Impact of Fuel-Borne Catalysts on Diesel Aftertreatment

David Human

DEER Conference
August 25th, 2003
MMT Additive for Improved Performance of Diesel Aftertreatment Systems

- Diesel Particulate Filter (DPF) with Several Fuel-Borne Catalysts
- Catalyzed DPF Project with Cummins
- Field Test Data
- Diesel NOx Adsorber Catalyst (NAC)
- Summary
M11 - 380C Regeneration Mode

![Graph showing DPF DP (kPa) with different catalysts: Cerium, ULSD Base, Cerium/Platinum, Ferrocene, Cerium/Iron, MMT.](graph.png)
Cummins ISB 5.9 in Test Cell
Diesel Aftertreatment Rack
Cummins ISB Steady-State DPF Loading

Catalyzed DPF Backpressure Loading Trends During Loading Sequence

Base fuel Trend:
\[ y = 0.0222x + 1.153 \]

MMT fuel Trend:
\[ y = 0.0175x + 1.1347 \]
Stepped Balance Point Temp Test

MMT and Base Fuel Stepped Balance Point Comparison
1500rpm 42 Hour Loading & 20-min Average Data
DECSE Presentation Method

Inlet Temp, °C

Trap Delta P, kPa

Base Inlet Temp
MMT dP
Base dP
Balance Point Slope Plot

MMT and Base Fuel Stepped Balance Point Comparison
1500rpm  42 Hour Loading & 20-min Average Data
Cummins Differential Presentation Method

~22°C Difference
Steady-State Regeneration Mode

50-Minute Trap Regeneration at 350°C
Cummins (Bus) Transient Cycle Loading

Exhaust Back Pressure, kPa

0.36 kPa per day rate of increase

0.16 kPa per day rate of increase

Exhaust Gas Inlet T (°C)

MMT EBP
Base EBP
MMT EGT
Base EGT
PM Emissions – Transient Cycles

No Mn is emitted at the tailpipe when using MMT with a DPF
DPF Mounted Underbody
Base Fuel - Delta Pressure vs. Mileage

3,100 miles
MMT Fuel - Delta Pressure vs. Mileage

Update 8/22/03 Currently at 15,000+ miles with no change in slope
Many current and proposed aftertreatment technologies are negatively affected by Phosphorous and Sulfur.

- Sulfur will continue to exist in most diesel fuels at some level even after 2007.
- P & S chemistry will continue to be used in crankcase lubricating oil to prevent wear and oxidation possibly at reduced levels.
- One solution involves scavenging P & S with additives before interaction with aftertreatment.
Manganese from combustion of MMT interacts with sulfur species in the exhaust to form Mn sulfate which is stable below 500°C.
Supplemental Fuel System for NOx Regens
NAC Conversion Efficiency vs Time

Slope of Base Fuel Line = -0.41

Slope of MMT Fuel Line = -0.19
Fuel Borne Catalyst Summary

Use of MMT in Diesel Fuel Improves Aftertreatment Performance

Phosphorous and Sulfur scavenging have been demonstrated in multiple diesel engines. Aftertreatment protection from P & S helps to preserve catalyst conversion efficiency.

- Higher lifetime catalyst efficiency will allow optimization of emission control systems.
MMT – Diesel Particulate Filters

MMT decreases the rate of soot accumulating in a DPF. There is also a significant reduction in soot oxidation temperature leading to earlier and more complete regeneration.

- Resulting lower average exhaust back pressure improves fuel economy
- Can reduce the need for heat addition to regenerate DPFs resulting in reduced fuel consumption penalty

For more details on the joint Cummins/Ethyl DPF research look for SAE 2003-01-3145 at the Fall Powertrain and Fluids Conference
Ethyl R&D continues to study fuel borne catalysts in current and advanced technology diesel engines

- Additional benefits of the fuel additive MMT in diesel have been discovered in bench tests and are being confirmed in engine tests

- Not all fuel borne catalysts are the same!