

Technology Forcing LEV II Standards Require Fuel Formulation Changes as Enabler

GASOLINE PROPERTIES FOR LEV II

CALIFORNIA LEV II ISSUE	GASOLINE PROPERTY ENABLER
0.010 g/mi NMOG (SULEV)	Lower Sulfur Aromatics Control Volatility Control
0.05 g/mi NO _x (LEV/ULEV)	Lower Sulfur, Lower Olefins Deposit Control Narrow band of oxygen content
0.01 g/mi PM ₁₀	Lower Sulfur Deposit Control Heavy Aromatics
120,000 Mile Durability (150,000 Mile Optional)	Lower Sulfur Deposit Control
Trucks to Car Standards	Lower Sulfur Deposit Control Volatility Control
OBD II Monitors	Lower Sulfur Volatility Control
SFTP	Lower Sulfur Volatility Control Narrow band of oxygen content
"Zero" Evap. and Refueling	Control of RVP, T ₁₀ , T ₅₀ No Waivers for RVP, T ₅₀ , T ₁₀ , or T _{(V/L)=20} for EtOH
Exhaust Reactivity	Lower olefins Poly-substituted aromatics control

% Emissions Increases with “DI-Compromised” Engine Calibrations

	NMHC	CO	NO _x
Mfgr. 1	15.5	14.2	0.0
Mfgr. 1	19.6	29.7	3.0
Mfgr. 1	31.3	277	15.2
Mfgr. 1	25.9	21	(50)
Mfgr. 2	67.8	77.6	89.7
Mfgr. 3*	12.9-48.7	5.9-36.3	4.7-(0.7)**
Mfgr. 3*	6.7-25.2	67.1-114.9	(1.1)-(5.4)**
Mfgr. 4	55	71	(17)

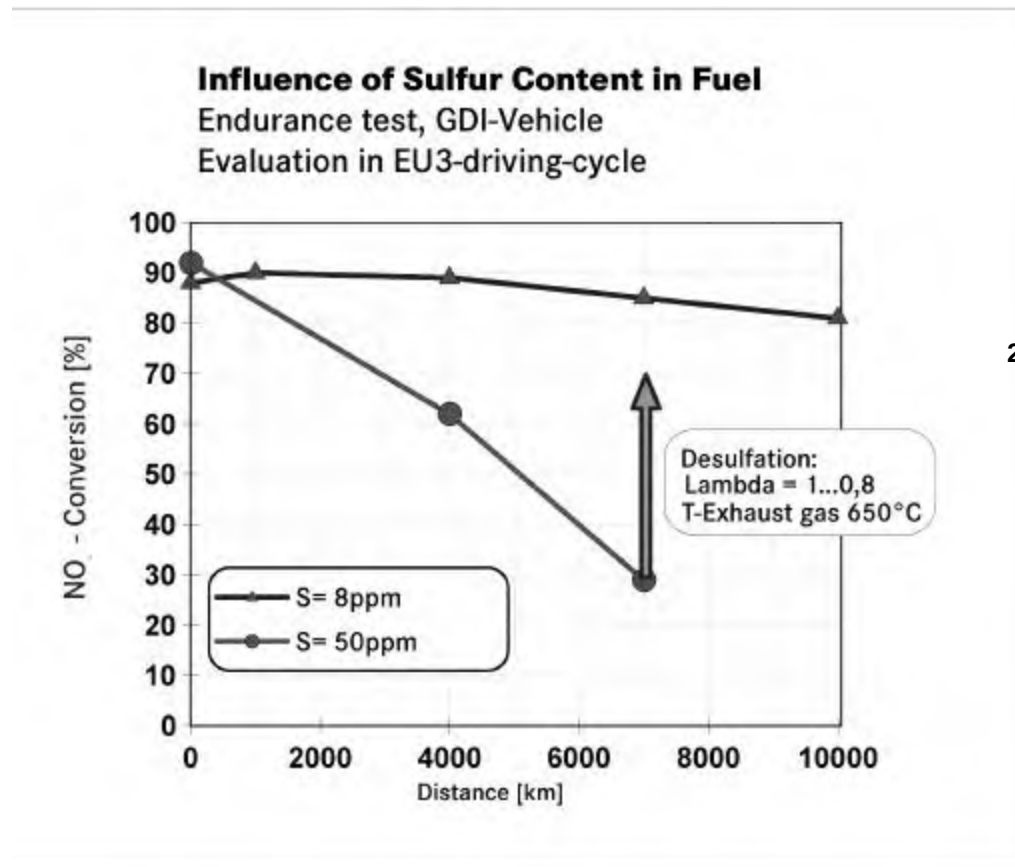
* Differing emissions increases with differing level of D.I. compromise

** (XX) indicates an emissions decrease of XX%

Phase 3 Gasoline Formulation Recommendation

<u>Parameter</u>	<u>Proposed Phase 3 Gasoline Specification</u>	<u>Current Phase 2 Gasoline Specification</u>
Sulfur	5 ppm max Eliminate avg/flat limits	80 ppm max 40 ppm flat limit 30 ppm avg
Rvp	Retain present limit No waiver for ethanol	7.0 psi max
T ₅₀	210/170 ° F max/min 200 ° F flat limit 190 ° F avg	220/170 ° F max/min 210 ° F flat limit 200 ° F avg
T ₉₀	Retain present limit (Include Combustion Chamber and Intake Valve Deposit Control)	330 ° F max 300 ° F flat limit 290 ° F avg
Driveability Index (DI)	Add 1200 DI max with oxygen correction	No specific limit Defacto limit 1227
Olefins	10 vol % max 5 vol % flat limit 3 vol % avg	10 vol % max 6 vol % flat limit 4 vol % avg
Aromatics	Retain present limit	30 vol % max 25 vol % flat limit 22 vol % avg
Oxygen	Retain current limits	2.7 wt % max(1.8 min) 1.8 - 2.2 wt % flat limit

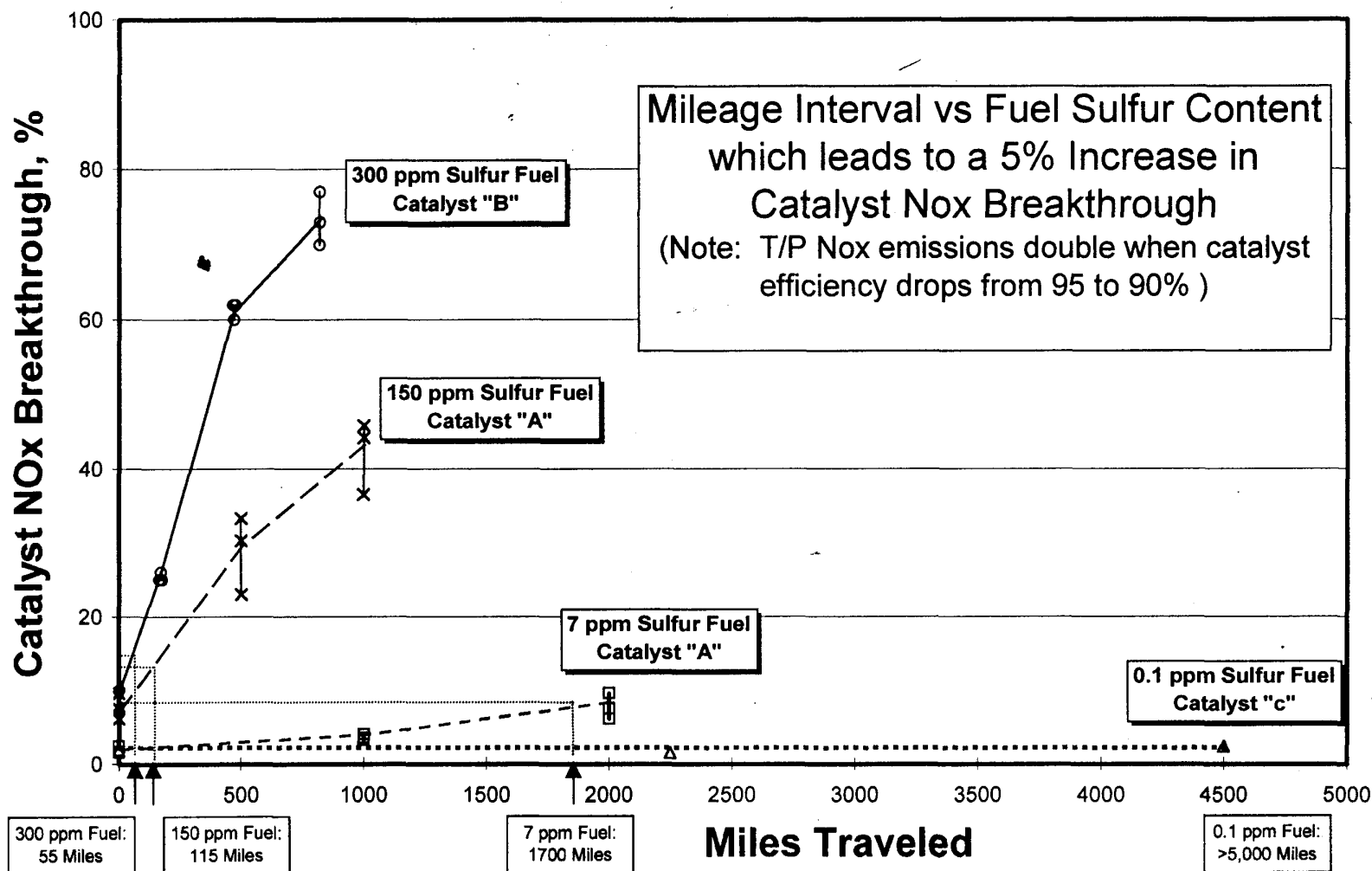
Sulfur Poisoning of NOx Storage Catalyst



20% Loss in NOx Efficiency

Example of fuel efficient technology with product application blocked by fuel sulfur

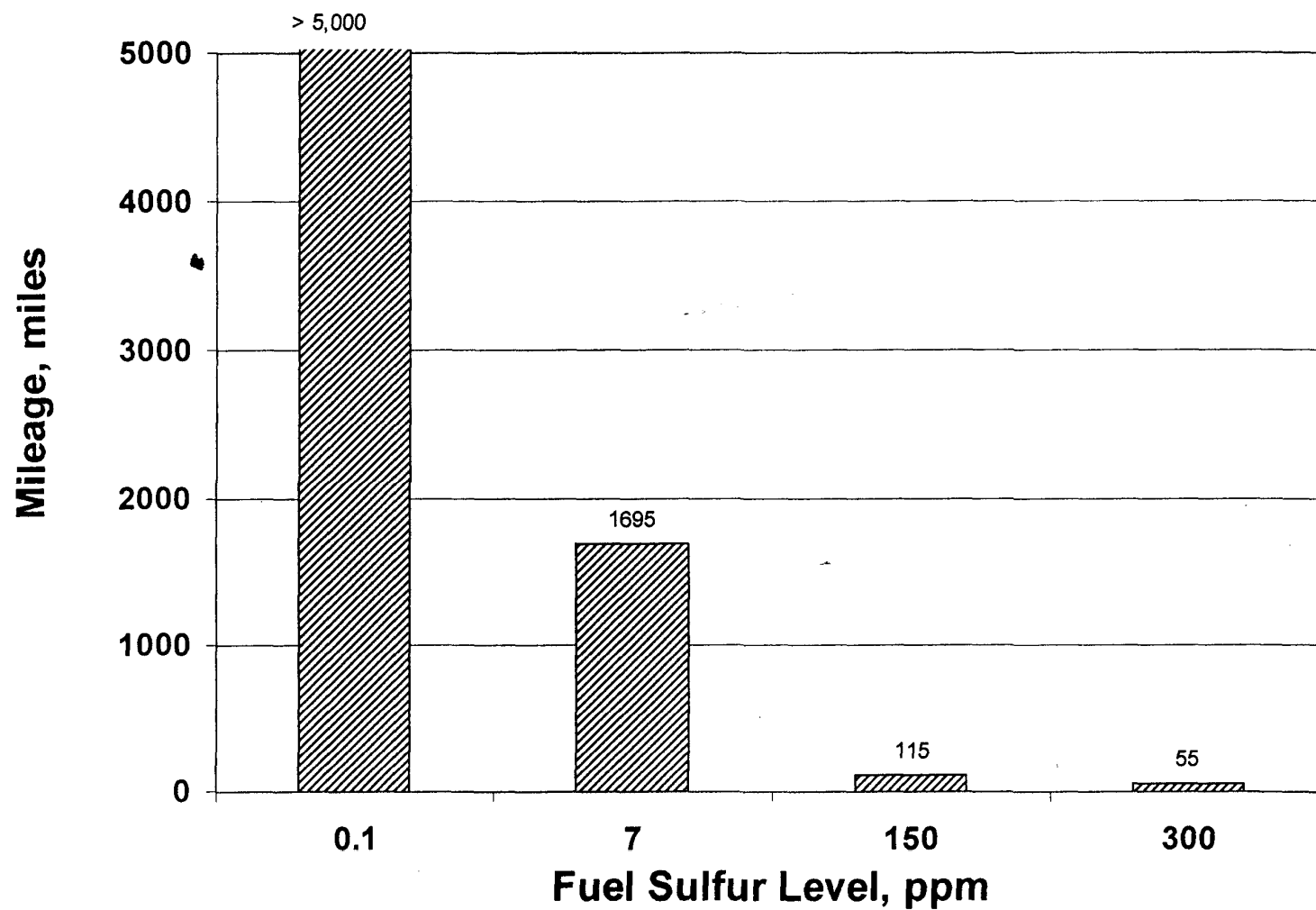
Lean NOx Adsorber Catalyst Data
Catalyst NOx Breakthrough vs Miles Traveled & Fuel Sulfur Content



7/30/1999

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Mileage Interval for 5% increase in catalyst NOx breakthrough



Nox Adsorber Catalyst Deactivation Vs Sulfur Mass Exposure

