Low Emission Diesel Engine Oils Conference

Post-Combustion Emission Control Devices For Diesel Applications

By Magdi Khair

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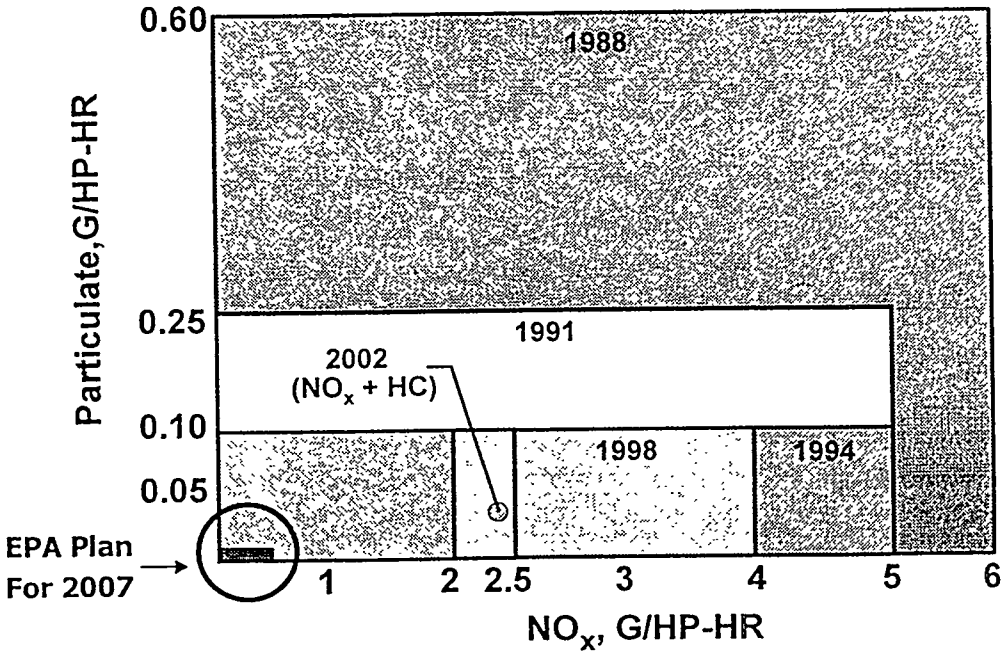
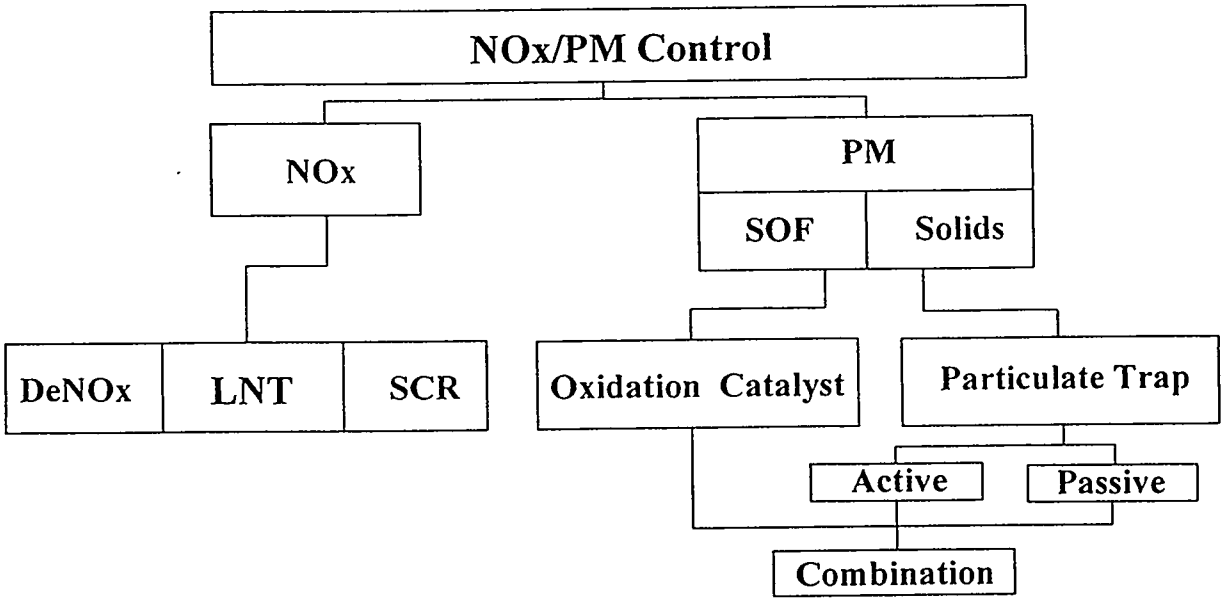
Presentation Outline

- **Standards, Goals, and Research Targets**
- **Post Combustion Emission Control Devices**
- **Description & Principle of Operation**
- **Advantages and Disadvantages**
- **Summary**
- **Conclusion**

Standards, Goals, and Research Targets



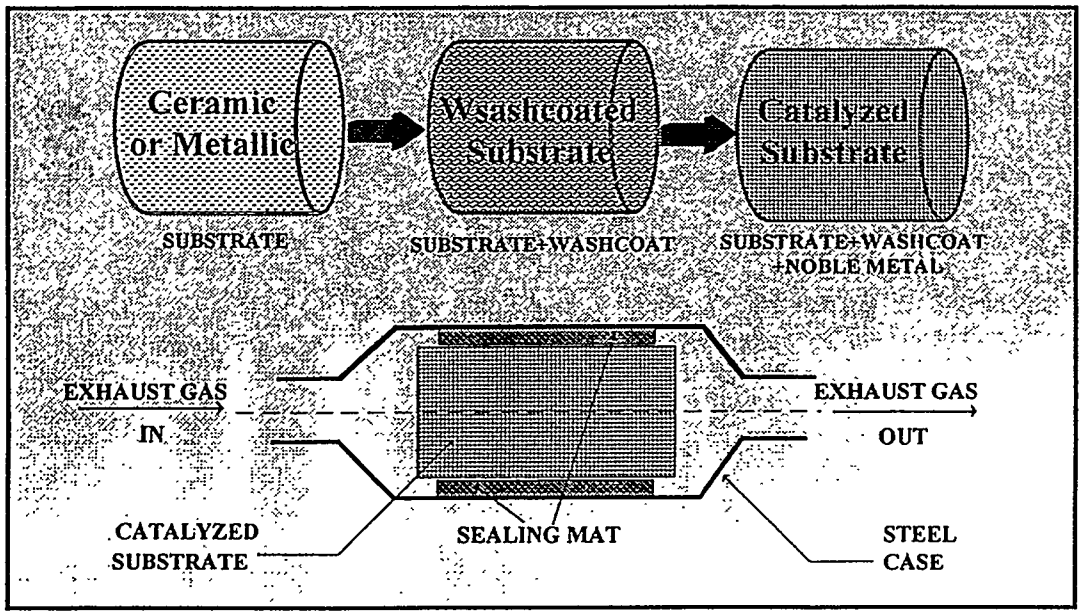
Post Combustion Emission Control Technology Options



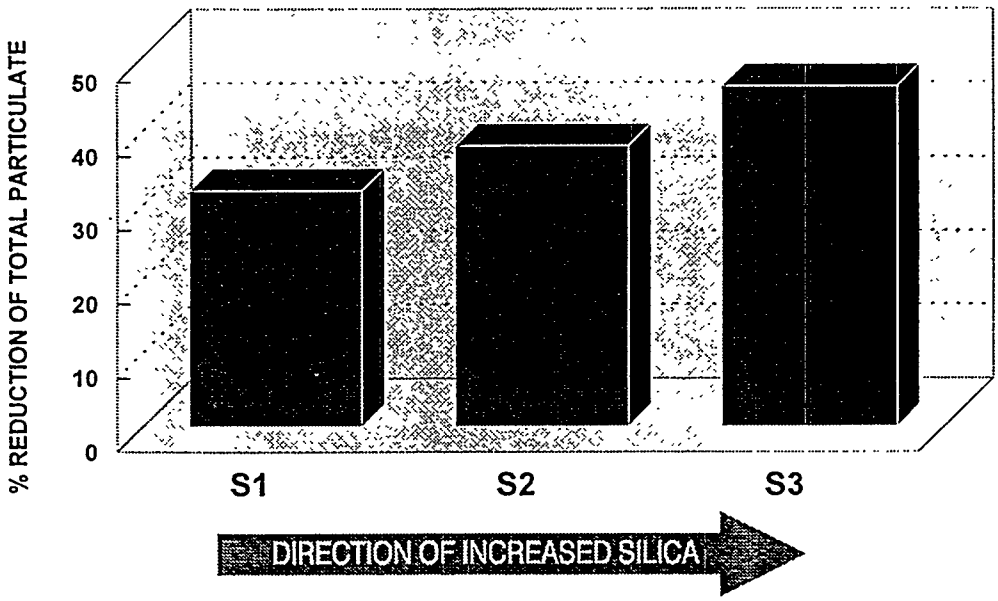
Post Combustion Emission Control Systems

- **Diesel Oxidation Catalyst (DOC)**
- **Diesel Particulate Filters (DPFs or Traps)**
- **Lean NOx Catalyst (LNC)**
- **Lean NOx Trap (LNT)**
- **Selective Catalytic Reduction (SCR)**
- **Combinations**

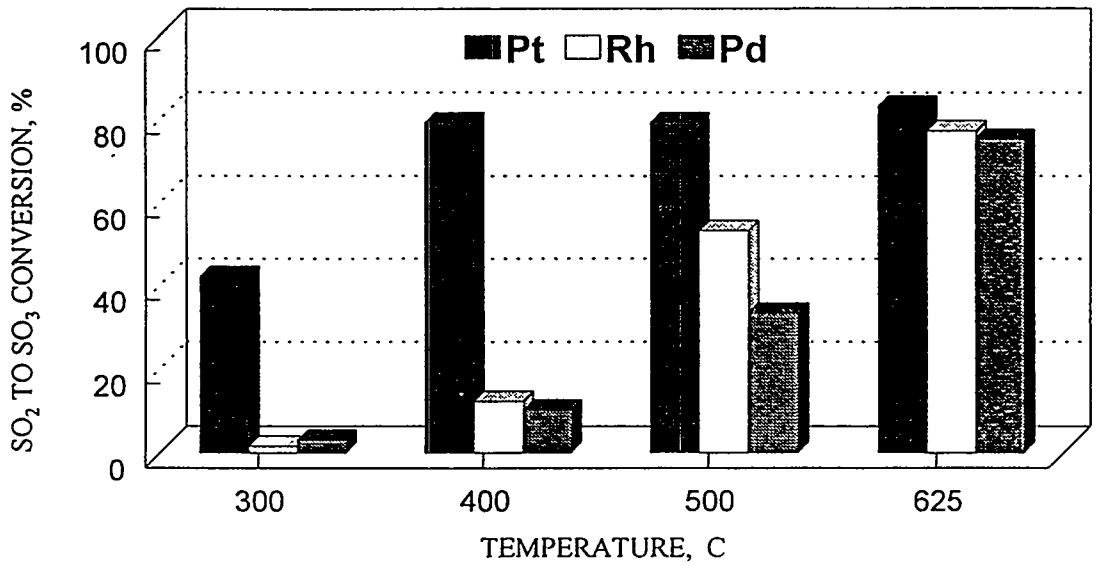
Diesel Oxidation Catalyst (1)



Diesel Oxidation Catalyst (3)

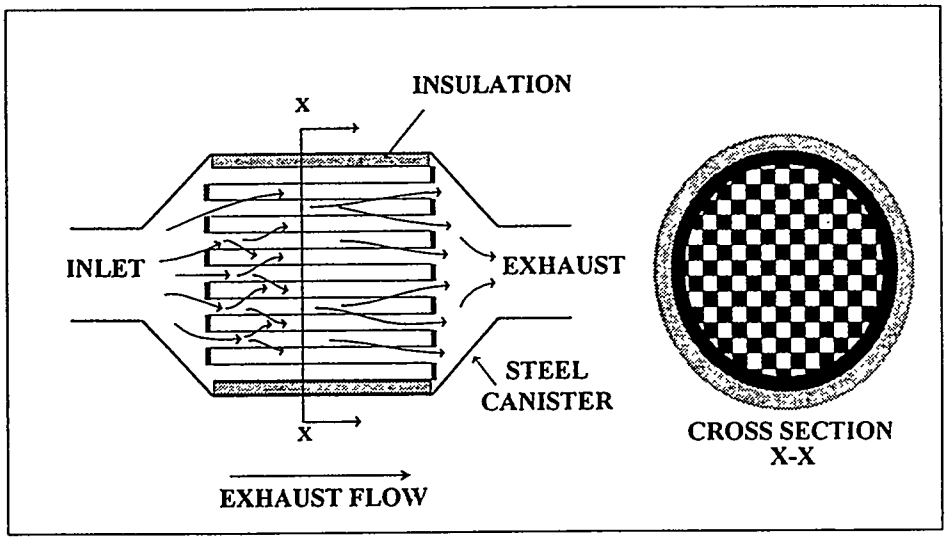


Diesel Oxidation Catalyst (2)



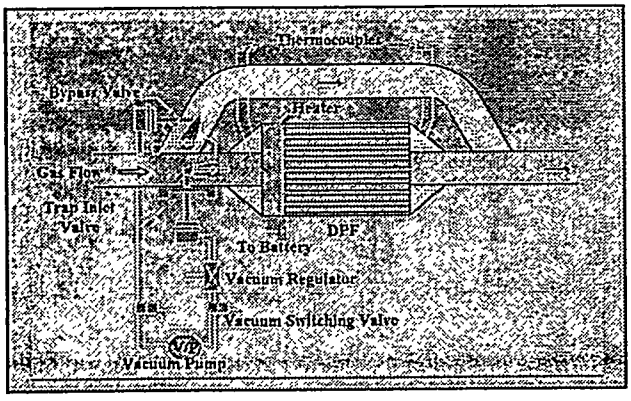
Diesel Particulate Filters (1)

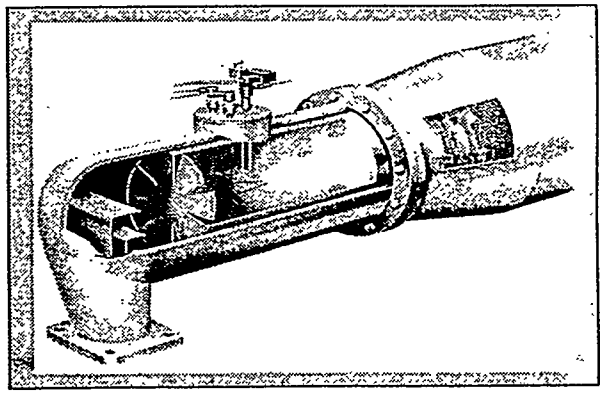
Most Common Filter Element
Wallflow Construction



Diesel Particulate Filters (2)

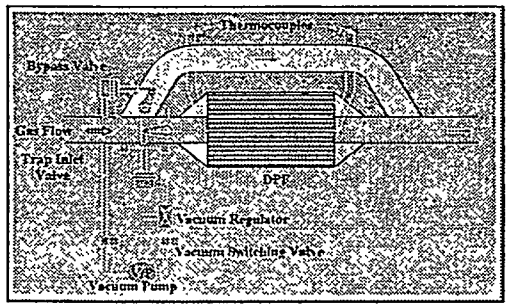
Methods For Active Regeneration



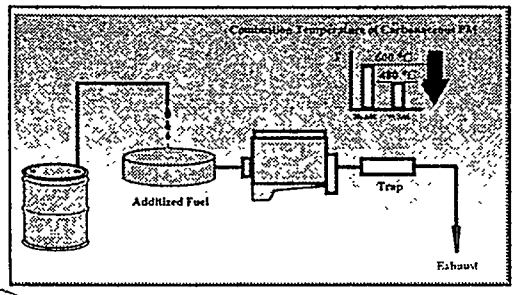


Diesel Particulate Filters (3)

Methods For Passive Regeneration



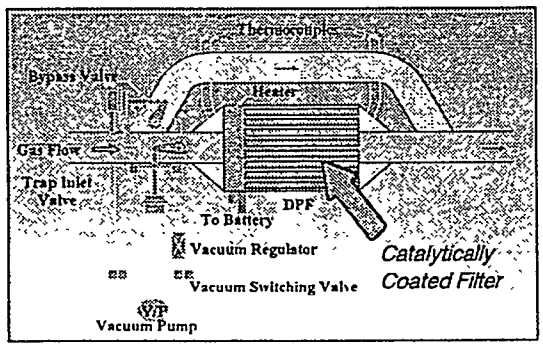
- With Catalytic Coating Assist



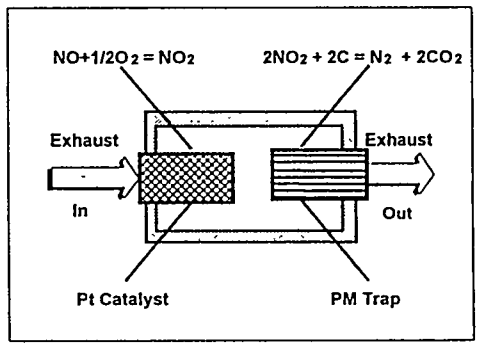
- Self Regenerating

Diesel Particulate Filters (4)

Combination Catalyst and Particulate Filter

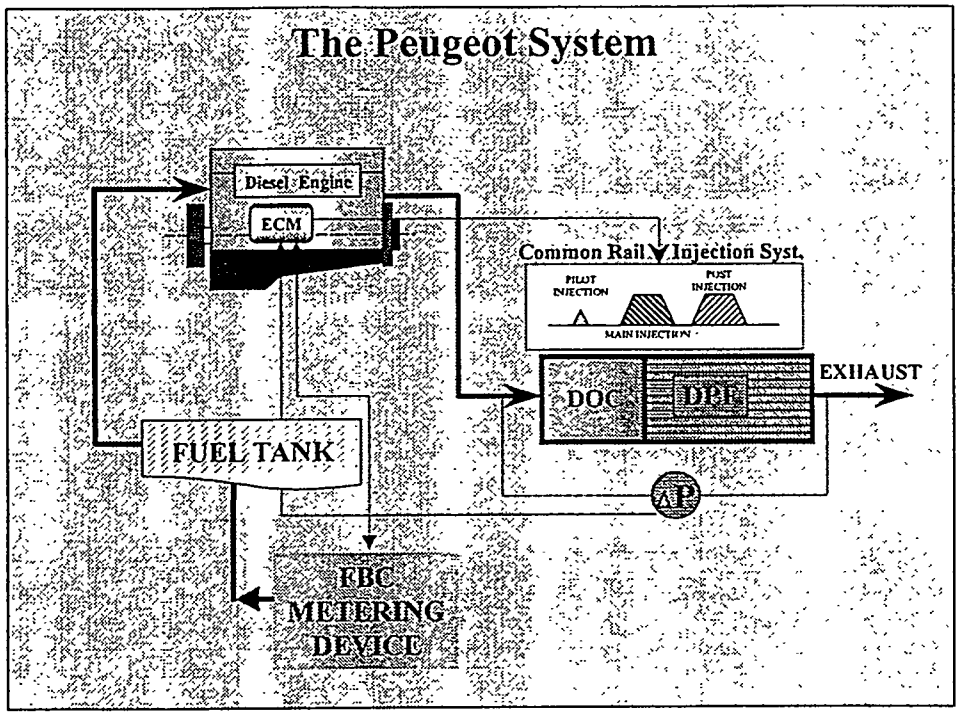


Catalyzed Soot Filter

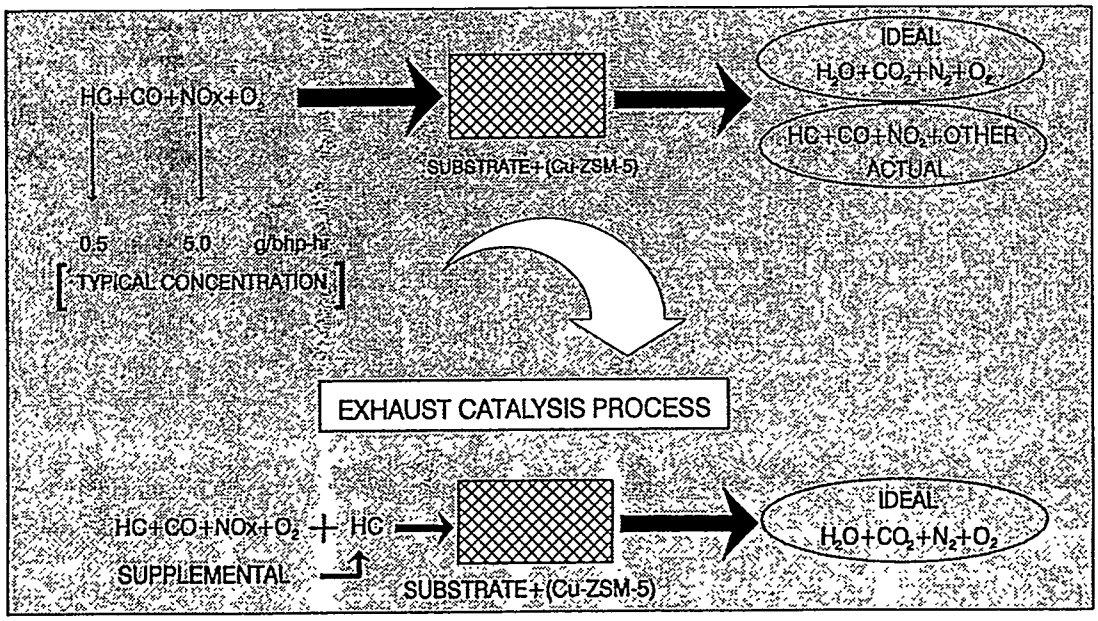


Continuously Regenerated Trap

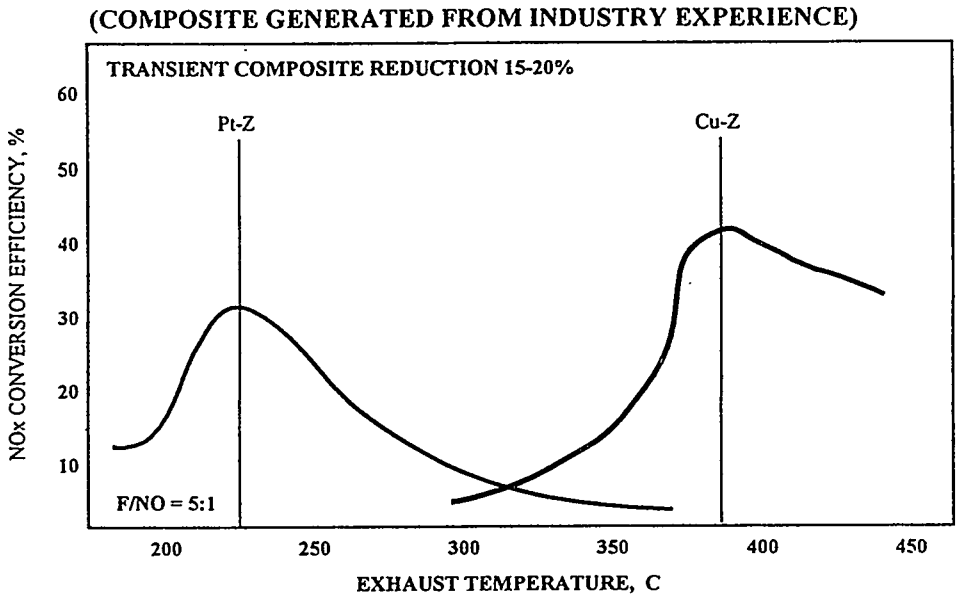
Diesel Particulate Filters (5)



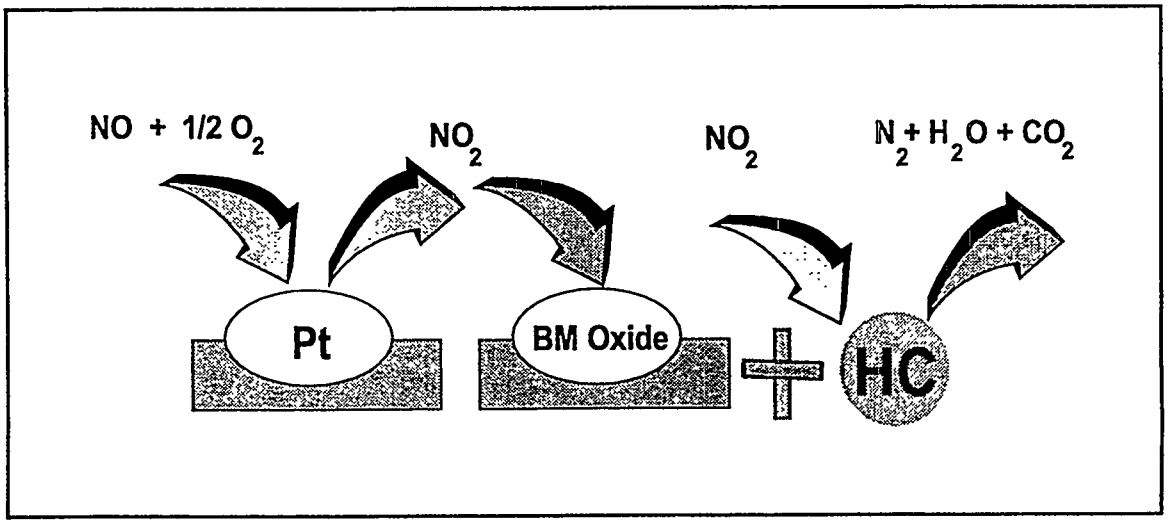
Lean NOx Catalyst (1)



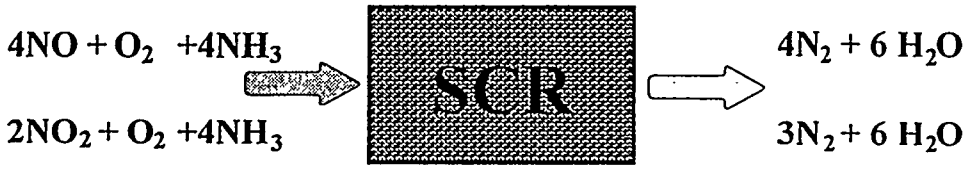
Lean NOx Catalyst (2)

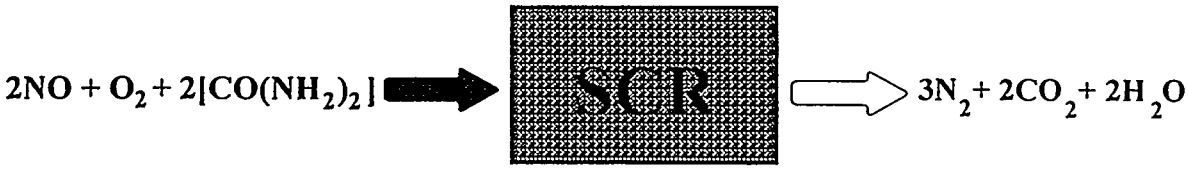


Lean NOx Trap (1)



Selective Catalytic Reduction

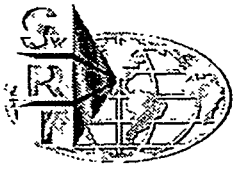




Advantages and Disadvantages

Diesel Oxidation Catalyst

Advantages	Disadvantages
Passive Device for PM Control	Effective on High SOF Engines Only
SOF Conversion Eff. of 50-70%	Sulfur Deactivation Concerns
Some Formulations Show Gas-Phase Activity	Lube Oil Additive Package Deactivation Concerns
Good Durability	Ineffective With EGR Systems
Proven Reliability	Highly Active DOCs Can Also Form Sulfate



Diesel Particulate Filters

Advantages	Disadvantages
Greater Than 90% PM Removal	Cost
Highest Potential For Reducing Fine Particles	Complex Controls
Has Synergistic Value When Used With EGR	Durability and Reliability Concerns
Passive Regeneration Techniques Are Attractive	High Back Pressure
	Potential of Plugging

Lean NOx Catalyst

Advantages

- Can Use Same On-Board HC
- Good Resistance to Sulfur
- No Appreciable Hydrothermal Deactivation For Low Temp.
- Some Limited Success For Passive Systems

Disadvantages

- Low NOx Conversion
- Narrow Temperature Range
- Void of NOx Conversion Between Low and High Temp. Catalysts
- N_2O Formation With Low T. Cat.
- Lack of Durability of High T. Cat.
- PM & Fuel Consumption Concerns

Lean NOx Trap

Advantages

- Experience With DI Gasoline
- Active in 250 - 450°C Range
- Potential For High NOx Conversion (>50%)
- Compatible With Total Engine/Aftertreatment Control Schemes

Disadvantages

- Serious Sulfur Deactivation
- May Require DOC in Rich Regime
- Relatively New For Diesel Applications
- Requires Sophisticated Controls
- Adverse Impact on Fuel Economy

Selective Catalytic Reduction

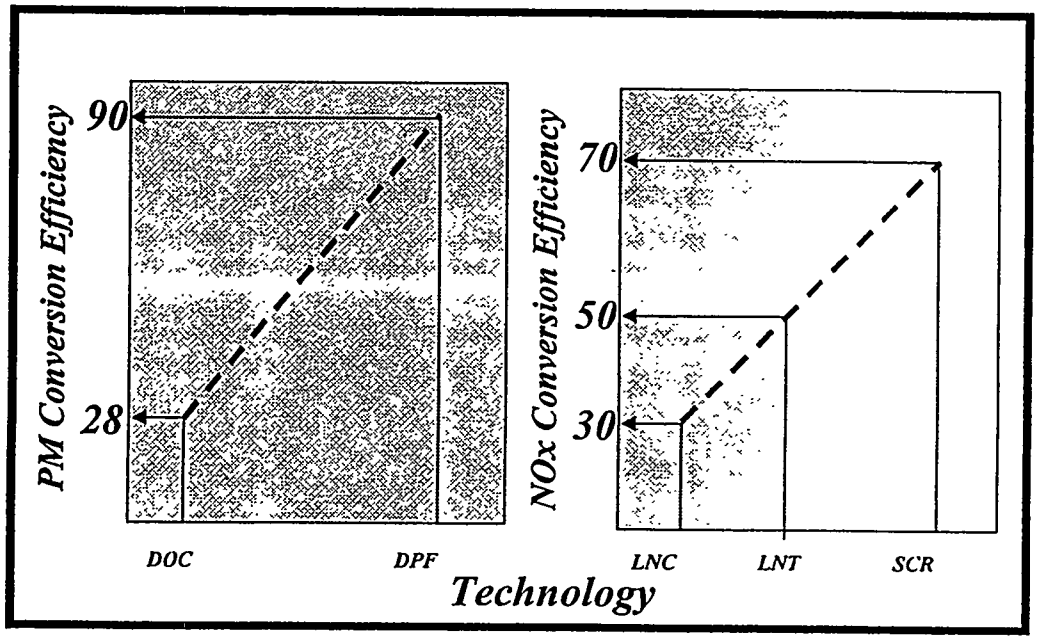
Advantages	Disadvantages
NOx Conversion of 70%	Additional On-Board Fluid
Established Technology (Stationary)	Requires Sophisticated Controls
Good Durability at Low- & Mid-Range Temperatures	Infrastructure For Urea Distribution
Maintain Engine Durability and Performance By Avoiding EGR and Timing Retard	Ammonia Slip Concerns
	US Regulators Non-Committal--May Have to Carry Life-Time Supply

Combination Systems

Advantages	Disadvantages
Overcome Limitations of Other Systems	They Each Have Limitations
CRT Technology Holds Good Promise--Requires 50ppm or less Sulfur	Requires Sophisticated Controls
Field Experience With Peugeot system	Are Application Specific
Designed to Achieve Extremely Low Emissions	CRT's Efficiency and Viability Depends on Availability of Low Sulfur Fuel
	Trap Regeneration Remains a Challenge

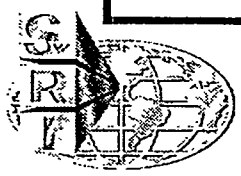
Summary

Progress in Post Combustion Emissions Reduction Technologies (Summary-1)



Progress in Post Combustion Emissions Reduction Technologies (Summary-2)

Technology	*Pros*	*Cons*
DOC	*Passive/Cost/Durability*	*Low Conv. Efficiency*
DPF	*Efficiency*	*Cost/Reliability & Durability*
LNC	*Reductant Common With Onboard Fuel*	*Fuel Consumption & Low Conv. Efficiency*
LNT	*Reductant Common With Onboard Fuel*	*Unproven-Durability Fuel Consumption-Sulfur*
SCR	*High NOx Conversion*	*Add. Fluid Onboard/ Cost/Infrastructure...*



Concluding Comments

- **There is no clear winner among the various aftertreatment systems**
- **Trap systems have the potential for PM control but still suffer from high cost, low durability, and low reliability**
- **CRT appears to be have good passive regeneration qualities but requires ultra low sulfur fuel**
- **LNT for diesel engines is still new and requires more research--We know that it requires very low sulfur content**