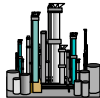


Why Low Sulfur Fuels?



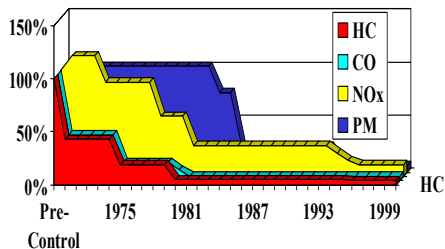
Sulfur Workshop
Mexico City
May 29-30, 2003



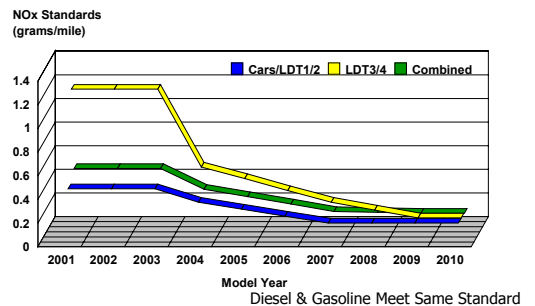
Outline

- Advanced Technologies To Reduce CH, HC, NOx and PM Are Available and Improving
- To Use and/or Maximize The Benefits of These Technologies, Near Zero Sulfur Fuel Is Required
- Near Zero Sulfur Fuel Is Spreading Worldwide
- It Is Cost-Effective To Produce Near Zero Sulfur Fuel in a Single Step and the Cost of Producing Near Zero Sulfur Fuel is Very Modest and Coming Down

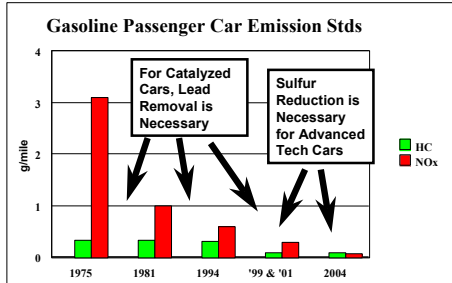
New Car Emissions Standards in the US – Pre Control to 1999



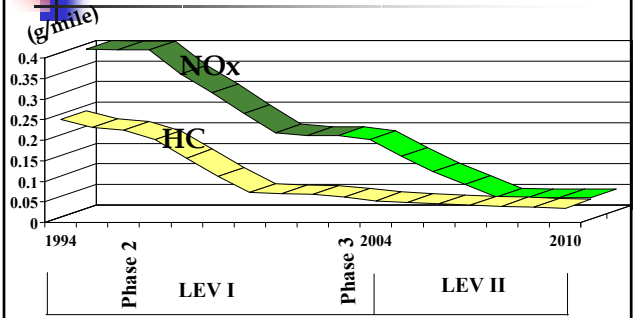
New Car Emissions Standards in the US - 2000 to 2010



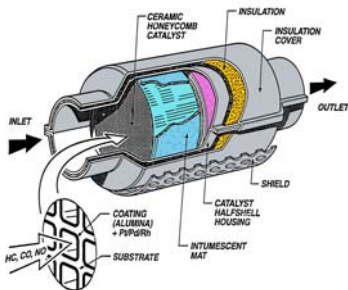
Enabling Emissions Control The Lead of the New Century Gasoline Cars and Trucks



California's Goal: "Zero" Emissions



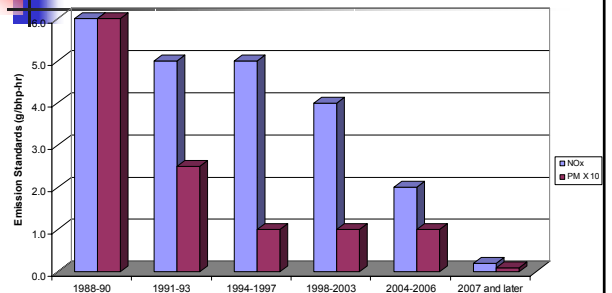
The Three-way Catalytic Converter: A Familiar Technology Re-Engineered for High Performance in Close-coupled and Underfloor Applications



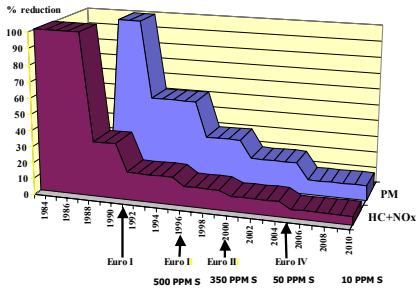
- Layered washcoat architectures and support materials with high thermal stability
- Integrated HC adsorption functions
- Mounting materials with improved durability
- High cell density ceramic or metallic substrates
- Insulation schemes for heat management

Maximum Emissions Performance Is Only Achieved With Near Zero Sulfur Fuel

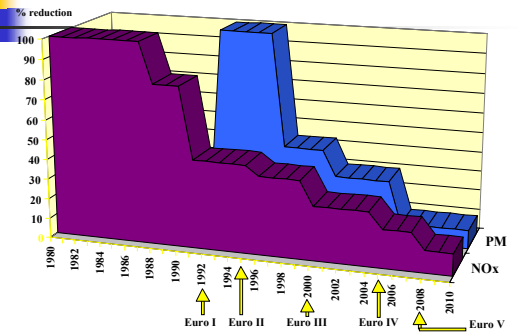
United States and California On-road Truck Engine Standards, Beginning with the 1988 Model Year



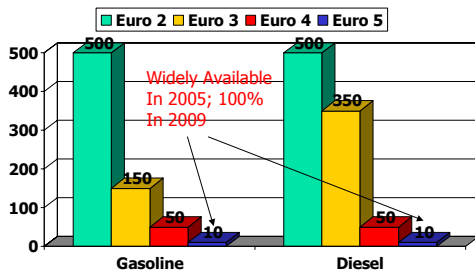
Emissions From Diesel Cars In Europe



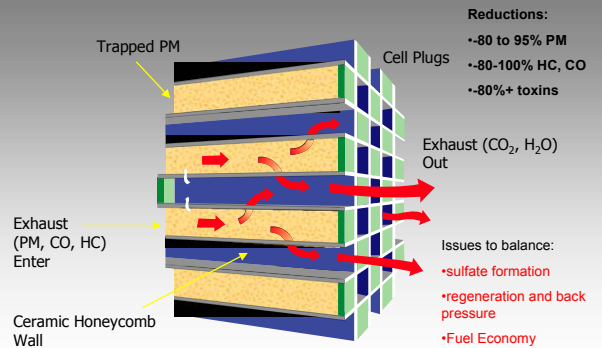
Heavy-duty Vehicles Emission Reduction In Europe On ETC Test Cycle



European Fuel Sulfur Levels (PPM)

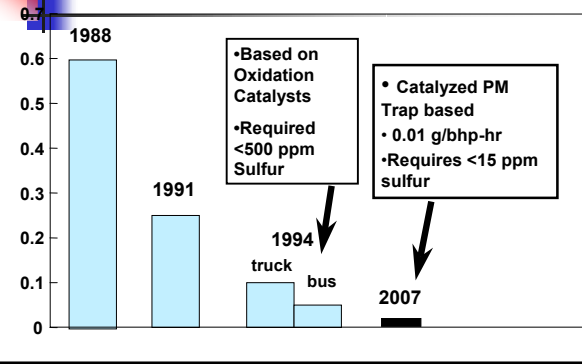


Diesel Particulate Filters



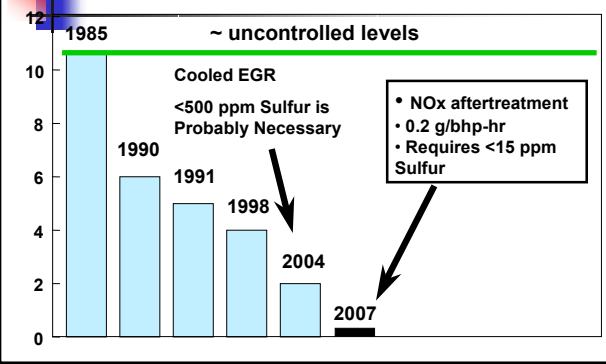
Enabling Emissions Control

US PM Standards for Diesel Engines

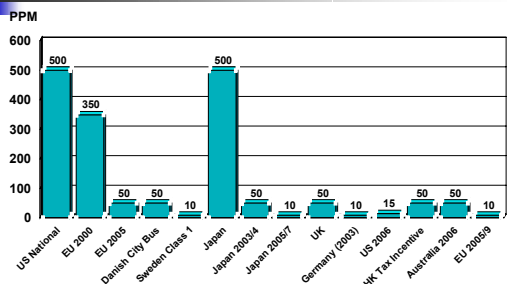


Enabling Emissions Control

US NOx Standards for Diesel Engines



Diesel Fuel Sulfur Specifications



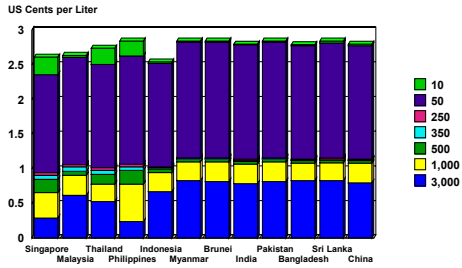
Low Sulfur Fuel is the Key To Advanced Technologies

Fuel Sulfur Negatively Affects Catalyst-Based Emission Control Technology

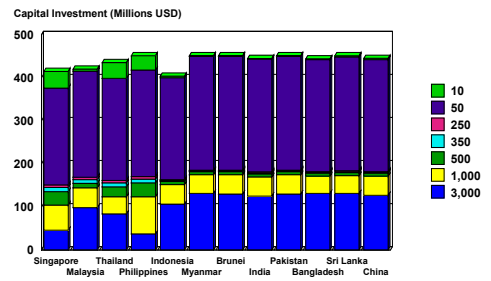
- Sulfur Inhibits Emission Control Performance and in Some Cases Is a Barrier to the Use of Certain Technologies
- Catalyst-Based Technologies Adversely Affected by Sulfur Includes
 - Automotive Catalysts
 - Oxidation Catalysts for Diesel Engines
 - Lean NOx Catalyst-Based Technologies for Automotive and Diesel Applications
 - Catalyst-Based Diesel Particulate Filters

All Catalyst Technologies Adversely Affected

Cost of Reducing Sulfur in Diesel Fuel in Asia (High Sulfur Crude)

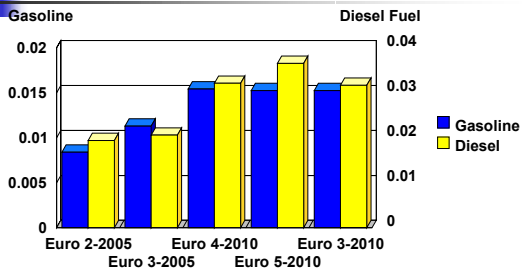


Cost of Reducing Sulfur in Diesel Fuel in Asia (High Sulfur Crude)



This is the Capital Investment Necessary to Produce 2 million tons/year in each country.

Cost of Providing Low Sulfur Fuels in China US Cents per Gallon





Policy Fundamentals From Bellagio Memorandum

- **Vehicles & Fuels Are A Package**
 - **Clean Fuels Reduce Emissions Directly**
 - **Clean Fuels Enable Advanced Technologies**
- Consider Air Quality and Energy Needs in Parallel
 - Case A - Diesel Cars - Conflict
 - Case B - Fuel Cells - Harmony
- Vehicles Doing Same Job Should Meet Same Standards
 - Diesel = Gasoline
 - Sport Utility Vehicles = Cars