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

Gasoline Passenger Car Emission Stds

For Catalyzed Cars, Lead Removal is Necessary
Sulfur Reduction is Necessary for Advanced Tech Cars

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

Low Sulfur Fuel Levels & Tight Vehicle Standards Proceed Together

European Fuel Sulfur Levels (PPM)

Gasoline

European Fuel Sulfur Levels (PPM)

Diesel Particulate Filters

Higher Sulfur Reduces Efficiency, Potential Durability, Fuel Economy

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

Issues to balance:
• sulfate formation
• regeneration and back pressure
• Fuel Economy

Reductions:
• ~80 to 95% PM
• ~80-100% HC, CO
• ~80-90% toxins

Trapped PM

Cell Plug

Exhaust (CO₂, H₂O) Out

Exhaust (PM, CO, HC) Enter

Ceramic Honeycomb Wall

Widely Available
In 2005; 100% In 2009
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

Low Sulfur Fuel is the Key To Advanced Technologies
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

Gasoline
Diesel Fuel

Euro 2-2005
Euro 3-2005
Euro 4-2010
Euro 5-2010
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