Lubricants and Advanced Integrated Exhaust Emission Control Technologies

Manufacturers of Emission Controls Association

Exploring Low Emission Diesel Engine Oils

USDOE/NREL Workshop

January 30 – February1 2000

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Presentation Outline

- Introduction
- Background
- Diesel Emission Control Technologies
- Deactivation Mechanisms
- Lubricant Considerations
- Conclusions

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Existing Technologies Provide Many Options and Emerging Technologies Show Much Promise

Existing Exhaust Emission Controls:

- Oxidation Catalysts
- Diesel Particulate Filters

Advanced Emission Control Technologies

- NOx Catalysts
- SCR
- NOx Adsorbers
- Plasma Technology
- Combined Systems

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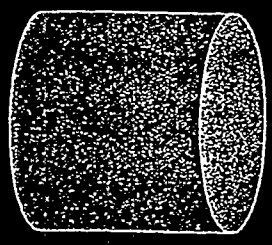
Diesel Oxidation Catalysts

Carbon
SOF
NOx
CO
HC



Carbon
NOx
Water

Oxidation Catalysts Oxidize CO, HC, and SOF to Reduce PM, CO, HC, and Toxic Emissions.

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Diesel Oxidation Catalysts Are Efficient and Have Excellent Operating Experience

- Oxidation Catalyst Control Capabilities
  - PM -- 20-50% Reduction
  - CO and HC -- >90%
  - Toxic HCs -- >70%
- Oxidation Catalyst Operating Experience
  - >5,000,000 Light-Duty Vehicles in Europe
  - >1.5 Million HDEs in the U.S.
  - >250,000 Nonroad Engines

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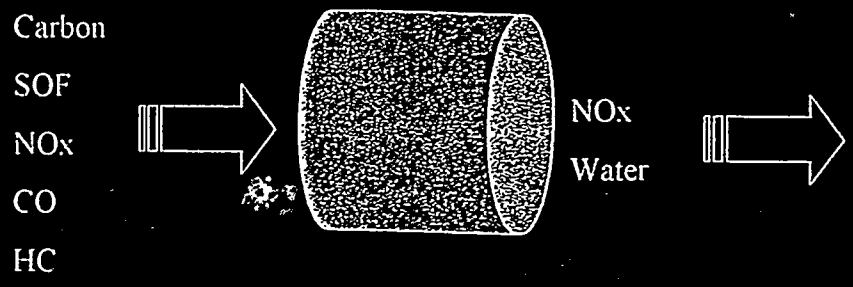
Diesel Particulate Filters Address Most Controlled Emissions



Diesel Particulate Filters Trap Carbon and Adsorbed SOF and Can Be Used to Oxidize CO, and HC to Reduce PM, CO, HC, and Toxic Emissions.

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Diesel Particulate Filters Are Efficient and Are Developing an Impressive Track Record

Filter Control Capabilities

- PM -- >80% Reduction
- CO and HC -- >90%
- Toxic HCs -- >90% Reduction

Based Filter Operating Experience

- Several Thousand Trucks and Buses in Commercial, Retrofit Operation in Europe
- Peugeot Will Offer Filter-Equipped LDVs in 2000
- Over 10,000 Non-Road Engines Equipped (Both OE Installed and Retrofit)

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NOx Technology Overview

Technology	Performance Range				Potential Commercial Availability
	NOx	CO	HC	PM	
Active Lean NOx	25-50	>70	>70	~ 30	2000
NOx Adsorber	50-70	>70	>70	> 30	2004
SCR Urea	>80	>50	>70	≥30	2000
Compact SCR	>90	>70	>70	≥30	2004
Plasma / NOx Cat.	>65	>50	>50	~ 30	Post - 2004

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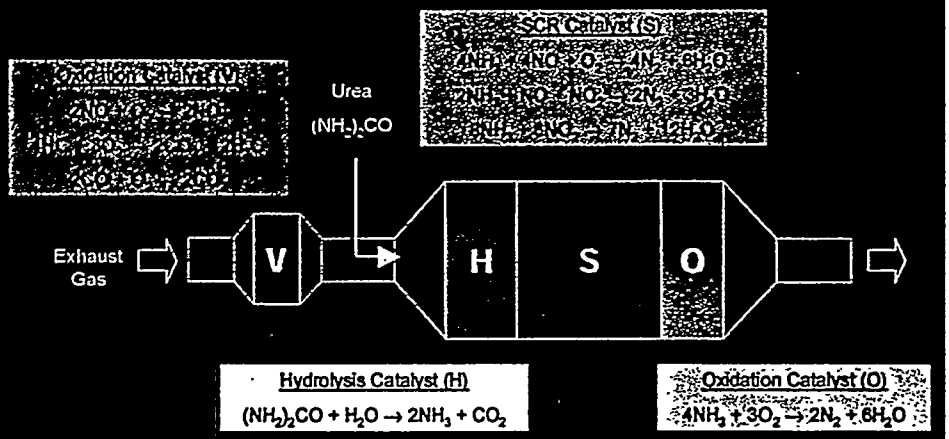
State-of-The Art SCR System has NO2 Generation and Oxidation Catalyst to Eliminate Ammonia Slip



Source: Schaefer-Sindlinger, Degussa, 9-99

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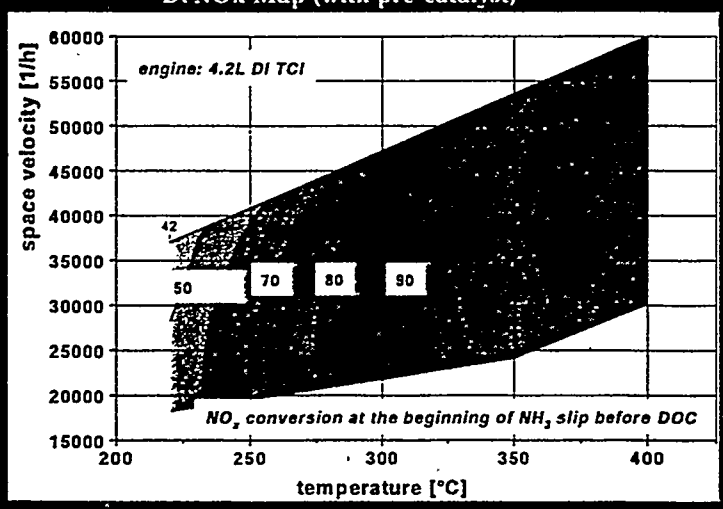
SCR Systems Can Achieve 80+% Efficiency under Reasonable Conditions



Source Schaefer-Sindlinger Degussa 9-99

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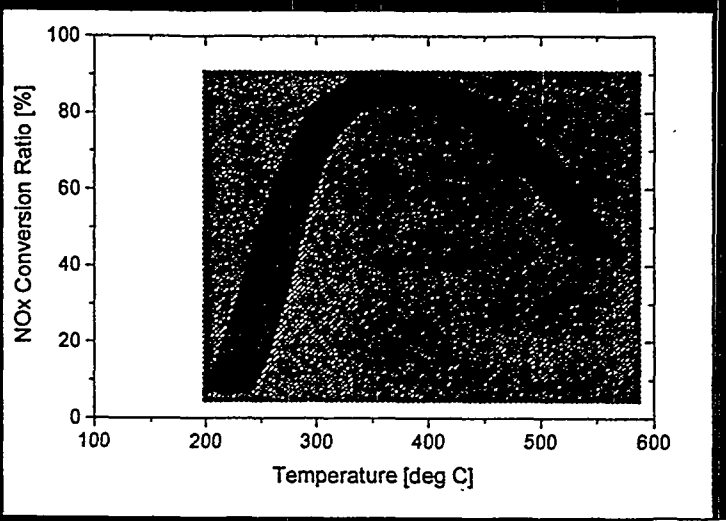
NO_x Adsorber Conversion Ratios Are Getting into the High-80% Efficiencies at Reasonable Temperatures



Source Geckler, FEV 6-99

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NOx Technologies Are in Various Stages of Development

- Passive Lean-NOx Catalysts Used on PC in Europe
- SCR Used on Stationary Sources, Marine Vessels, Locomotives and Have Been Used in Truck and PC Demonstration Programs
- NOx Adsorbers Are in Vehicle Trials
- Plasma Technology Is in the Laboratory Stage and Emerging on Vehicles

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Integrated Systems

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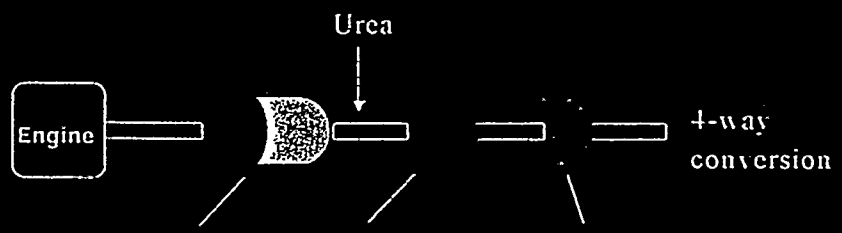
Integrated System Using a DOC, DPF, and SCR



CATALYST/FILTER

Removal of
HC, CO, PM

SCR

Removal of
NOx

Oxidation Cat

Removal of
NH_3 slip if required

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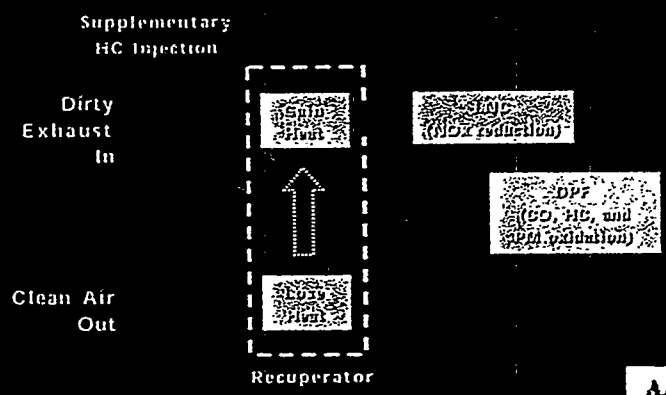
Integrated System -- Lean NOx Catalysis + Filter

Integrate heat transfer and chemistry for simultaneous reduction of NOx, CO, HC, & PM



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Catalyst Deactivation Mechanisms

- Thermal Sintering
- Masking
- Chemical Poisoning

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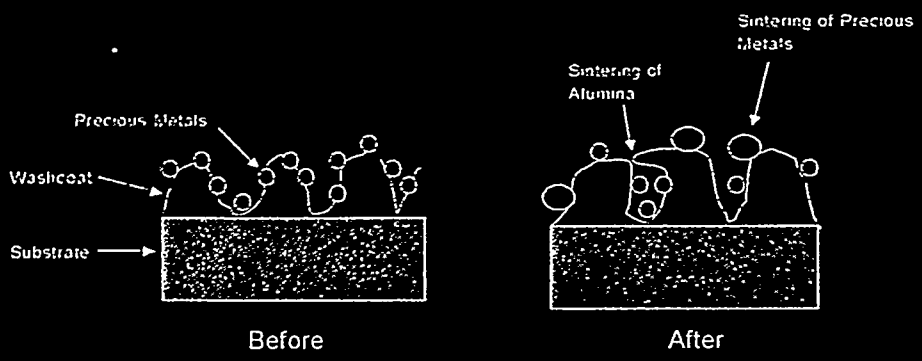
Thermal Sintering



Before

After

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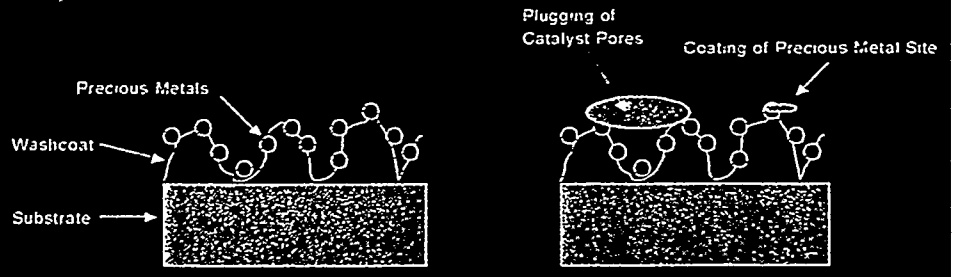
Masking



Before

After

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Lube Oil Components Can:

- Increase Light-Off Temperature
- Reduce Emission Control Performance
- Compete for Desired Reactions
  - Upstream NOx Catalyst Assisted Filter
    - Increase Backpressure
    - Decrease Regeneration Potential
  - Oxidation Catalysts and Filters
    - Create Particulate
- Affect Durability

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