



SFR D-SOL

Multi-functional Diesel Fuel Conditioner



Report Outline

- Diesel Fuel Overview
- Properties of Diesel Fuel
- Premium Diesel Performance
 - Lubricity
 - Cetane Number
 - Corrosion
 - Fuel Detergency
 - Fuel Economy
 - Cold Weather Performance
 - Fuel Stability
 - Conclusions



Diesel Fuel Lubricity



Lubricity Requirement

- Lubricity is required to protect fuel injection systems
- Lubricity is measured as a function of wear
 - Measured by ASTM D 6079 – High Frequency Reciprocating Rig (HFRR)



Lubricity Requirement

- New revision to ASTM D 975 04b requires wear scar diameter of < 520 microns
 - Effective date of revision is 01/01/2005
 - Enforcement of ASTM D975 04b is at the State level. ASTM has no authority.
 - At last check, 26 states require diesel fuel to meet ASTM D 975 04b – 520 micron average scar wear diameter.

ASTM D975 5 Enforcement by State

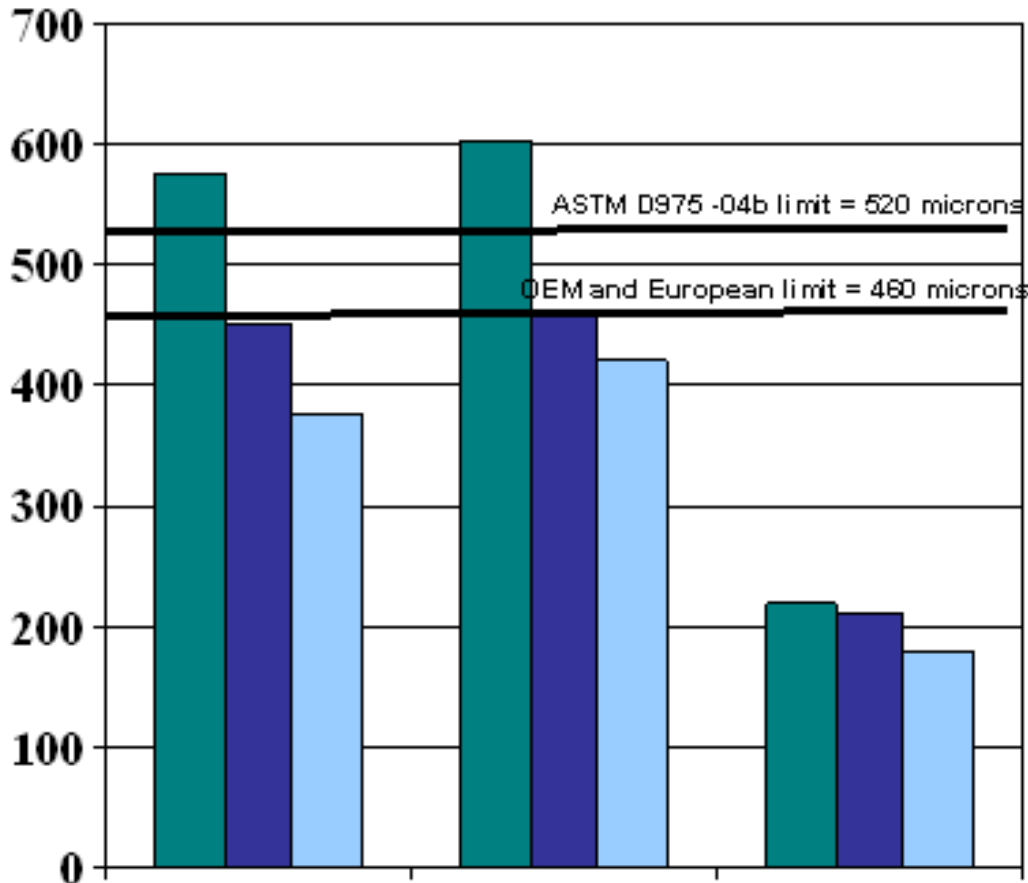
- Arkansas
- California
- Colorado
- Connecticut
- Delaware
- Florida
- Idaho
- Illinois
- Idaho
- Kansas
- Louisiana
- Maryland
- Michigan
- Mississippi
- Missouri
- Montana
- Nevada
- New Hampshire
- New Mexico
- North Carolina
- Oklahoma
- South Carolina
- Tennessee
- Washington
- West Virginia
- Wyoming



Reference: Al Mannato, API SD Conference, June 14, 2006 Washington, DC



Performance
Technologies
for a Clean Planet



Lubricity

- Blank
- D-SOL Lubricity / Cetane Fuel Conditioner
- D-SOL Multi-functional Diesel Fuel Conditioner

D-SOL Multi-functional Diesel Fuel Conditioner will meet the suggested wear requirements of OEMs



Benefits and Features of D-SOL Multi-functional Diesel Fuel Conditioner

- Enhance performance of fuels with poor lubricity characteristics
- Increase service life of fuel handling and metering systems
- Perform well on industry lubricity tests
- Demonstrated minimal interaction with basic system contaminants (lube oils and caustic)
- Excellent tolerance to water contamination
- Does not contribute to combustion deposits

D-SOL Multi-functional Diesel Fuel Conditioner meets “No Harm” requirements of diesel fuel additives



Cetane Number

Cetane Number

- High cetane fuels burn with a shorter ignition delay and lower peak pressure.
- High cetane fuels typically burn with less smoke and odor.
- Cold temperature starting is improved with high cetane fuels.
- Straight chain paraffins auto-ignite more readily than branched chain and aromatics of the same carbon number
 - ULSD fuels are expected to have higher cetane numbers than LSD or HSD



Cetane Number Improvement

Fuel	Baseline Cetane #	D-SOL MF Diesel FC Cetane #
Pipeline Spec/LSD	40	44
ULSD	40	44

D-SOL Multi-functional Diesel Fuel Conditioner can increase Cetane Number by up to 4 numbers



Corrosion Protection

Corrosion Protection

Fuel mixture	NACE Rating
LSD blank	C
ULSD blank	C
LSD with D-SOL Multi-functional Diesel Fuel Conditioner	A
ULSD with D-SOL Multi-functional Diesel Fuel Conditioner	A

D-SOL Multi-functional Diesel Fuel Conditioner improves the corrosion protection of diesel fuel



Detergency

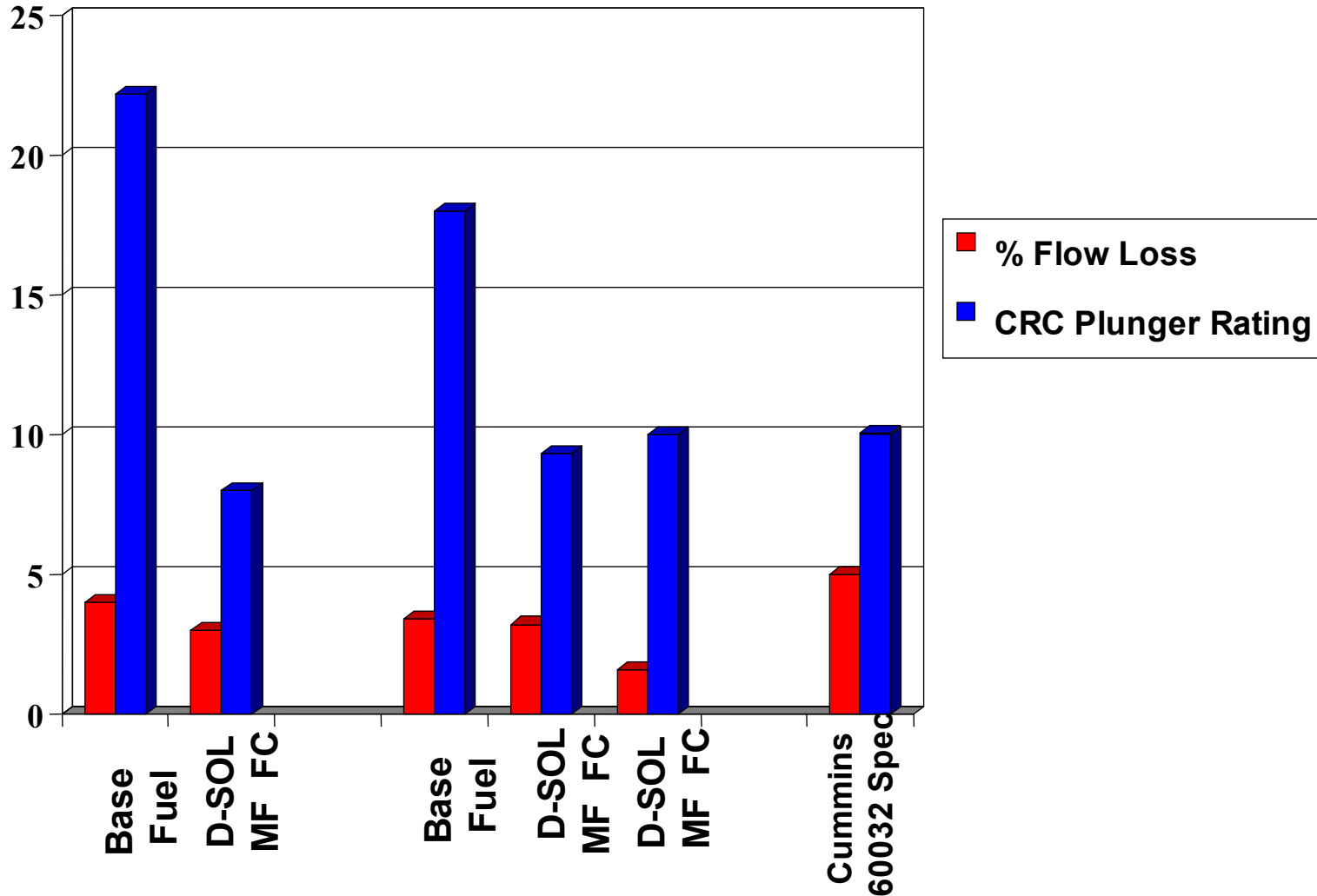


Fuel Detergency

- Detergents are used in diesel fuel to help control deposit formation on fuel injector nozzles and act to prevent corrosion of nozzle ports.
- Detergents also aid in preventing deposit and gum formation on high pressure fuel injector parts.
- Use of detergents in ULSD fuel will likely gain even more importance with the launch of the 2007 diesel engines designed specifically for ULSD fuel.

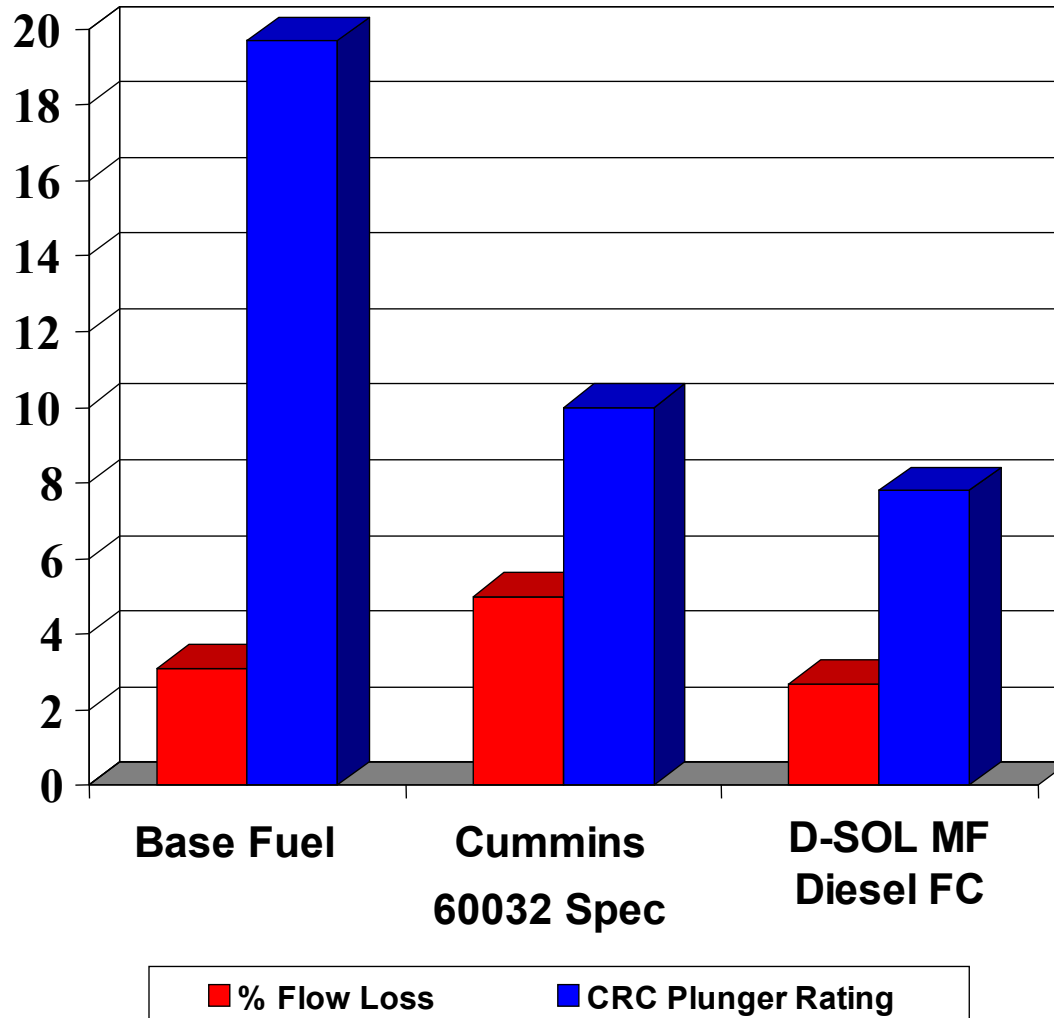
CUMMINS L-10

125 HOUR INJECTOR DEPOSITING TEST



CUMMINS L-10

125 HOUR INJECTOR DEPOSITING TEST





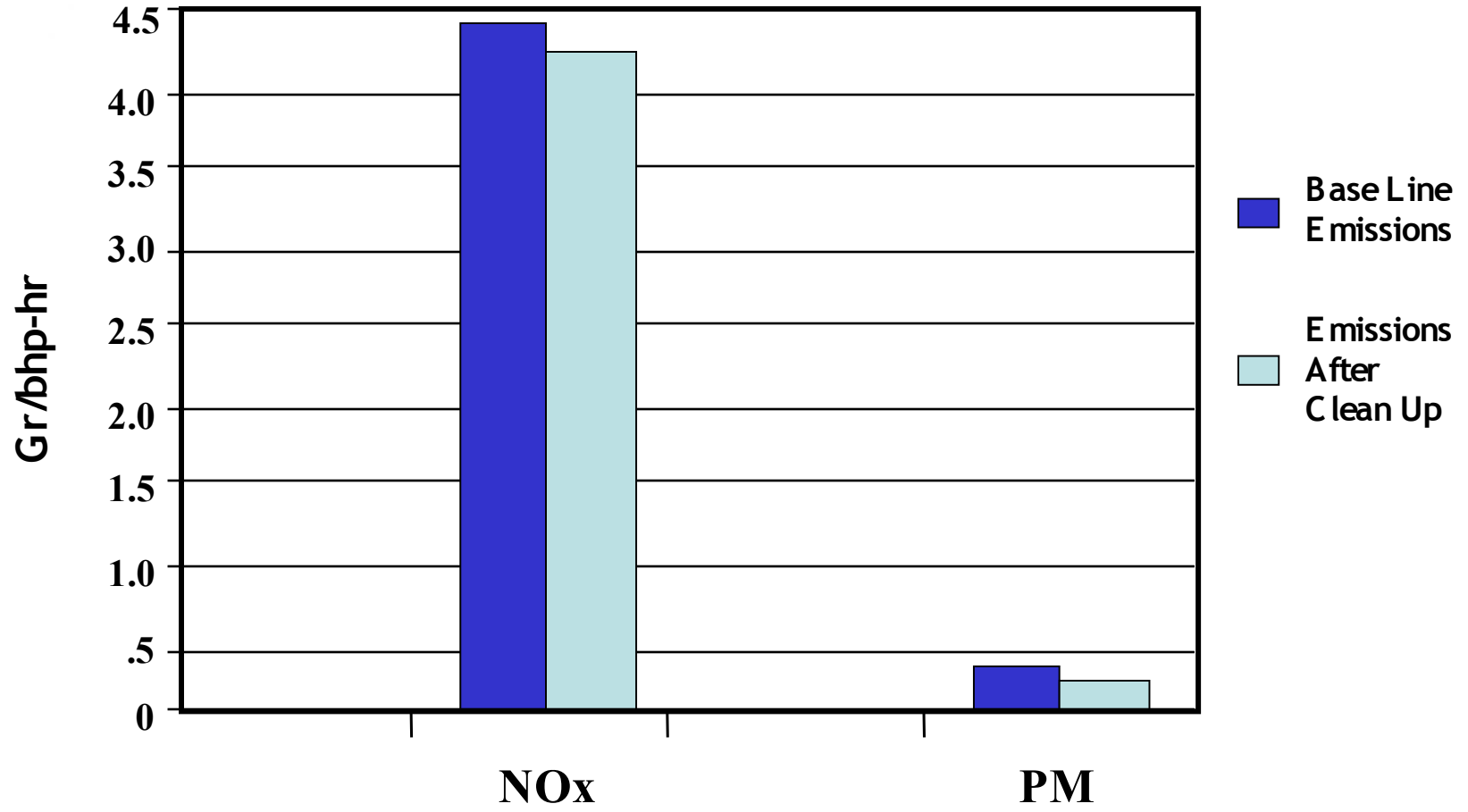
Fouled Direct Injector



Clean Direct Injector



Cummins L-10 Emissions Test Data

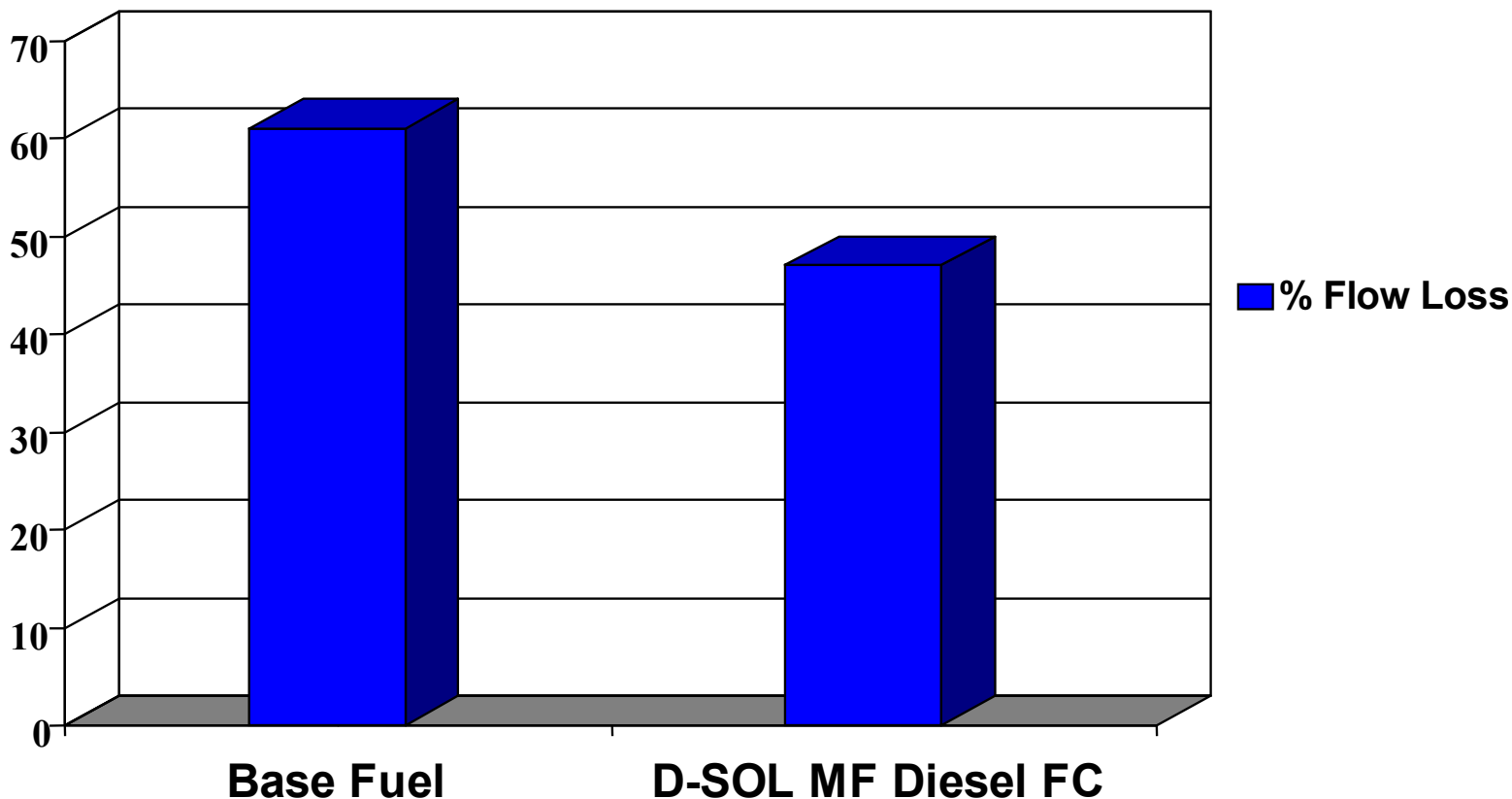


D-SOL Multi-functional Diesel Fuel Conditioner reduces emissions after clean up



Daimler Benz OM-616 Nozzle Coking Test

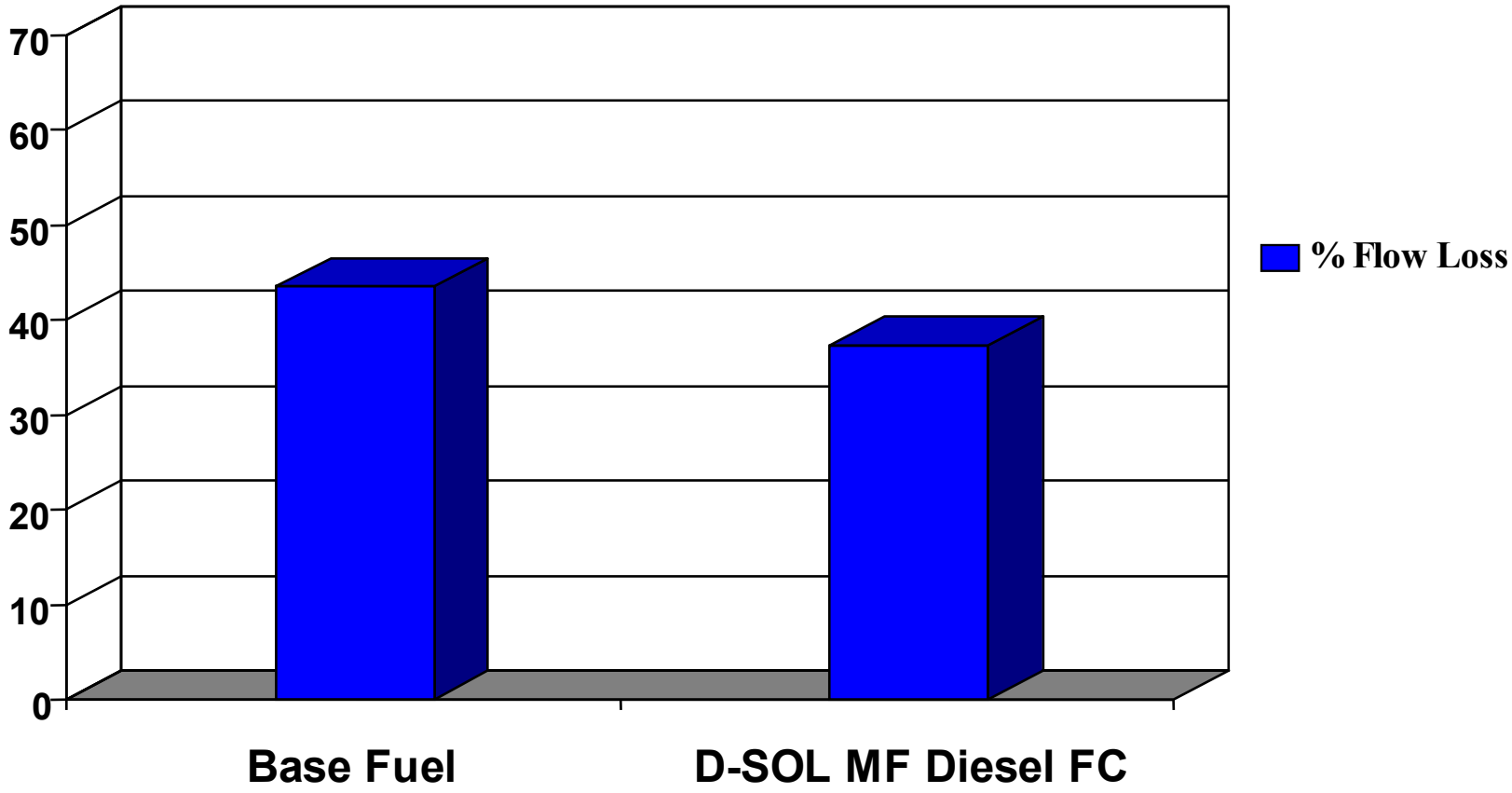
Light Duty Vehicle Injectors



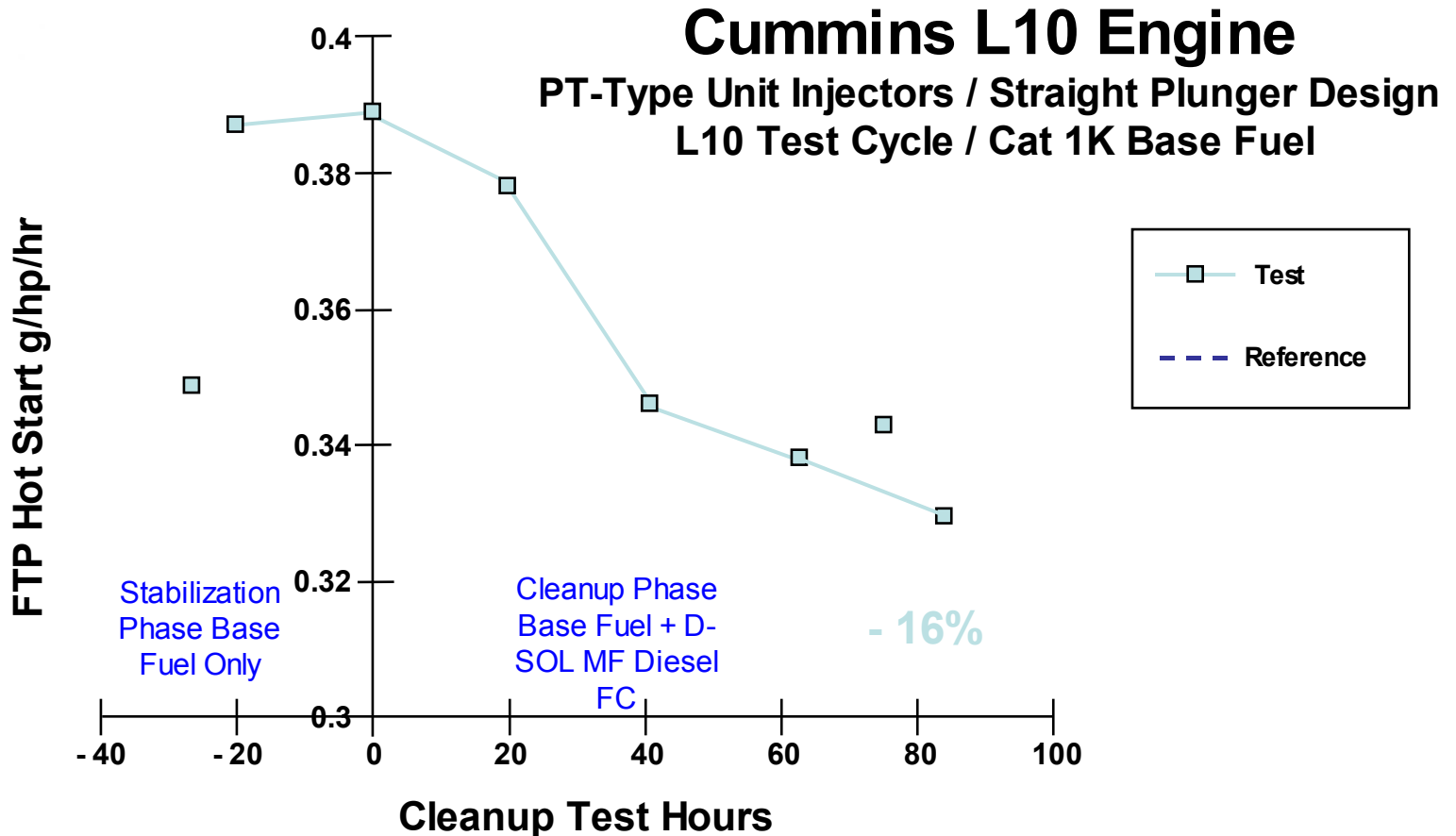


Mercedes Benz OM-602A Nozzle Coking Test

Passenger Car Injectors



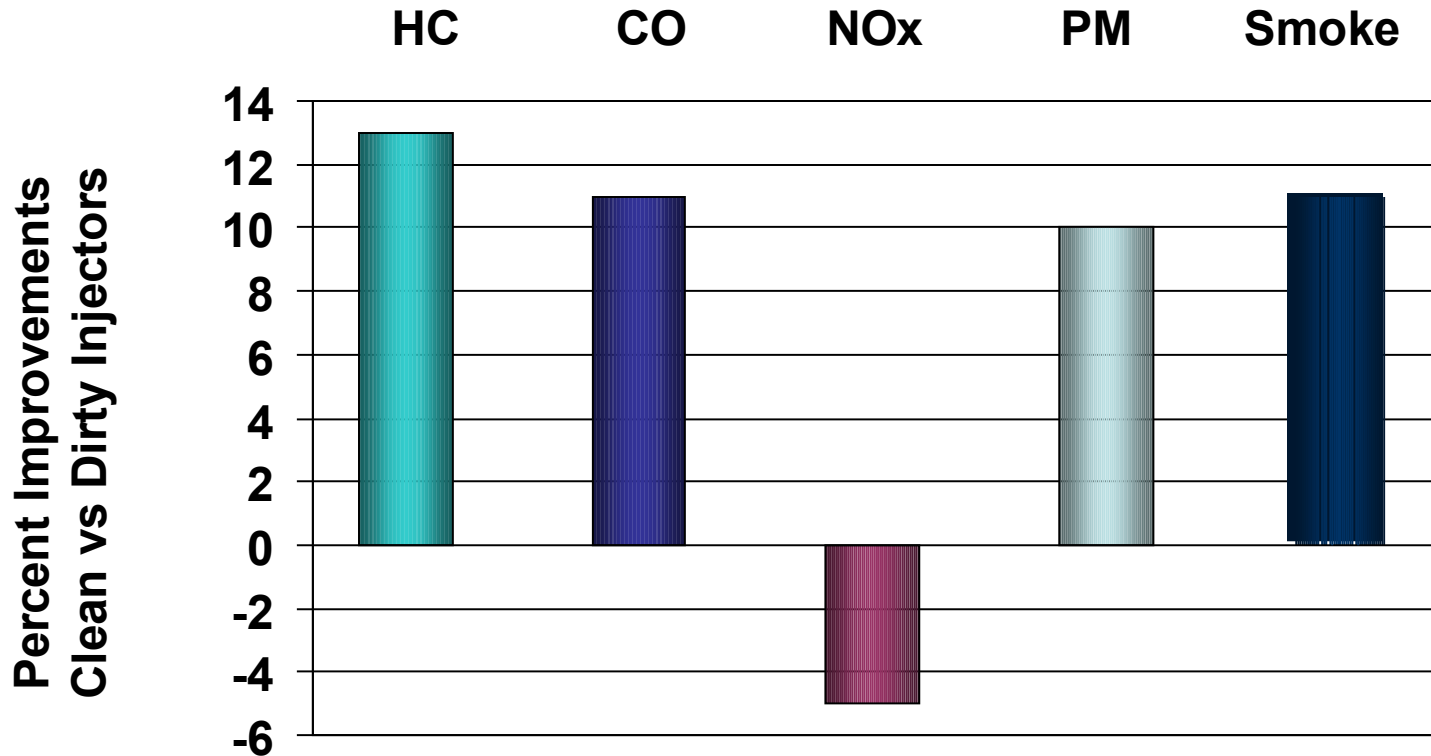
Particulate Emissions



**D-SOL Multi-functional Diesel Fuel Conditioner
reduces emission by 16%**



Improvement in Emissions based on Clean Vs. Dirty Injectors



Data Source: ASME paper "Automotive Diesel Emissions Durability Trends" by R.E. Olsen, et al, 1994



Fuel Economy



Fuel Economy

SFR's testing of D-SOL MF Diesel FC includes:

- Testing in Cummins L10 test engine
- US field testing in heavy duty truck fleet
- European field testing in light duty diesel fleets



Fuel Economy

- Testing in Cummins L10 test engine
 - Baseline (clean) injectors were 4.5% more fuel efficient than “worst-case” (dirty) injectors
 - Fuel economy improvement of 1.2% was observed in an engine with dirty injectors using 600 gallons of diesel treated with D-SOL MF Diesel FC @ clean up treat rate.
 - Injectors showed 9.5% CRC injector rating improvement & 8.0% in injector flow rate during clean-up test cycle



Fuel Economy

- US field testing
 - Heavy-duty truck fleet of 28 vehicles over a 2.5 year period
 - Fuel injectors used comprise ~ 90% of all on-highway, Class 8 vehicles
 - Individual trucks showed as much as 4.6% fuel economy improvement over base line mpg without D-SOL MF Diesel FC



Fuel Economy

- European testing
 - Two light duty fleets
 - 10 different vehicle types
 - 14 vehicles
 - Base line mileage was established in fuel w/o D-SOL MF Diesel FC
 - In one fleet, some vehicles achieved as much as a 14.7% improvement in miles per gallon
 - In the other fleet, some vehicles achieved as much as 10.3% improvement in miles per gallon



Fuel Economy

The improvement in fuel economy may be the result of the ability of D-SOL MF Diesel FC to “clean up” injectors



Cold Weather Operability



Low Temperature Performance of D-SOL Multi-Functional Diesel Fuel Conditioner

Blend	Pour Point, °F	CFPP, °F*
ULSD Baseline	-1	10
ULSD/D-SOL MF Diesel FC	-36	-22

* CFPP = Cold Filter Plugging Point

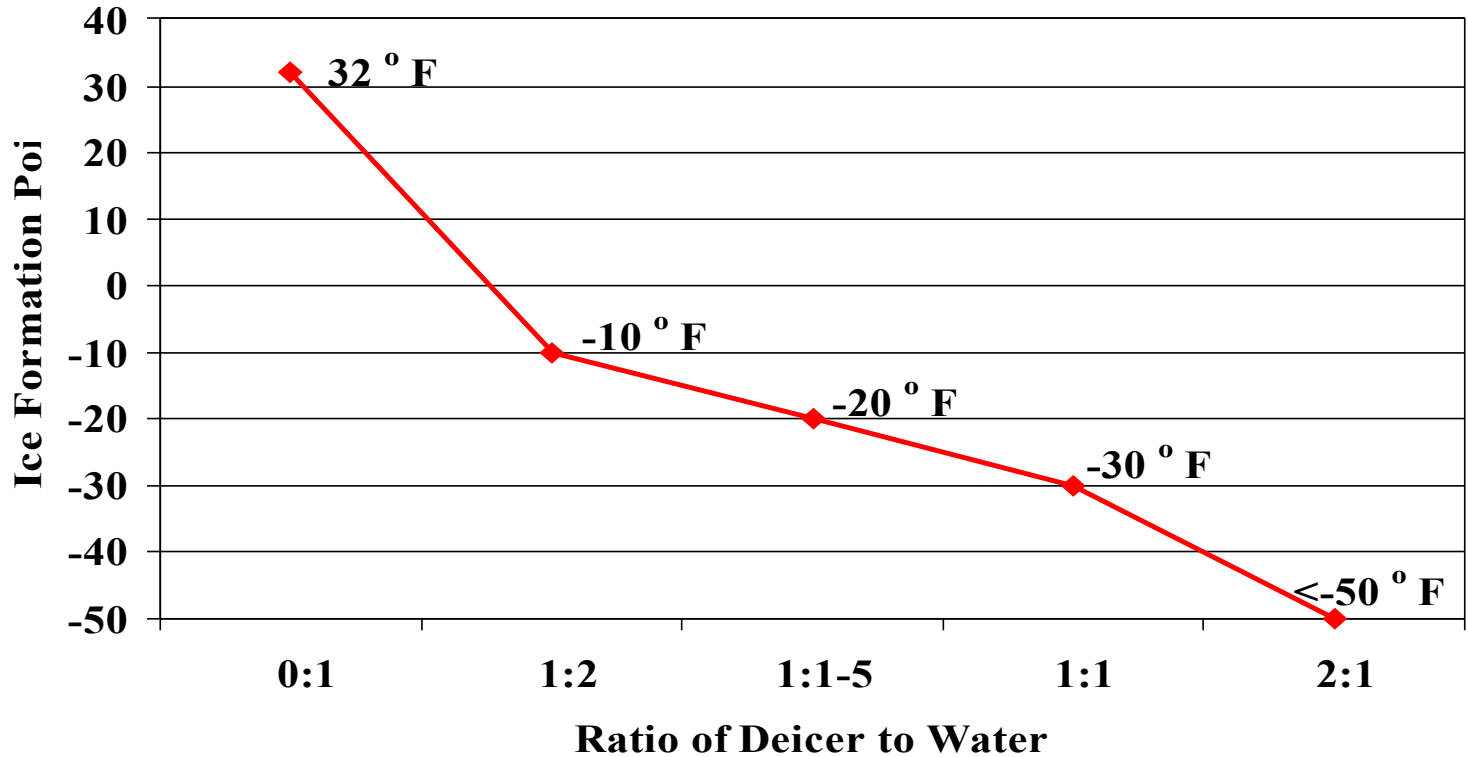
D-SOL Multi-Functional Diesel Fuel Conditioner improves low temperature characteristics of diesel fuel



Diesel Fuel De-icer Performance



Diesel Fuel De-icer Performance



D-SOL Multi-Functional Diesel Fuel Conditioner is effective in reducing ice formation



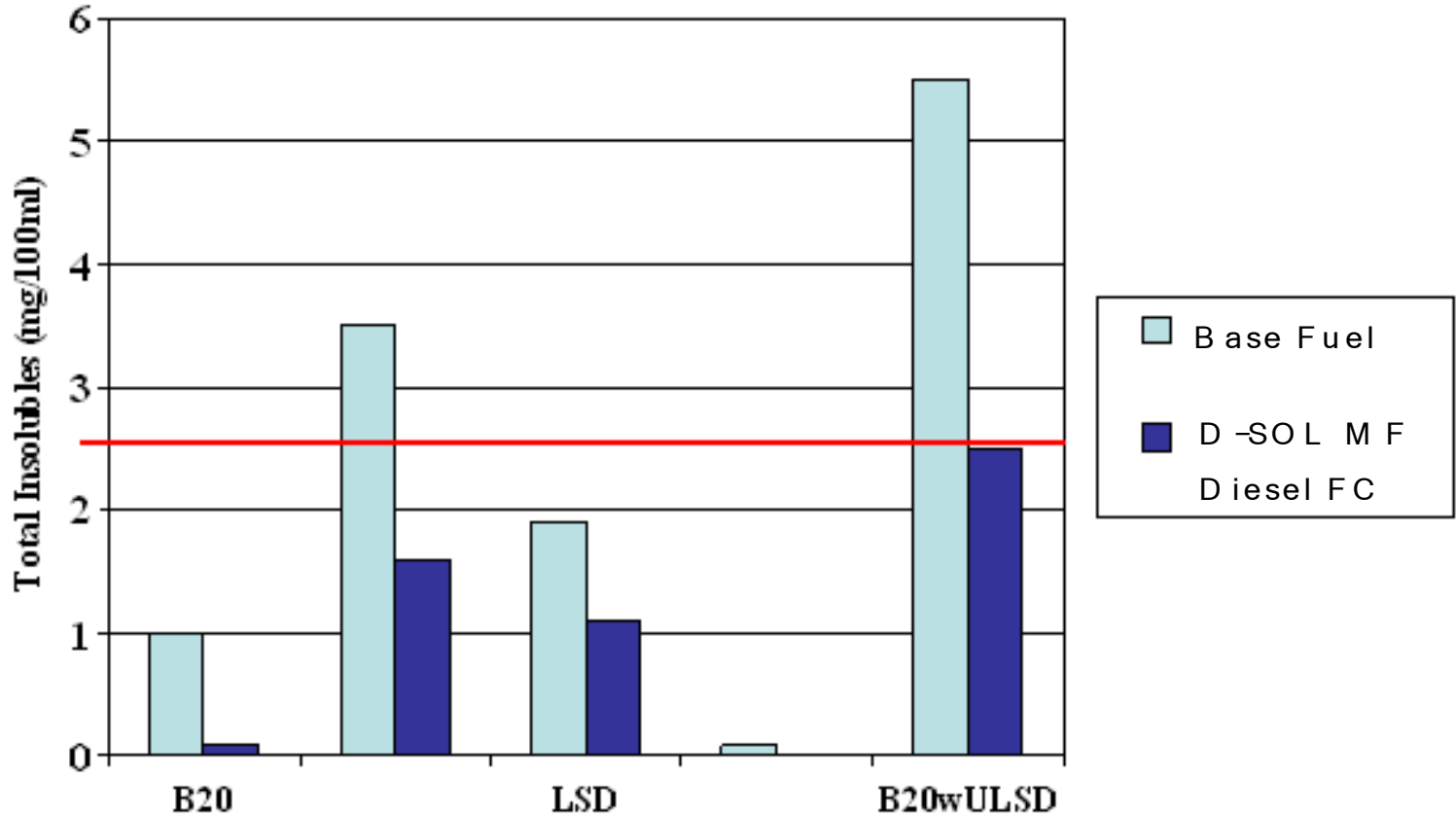
Diesel Fuel Stability

Diesel Fuel Stability

➤ Thermal Stability

- Unstable fuels will turn dark and produce gum forming residues. Filter plugging and poor performance will follow. Stabilizers are usually added to prevent this degradation.
- Literature reports suggest that the thermal/oxidative stability of ULSD fuel will not require additional stabilizer. ULSD fuel is highly paraffinic with very low aromatic and olefinic content.
- Work conducted by SwRI suggests that combinations of ULSD fuel combined with biodiesel fuel(B20) are unstable and difficult to stabilize. (SwRI – CRC report 2005)

Oxidation Stability (ASTM D2274)



**D-SOL Multi-Functional Diesel Fuel Conditioner
improves the storage stability of diesel fuel**

Conclusions

- D-SOL Multi-Functional Diesel FC will....
 - Meet the lubricity requirements suggested by the OEMs
 - Improve Cetane Number by up to 4 numbers
 - Provide engine clean up and keep clean performance
 - Improves fuel economy
 - Reduce emissions

Conclusions

- D-SOL Multi-Functional Diesel FC will....
 - Provide excellent corrosion protection
 - Reduce Pour Point by up to 35 degrees
 - Reduce CFPP by up to 32 degrees
 - Provide de-icing protection down to $<-50^{\circ}$ F
 - Improve fuel stability