

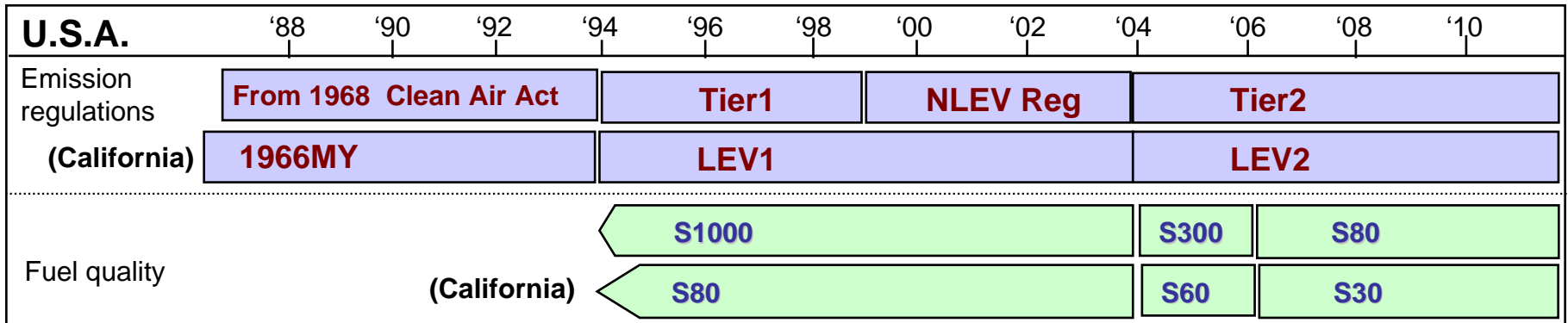
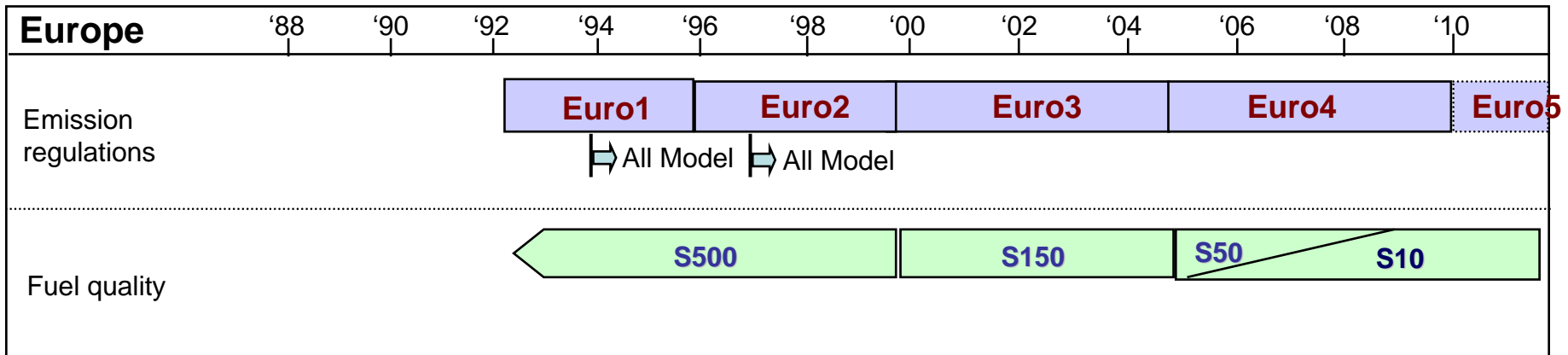
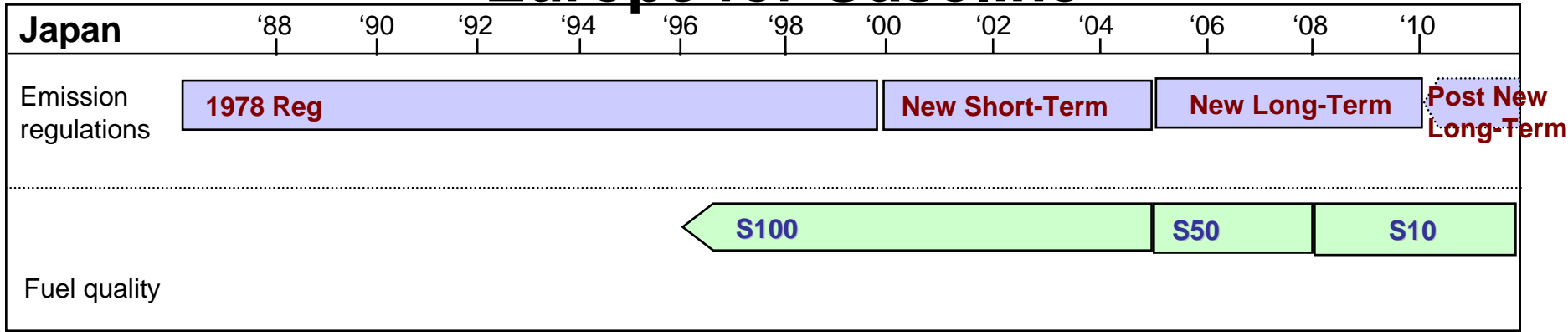
Tailpipe Emissions to Fuels Quality Standard

Atsushi Kameoka
Japan Automobile Research Institute

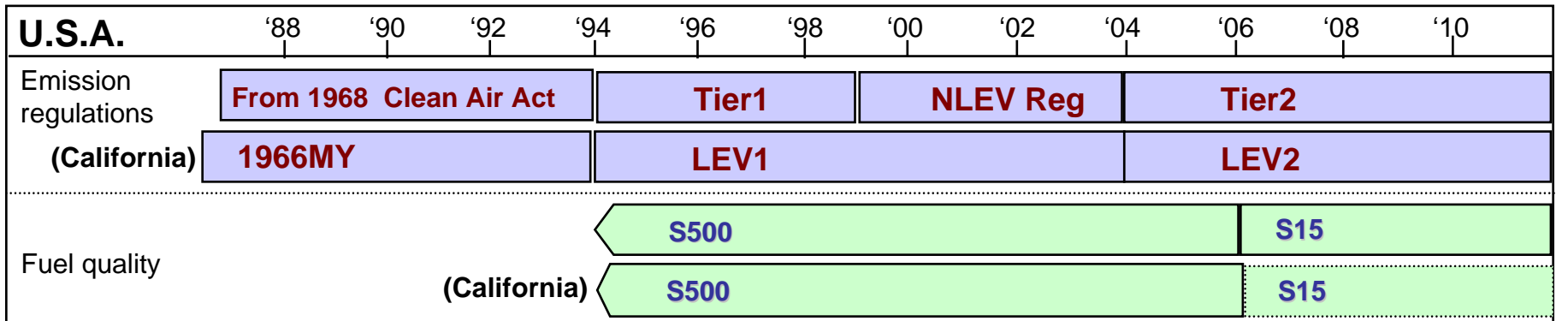
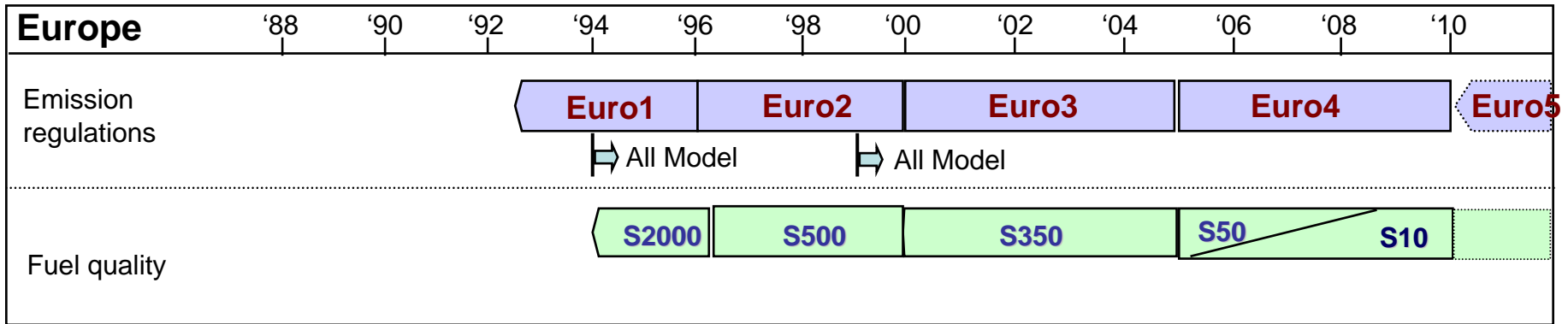
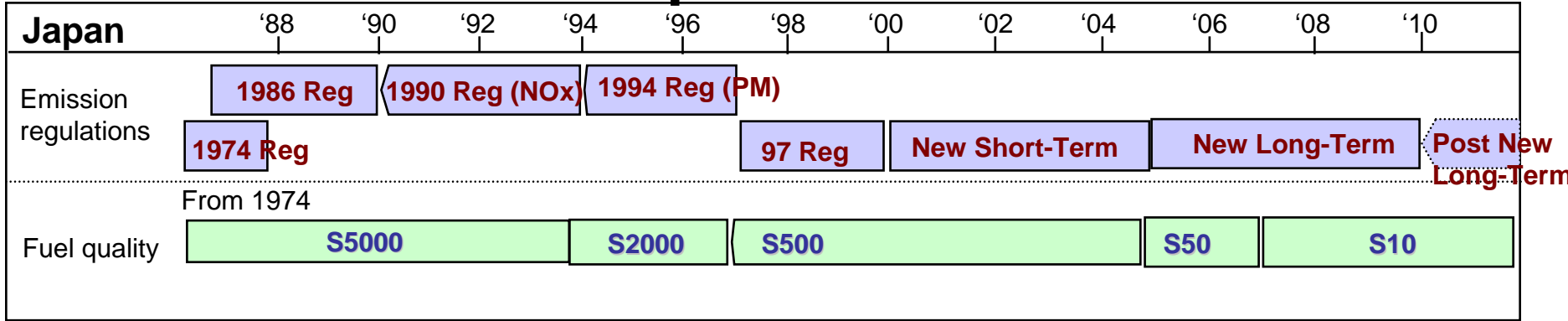
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1. Emission/Fuel Regulations of Japan, U.S. and Europe
2. Effect of Gasoline Fuel Quality
3. Effect of Diesel Fuel Quality

Emission/Fuel Regulations of Japan, U.S. and Europe for Gasoline



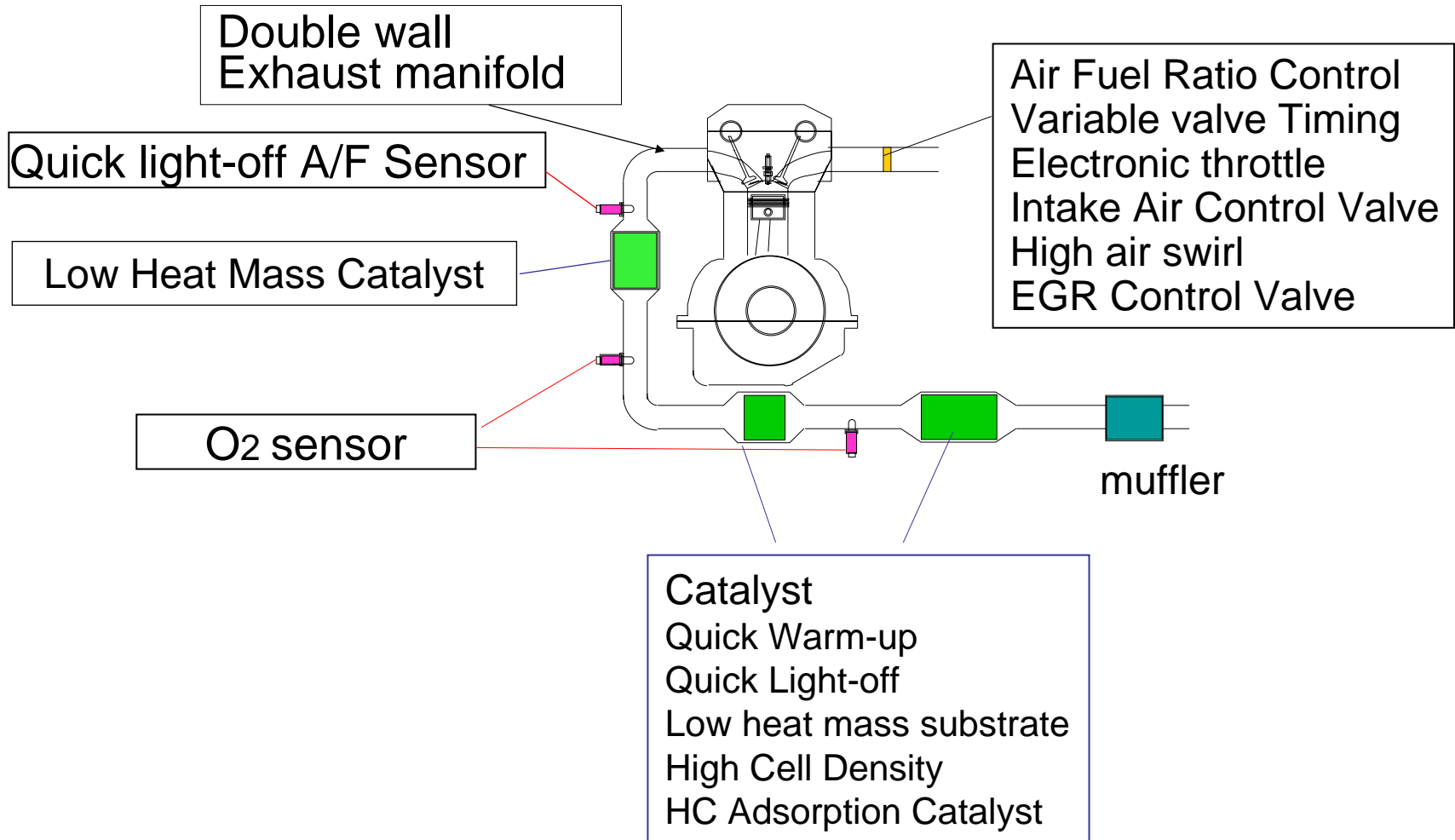
Emission/Fuel Regulations of Japan, U.S. and Europe for Diesel



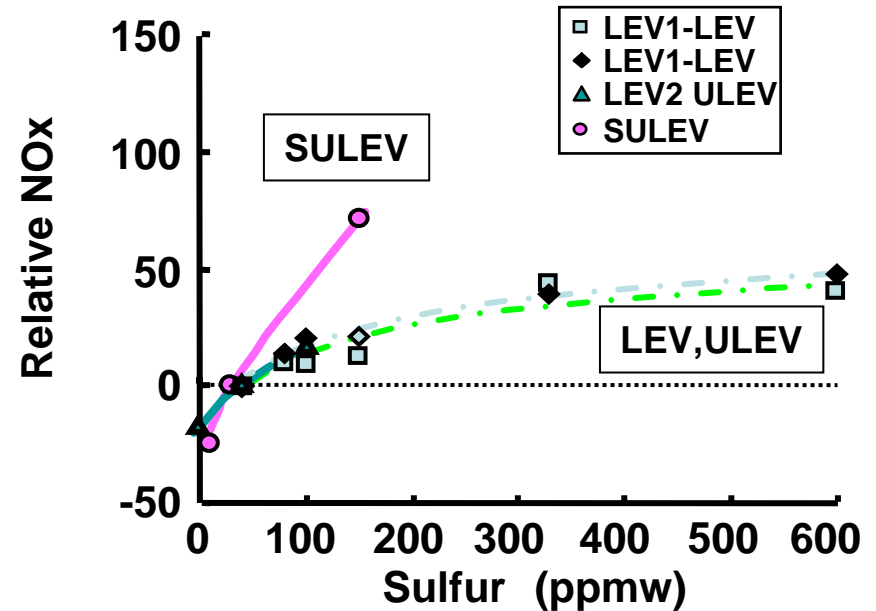
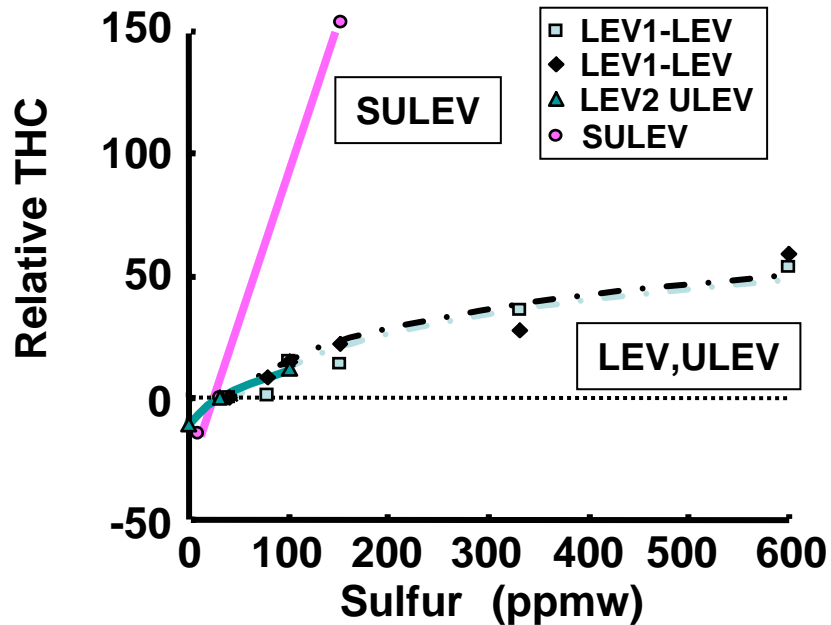
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Low Emission Technologies for Gasoline Engine



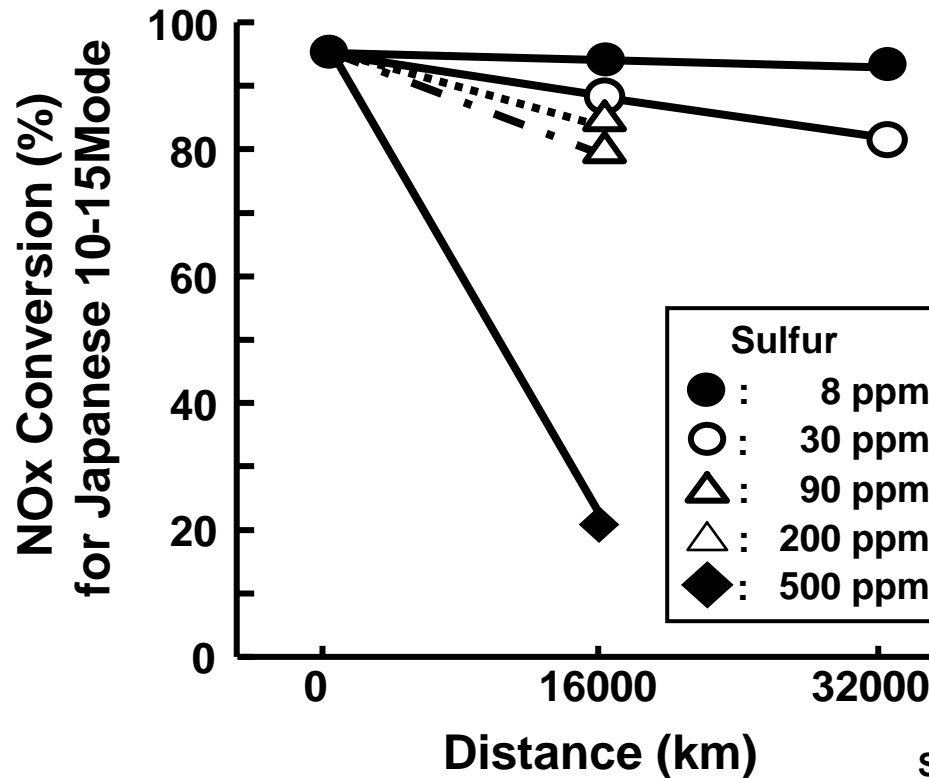
Effects of Sulfur in Gasoline on Exhaust Emissions



Source : SAE2000-01-2019

SULEV : Super Ultra Low Emission Vehicle, ULEV : Ultra Low Emission Vehicle, LEV : Low Emission Vehicle

Effects of Fuel Sulfur on NSR Catalyst Performance

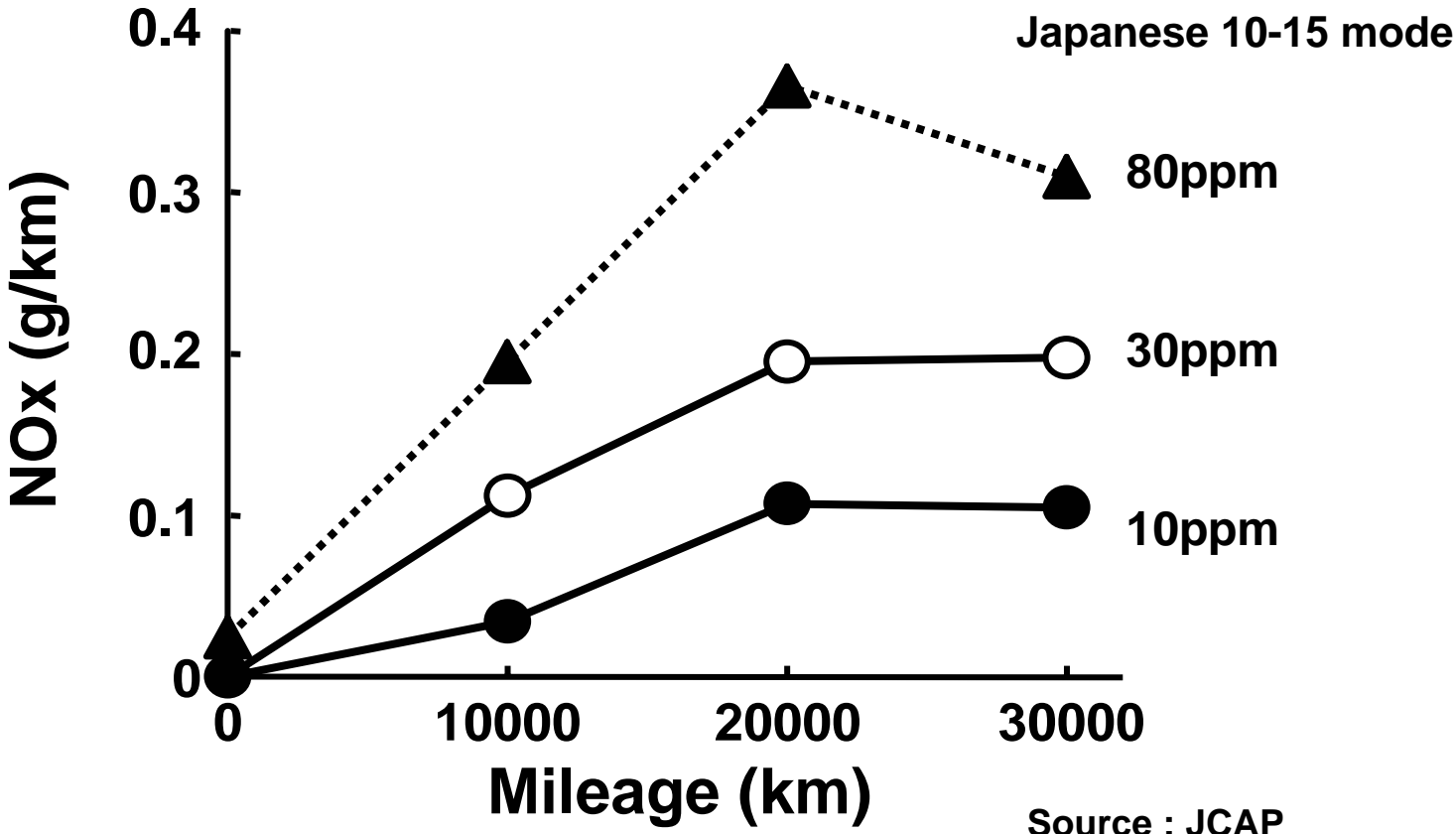


Source : SAE2000-01-2019

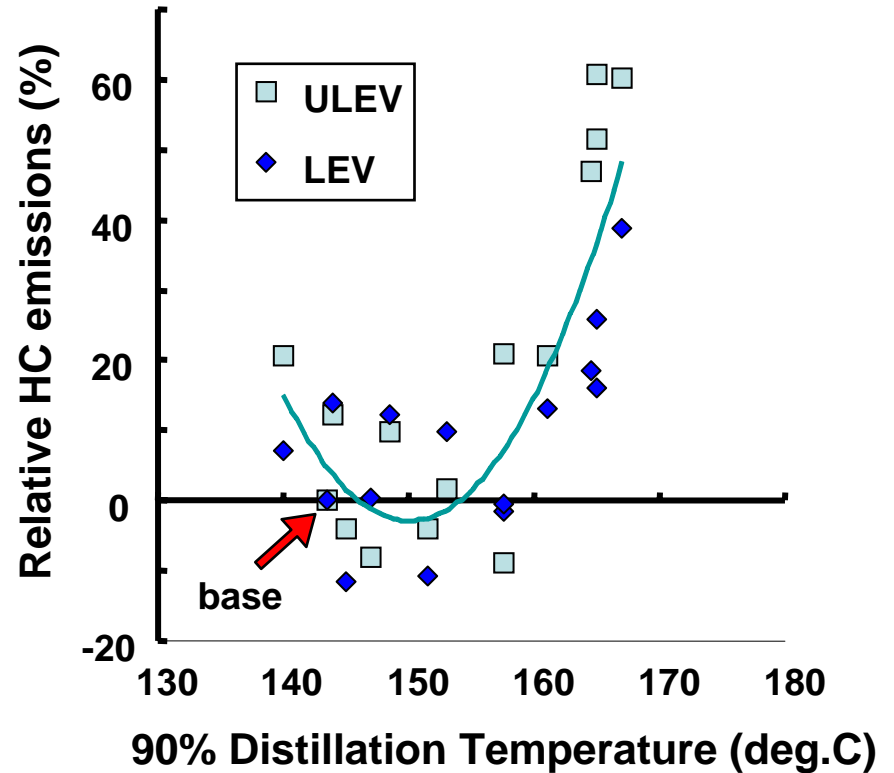
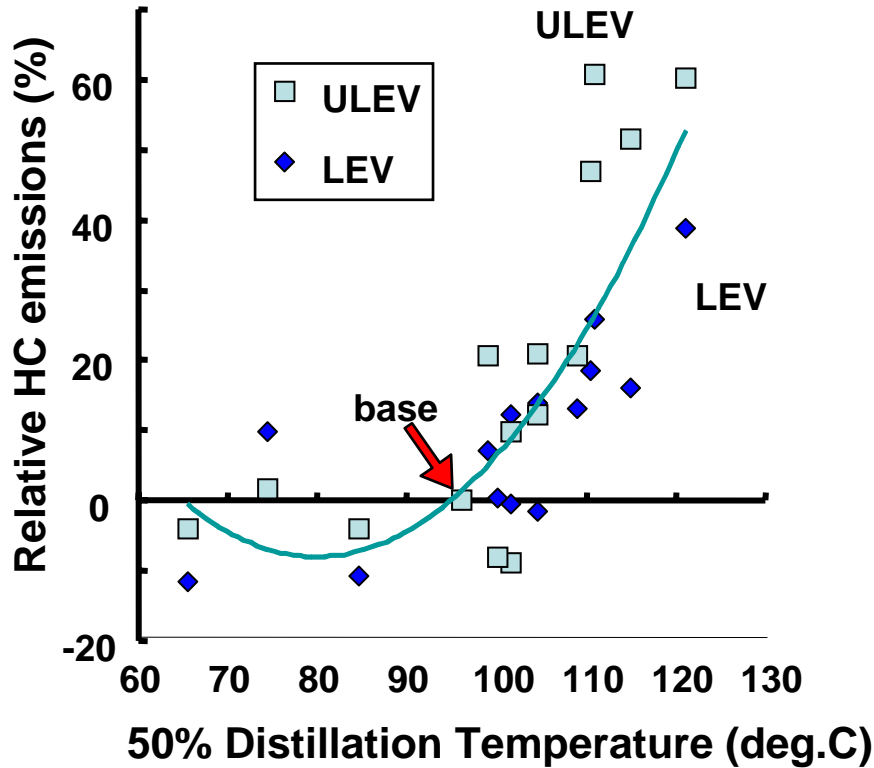
•Fuel sulfur has significant impact on NOx catalyst performance.

Effects of Sulfur in Gasoline on Catalyst Performance

NSR Catalyst (Lean burn)



Effects of Distillation Temperature on Exhaust Emissions



Source : SAE2000-01-2019

ULEV : Ultra Low Emission Vehicle, LEV : Low Emission Vehicle

Effects of Fuel Properties on Emissions

Gasoline

Properties \ Emissions	HC	CO	NOx	Toxics
T50 ↓	↘		→	
T90 ↓	↘			↘
Aromatics ↓	↘	↘	✕	↘
Olefins ↓			↘	
Sulfur ↓	↘	↘	↘	↘
Oxygenates ↑	↘	↘		
Detergent ↑	↘	↘	↘	

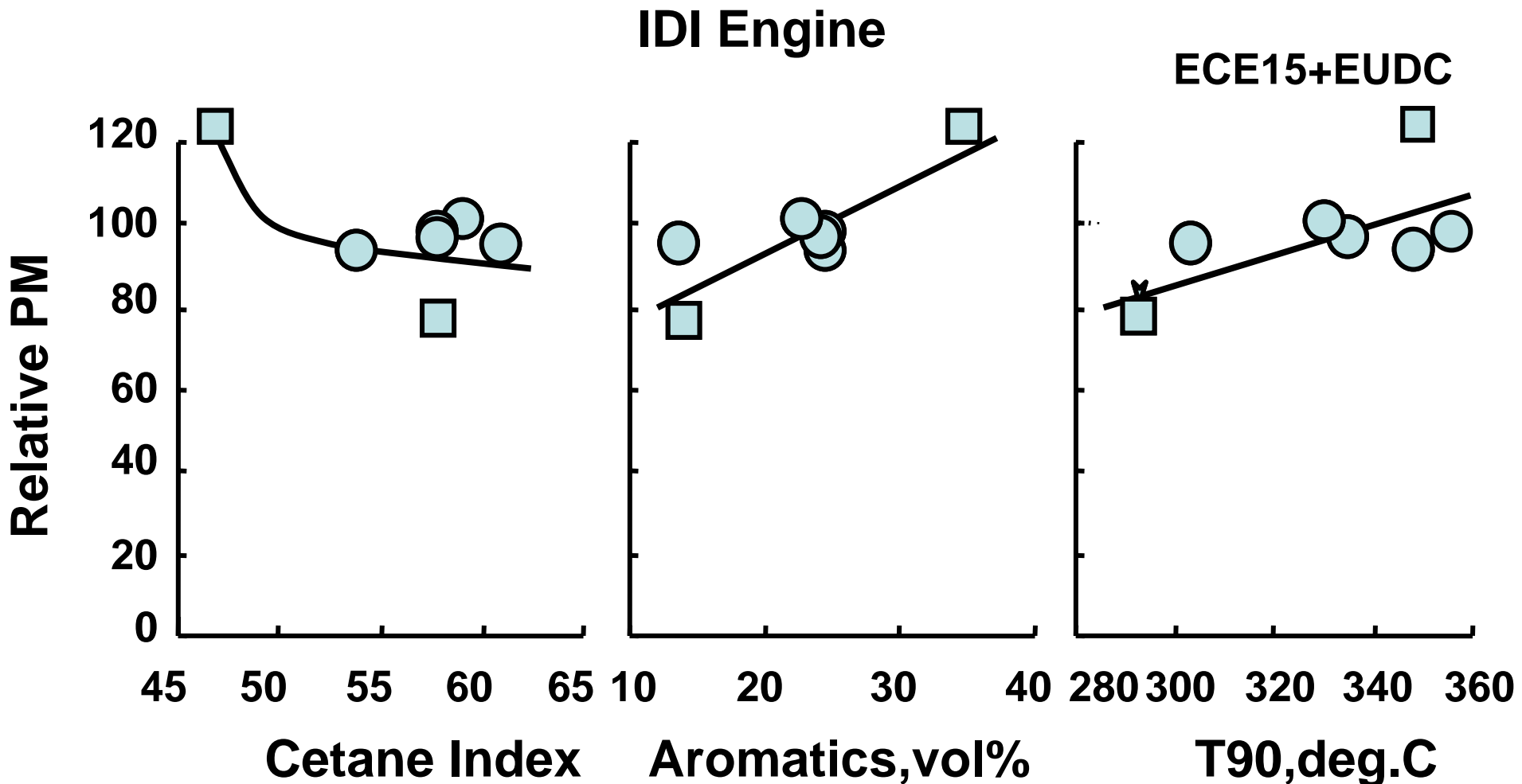
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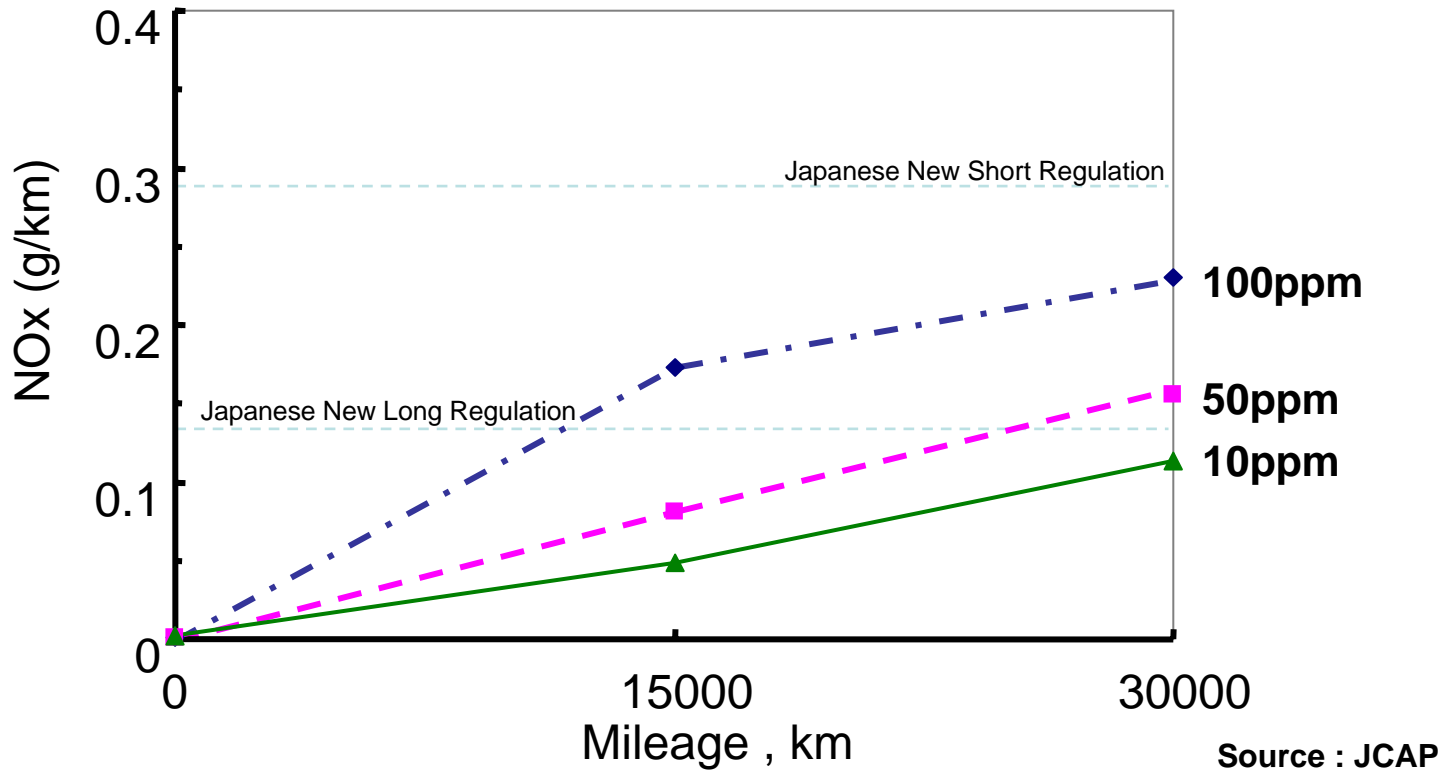
Emission Reduction Technology

- Injection Timing Retard
- Combustion Improvement
- Inter-Cooler Turbo Charger
- EGR Cooler
- EGR(Exhaust Gas Recirculation)
- DPF(Diesel Particulate Filter)
- Oxidation Catalyst
- LNT(Lean NOx Trap)
- NSR(NOx Storage Reduction)
- SCR(Selective Catalytic Reduction)

Effects of Diesel Fuel Properties on PM

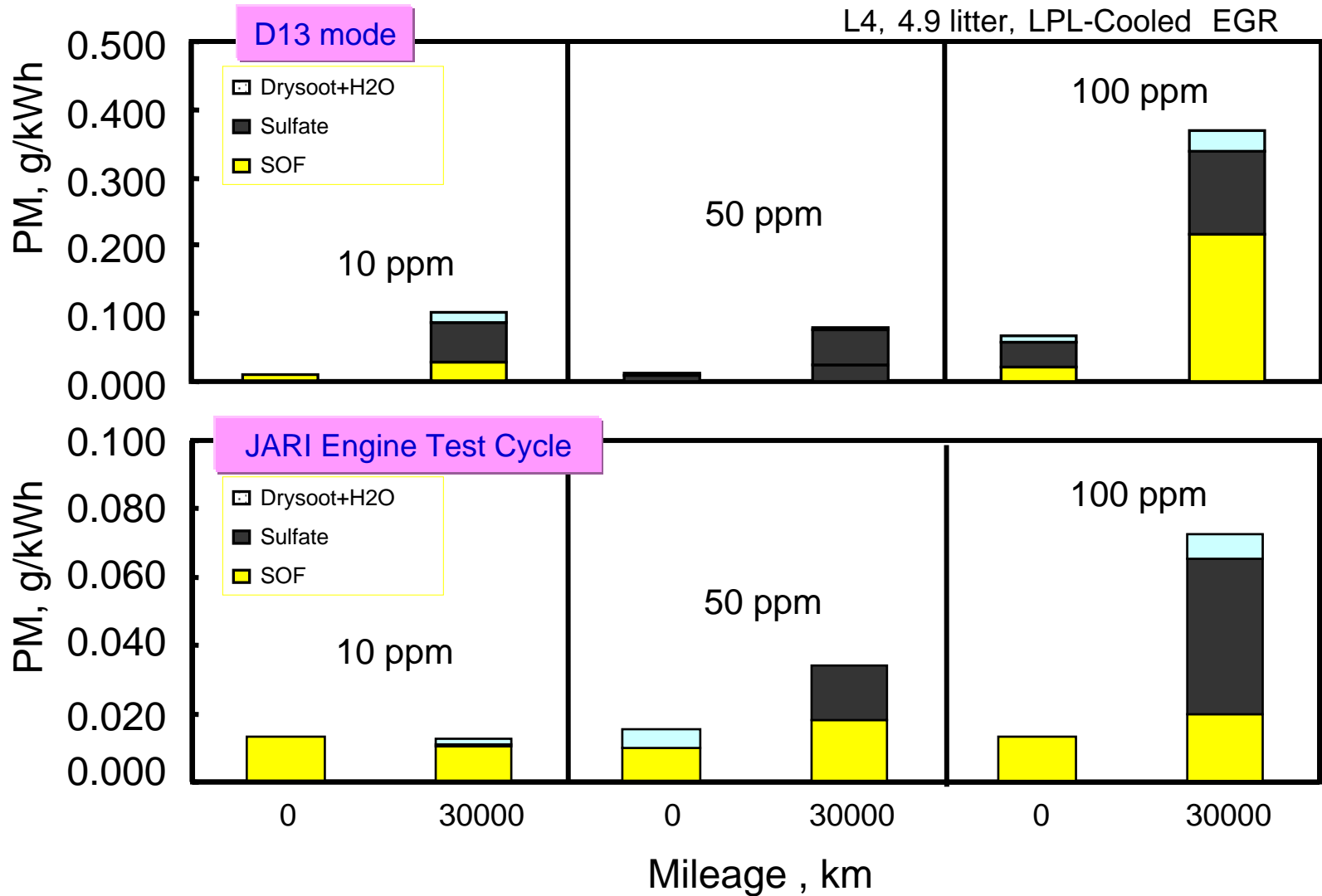


Effects of Sulfur in Diesel Fuel on NOx (NOx Catalyst System)



Fuel sulfur has a significant impact on NOx emissions from vehicles with NOx catalyst.

Effects of Sulfur on PM (CR-DPF System)



Effects of Fuel Properties on Emissions

Diesel Fuel

Properties \ Emissions	Smoke	CO	NOx	PM
T90 ↓	↘		↘	↘
Aromatics ↓	↘	↘	↘	↘
Poly Aromatics ↓				↘
Sulfur ↓				↘
Oxygenates ↑	↘			↘
CN ↑		↘	↘	↘
Density, Viscosity ↓	↘		↘	↘

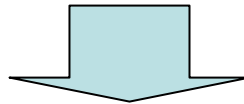
Sulfur Reduction in Diesel Fuel

Emission control systems to be required for emission reduction are

- Euro2 EGR, Oxidation catalyst
- Euro3 Cooled EGR, Oxidation catalyst
- Euro4/5 Cooled EGR, DPF, DeNOx catalyst

When higher sulfur diesel fuel than the requirement used,

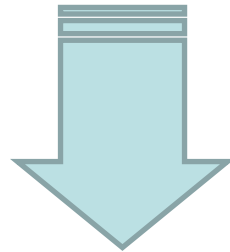
- Lowering engine durability significantly
- Reducing life of Aftertreatment system
- Deteriorating emission



Lowering sulfur is essential to introduce lower emission technology for improving air.

Summary

- ✓ Fuel quality relates closely to emissions and vehicle performance.
- ✓ In order to achieve improving air quality, introducing quality fuel is important from the viewpoint of reducing emissions.



Sulfur:	Gasoline	Diesel fuel
	EU regulation	EU regulation
Euro2	500	500
Euro3	150	350
Euro4	50	50