meets new 2007 EPA diesel specs
- ❖ Reduces Cancer Potential
- ❖ Best Liquid Fuel for Global Warming:
 - Reduces Life Cycle CO₂ by 78%



Positive Attributes Recognized

- ❖ EPACT: ECRA modifications 1998
 - 450 gallons of B100 same as new AFV
- ❖ Executive Orders: 13101, 13134, 13149
- ❖ EPA School Bus Program
- ❖ State Legislation, 2003
 - Over 85 biodiesel bills in 33 states
 - Bills passed in 10 states as of May 2003
 - Supply, demand and infrastructure incentives



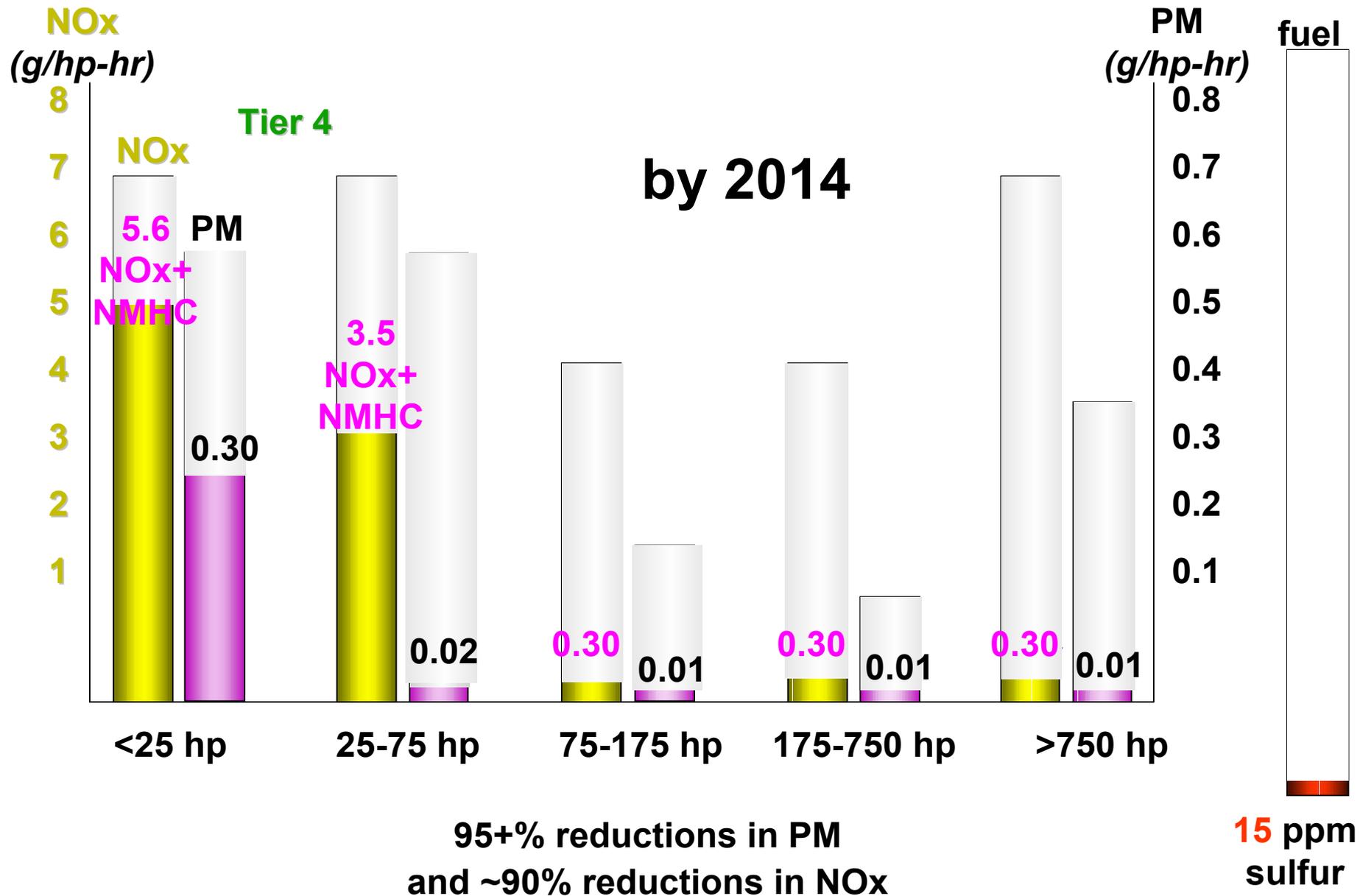
Senate Energy Bill, 2003

- ❖ \$1.00 per gallon incentive for each B100 gallon used in B20 blends or less (50 cents for recycled cooking oil biodiesel)
- ❖ Available for both on and off road diesel
 - Highway Trust Fund is NOT impacted
- ❖ Credit will go to the blender
- ❖ The following Senators have already joined Senators Grassley and Baucus as co-sponsors: Bingaman (D-NM), Bond (R-MO), Brownback (R-KS), Coleman (R-MN), Conrad (D-ND), Daschle (D-SD), Dayton (D-MN), DeWine (R-OH), Domenici (R-NM), Dorgan (D-ND), Durbin (D-IL), Frist (R-TN), Harkin (D-IA), Inhofe (R-OK), Jeffords (I-VT), Lincoln (D-AR), Nelson (D-NE), Talent (R-MO), Thomas (R-WY) and Voinovich (R-OH).



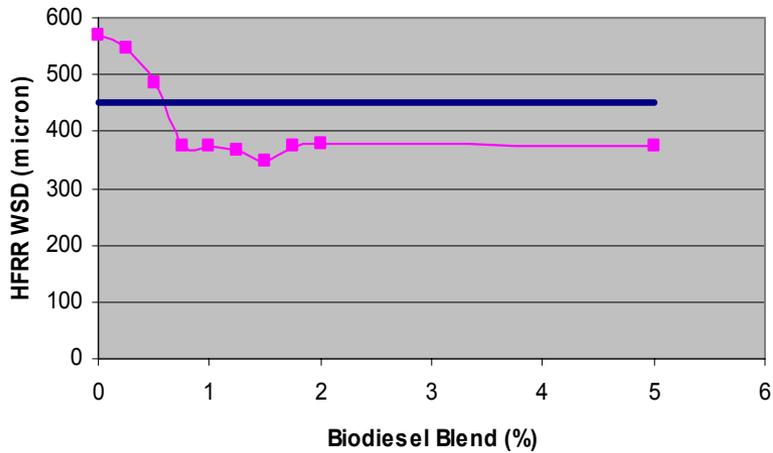
15 PPM Sulfur Diesel Fuel

- ❖ On-road diesel fuel will have 15 ppm sulfur maximum to enable diesel after-treatment devices
- ❖ In 2007, PM and NO_x emissions requirements reduced over 90%
- ❖ Most biodiesel is already less than 15 ppm sulfur content



Source: EPA

Ultra-low Sulfur Diesel



Paul Henderson, Stanadyne

Chair, ISO Diesel Lubricity Stds

Chair, SAE Fuel Lubricity Group

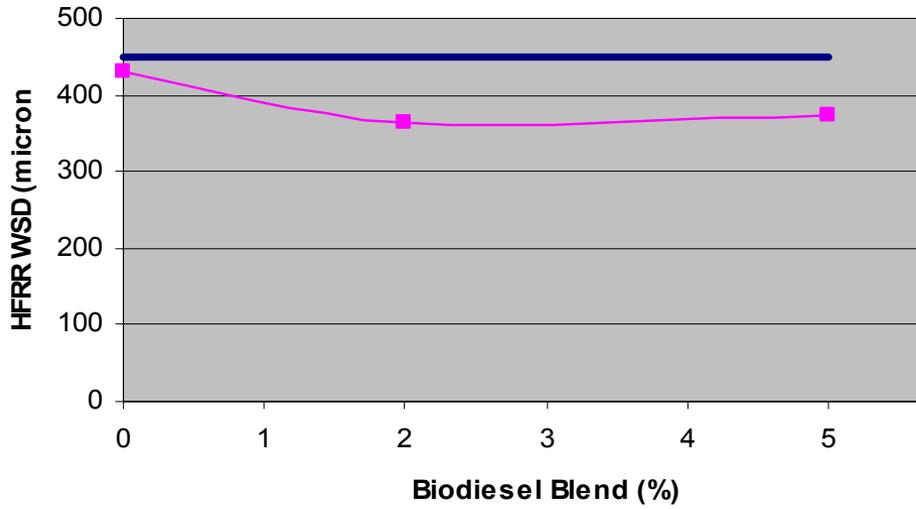
Comments to EPA 15 ppm sulfur
ruling:

“Indeed, the amount of hydrotreating necessary to achieve 15 ppm ... will require the use of lubricity additives.”

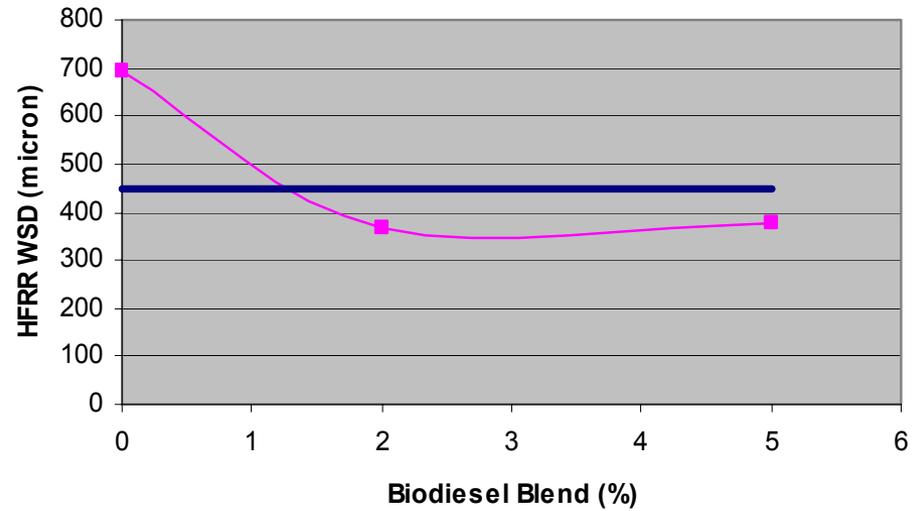
“...We strongly encourage EPA to consider the use of a low blend of biodiesel into the entire US diesel pool. Biodiesel itself is a clean burning, zero sulfur diesel fuel made from domestically produced renewable fats and oils and appears to fit in well with the goals and objectives of this proposed rule.”

- ***2% biodiesel enough to make any fuel fully lubricious***
 - ***eliminates inherent variability***
- ***Biodiesel fuel itself – no problems w/ overdosing***

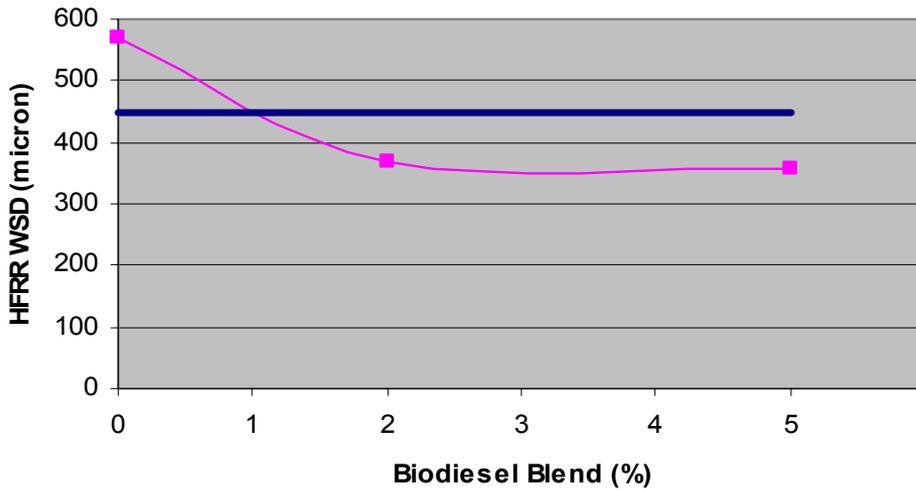
#2 Low Sulfur Diesel



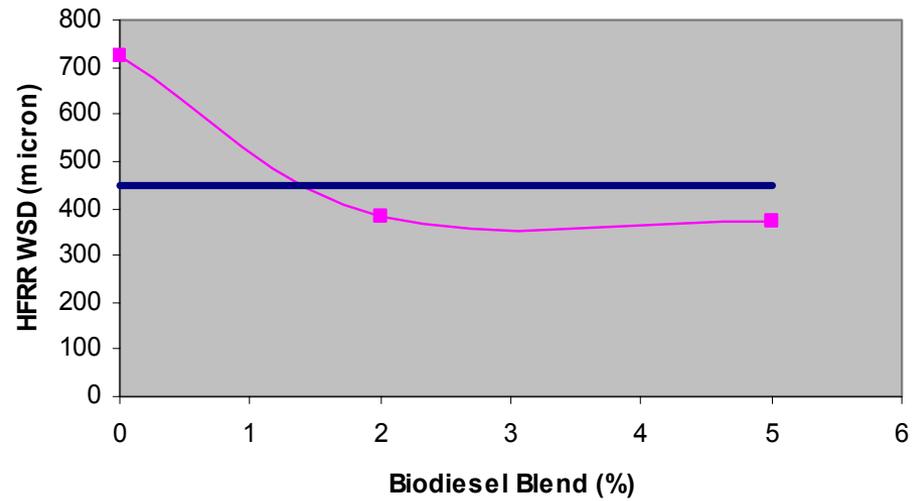
#1 Low Sulfur Diesel



Canadian #2 Winter Diesel



JP-8





Biodiesel and 15 ppm Diesel

- ❖ Already less than 15 ppm sulfur
 - Good for catalyst technology effectiveness
- ❖ Reduces PM emissions
 - Good for EGR
 - Good for catalyst technology (less loading)
- ❖ Solves lubricity problem with S15 diesel
- ❖ Inherently high (50+) cetane
- ❖ Helps enable 90% NO_x and PM reductions



US Industry Direction

- ❖ Incentives for Biodiesel Use:
 - National, State
 - Reduce the Cost Barrier
 - Major Player in National Energy Security
- ❖ Incorporate B2 on a Nation Wide Basis
 - Start with farming sector
 - Use incentives for national effort
- ❖ Increase use of B20
 - EPACT Fleets
 - School Buses



US Industry Direction

- ❖ Partnerships with Petroleum Industry
 - Incorporate biodiesel into infrastructure
 - Upstream fuel blending and delivery
- ❖ Partnerships with US Departments of Agriculture, Energy and Environment
 - Fully incorporate biodiesel into plans
- ❖ Partnerships with OEM's
 - Existing engines
 - Future engine designs and optimization