

**“A Systematic Investigation of Parameters Affecting
Diesel NOx Adsorber Catalyst Performance”**

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San Diego

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◆ Introduction

- Operating Conditions
- Characteristics of Ba based and Ba + Alkali Metals NOx Adsorbers

◆ List of Study Parameters

- Inlet Temperature
- NOx Flow: Space Velocity, Lean Duration, Inlet NOx Concentration
- Exhaust Composition
 - » HC, CO, H₂
- Sulfur Poisoning and De-S
- PGM and Substrate

◆ Summary/Conclusions

◆ Acknowledgements

Lean A/F=20-35

300-700ppm NOx

Stoichiometry

250-600 °C

Rich A/F=12-14

Lean A/F=20-50

50-700ppm NOx

Stoichiometry

150-550 °C

Rich A/F=12-14

Gasoline

Partially lean: LNT/3-way

Less fuel penalty

Rich operation: Easy

Reductants: CO, HC, H₂

Durability required: 800-850 °C

Diesel

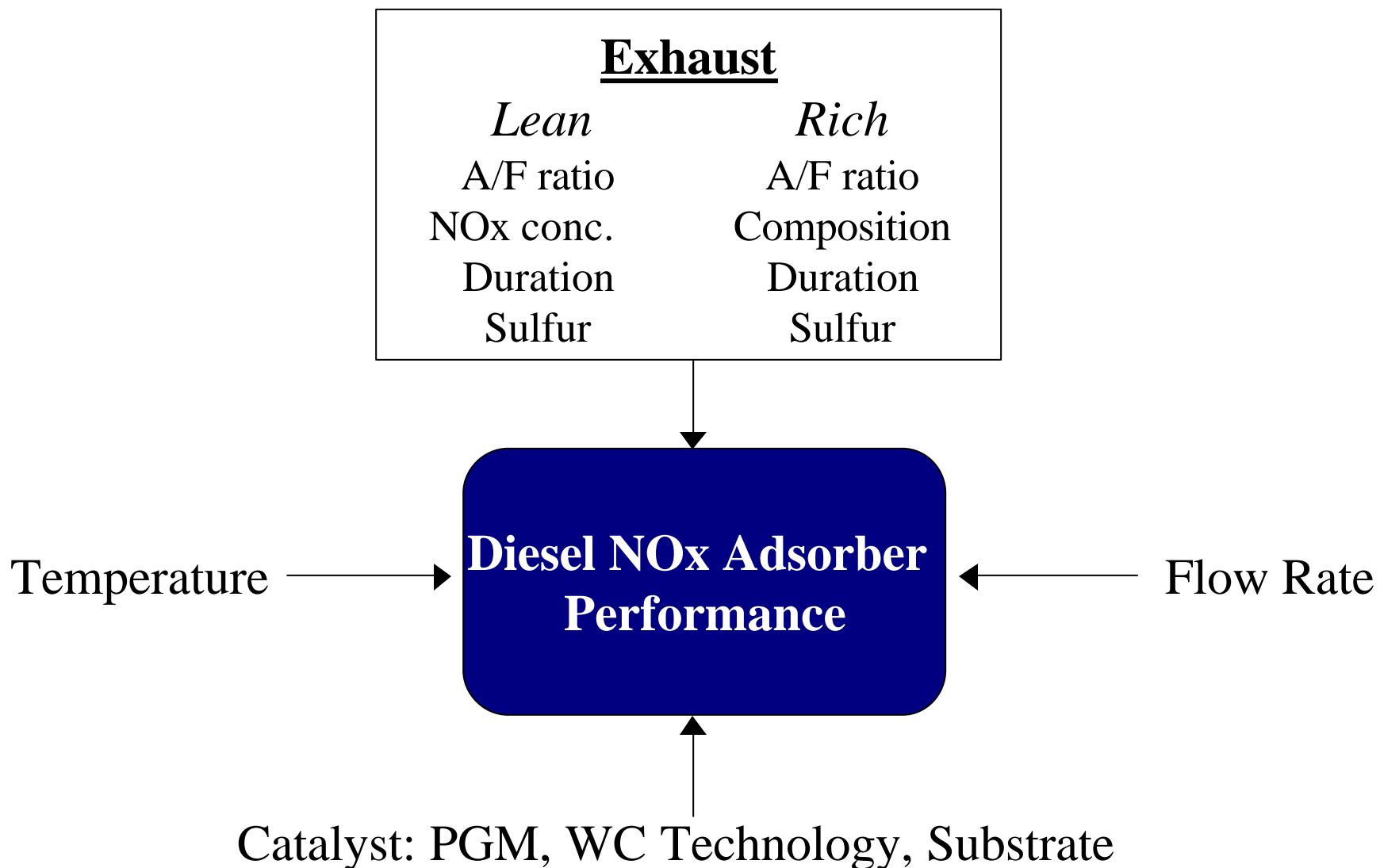
Continuous lean

More “apparent” fuel penalty

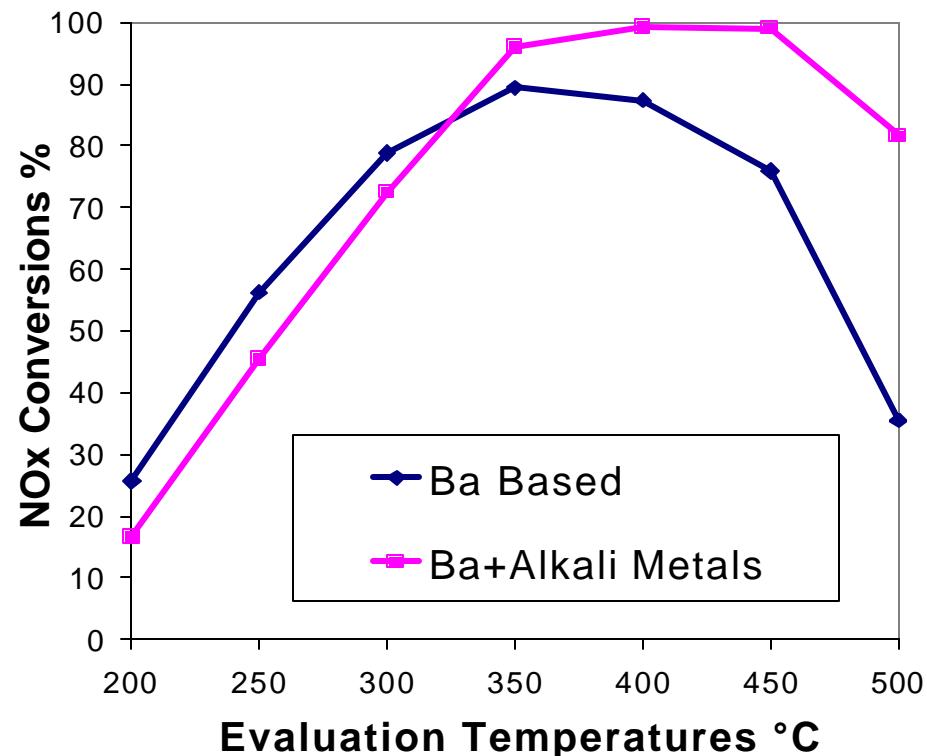
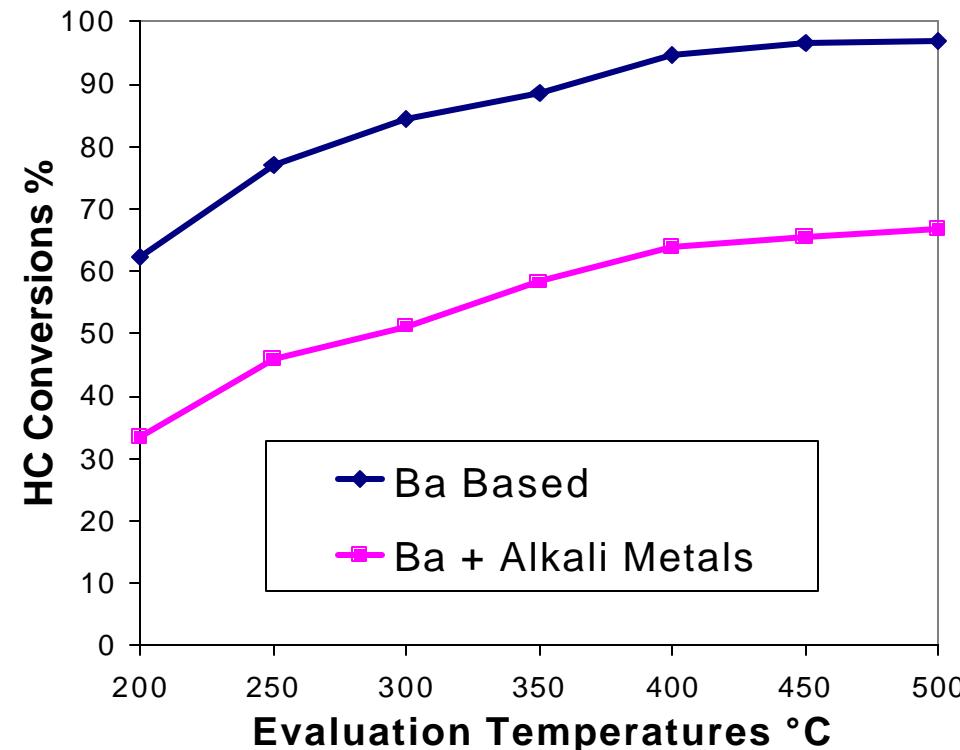
Rich operation: Difficult, PM

Reductants: HC, CO, H₂

Durability required: 650-700 °C



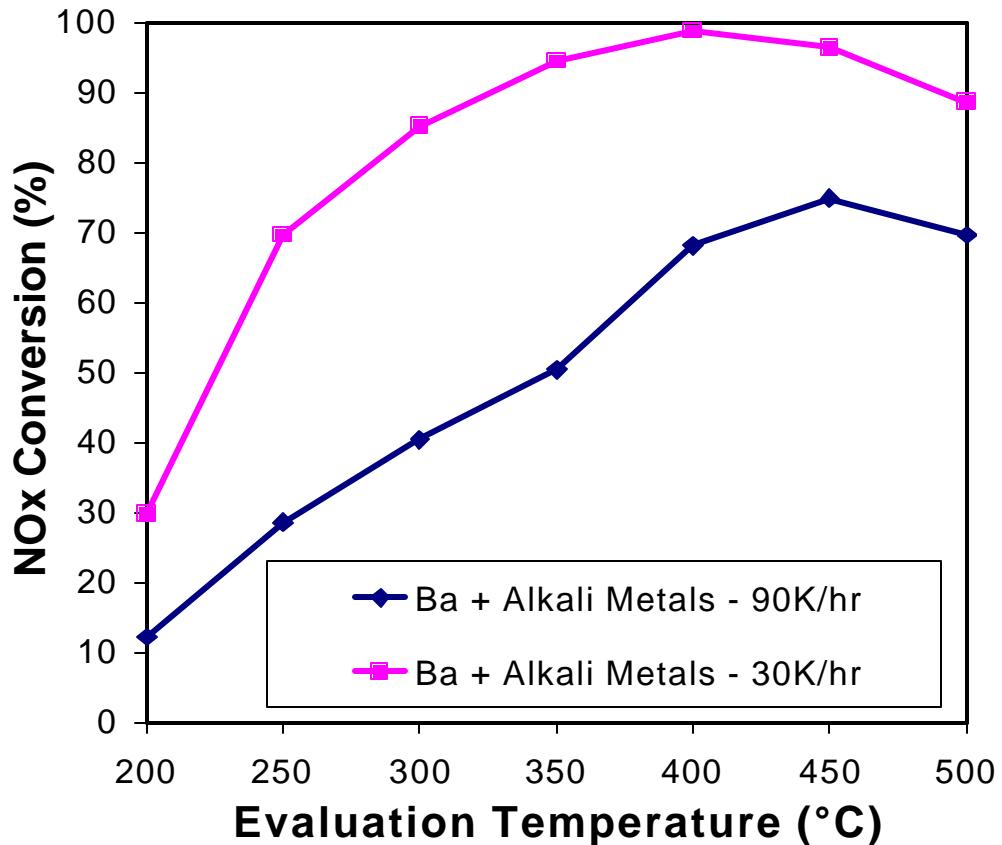
WC technology has a large impact on HC and NOx conversions
NOx and HC conversions are highly temperature sensitive



Aging: 700 °C, air/H₂O for 16hrs

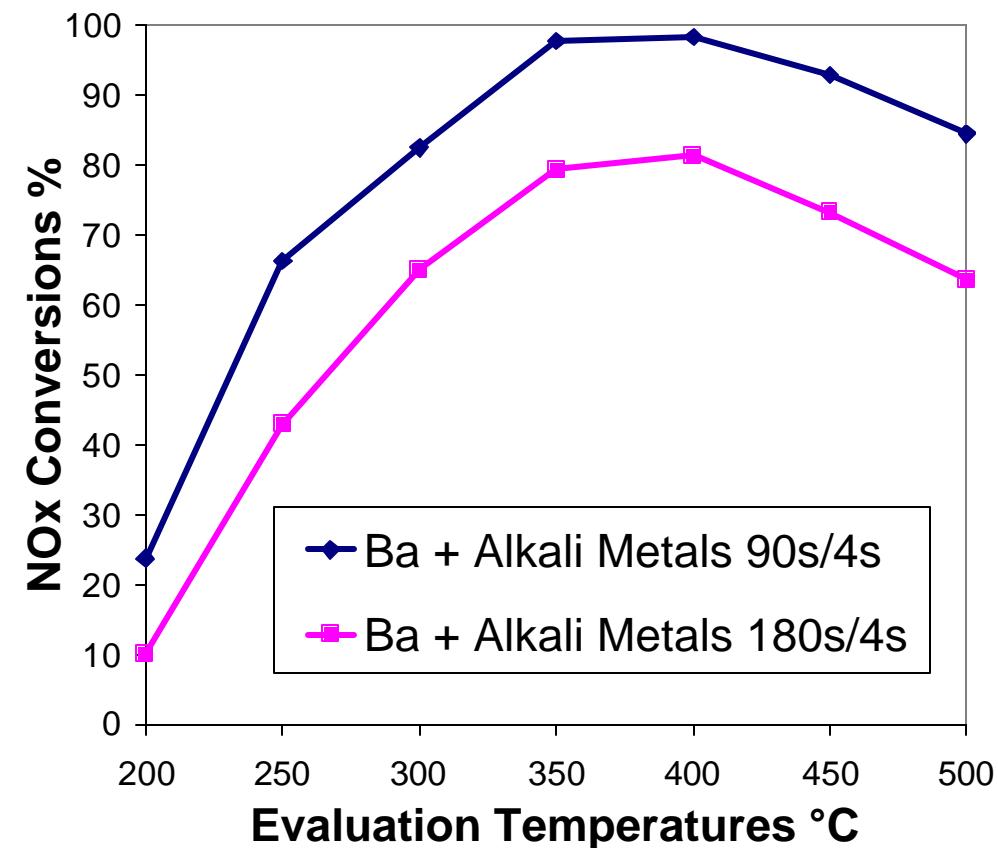
Test: Gasoline Engine 30s/2s, 500ppm NOx, SV=30K/hr

Higher NOx mass flow, lower NOx conversions
NOx conversions are capacity limited



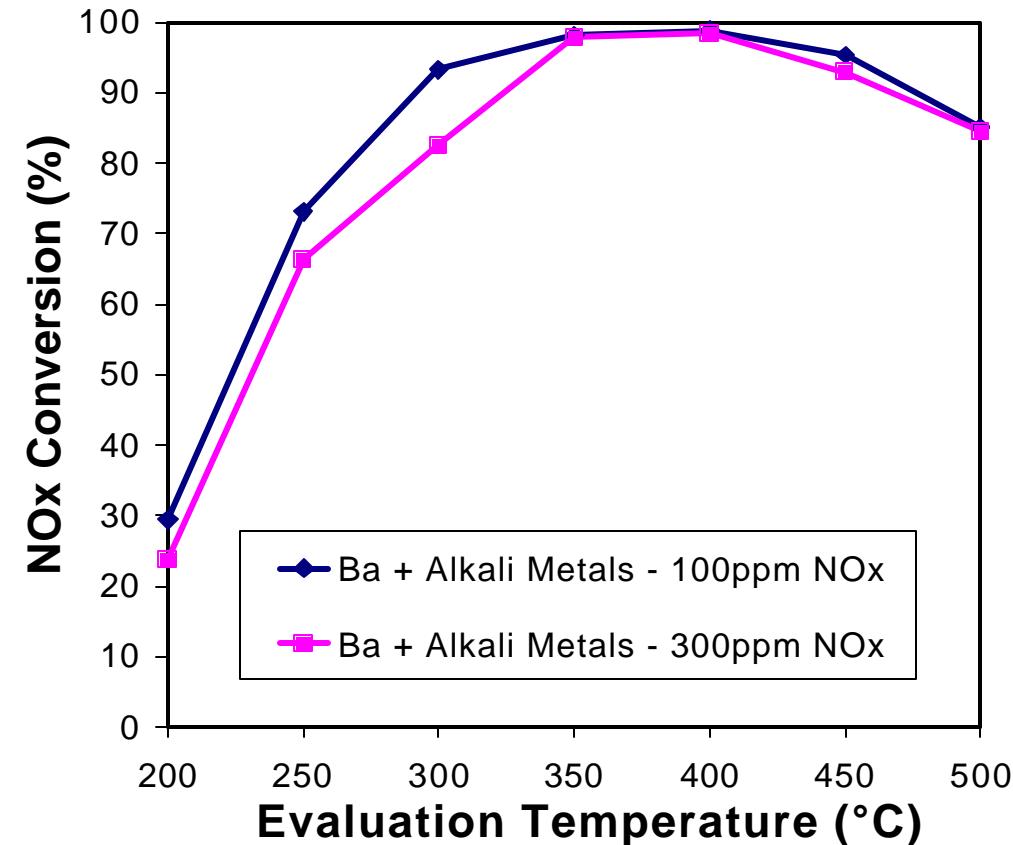
<u>Conditions</u> (Synthetic Gas Reactor)	
Aging:	700 °C Air/H ₂ O
Lean A/F	34
Lean Time	90s
Rich A/F	13
Rich Time	4s
NOx	300ppm
SV	30 or 90K/hr

Longer storage time, lower NOx conversions
NOx conversions are capacity limited



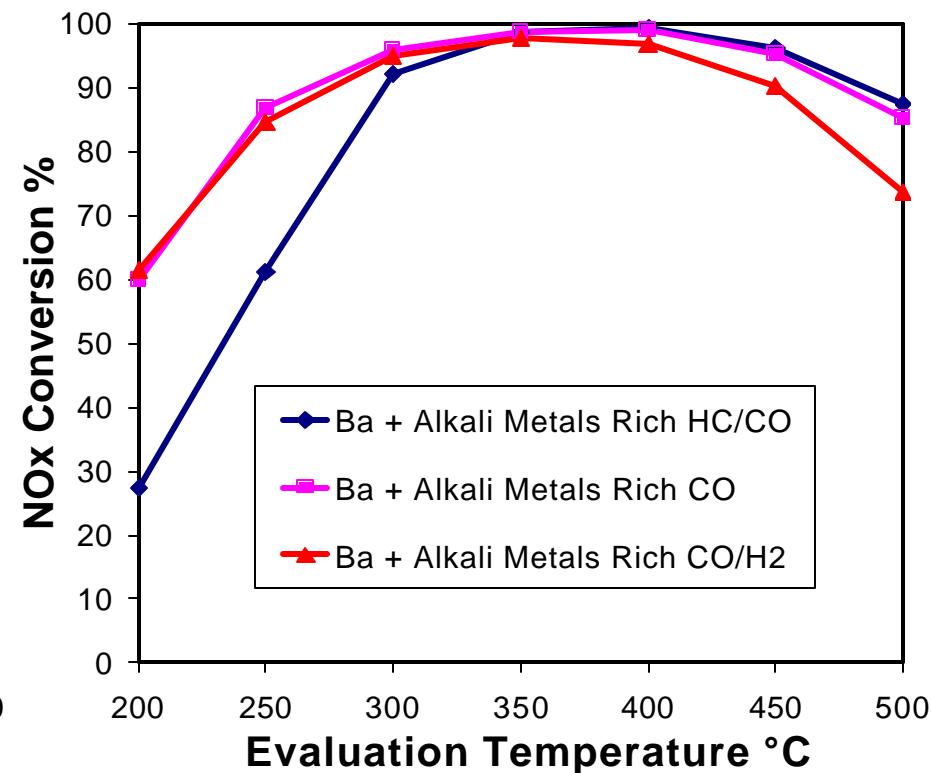
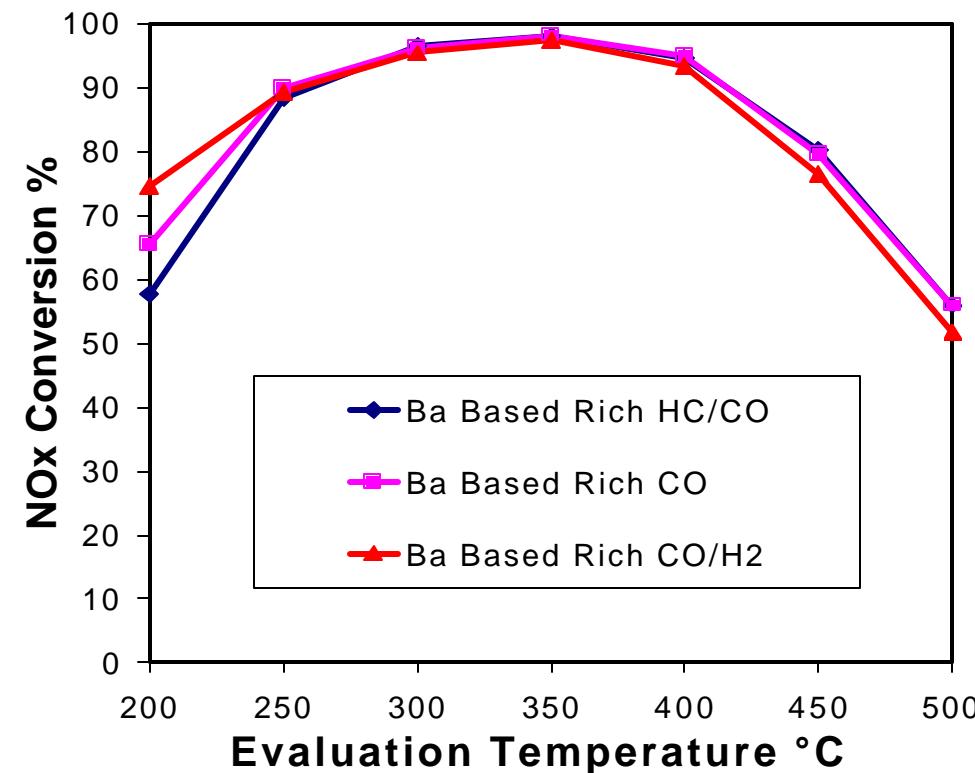
<u>Conditions</u> (Synthetic Gas Reactor)	
Aging:	700 °C Air/H ₂ O
Lean A/F	34
Lean Time	90s or 180s
Rich A/F	13
Rich Time	4s
NOx	300ppm
SV	30K/hr

Higher NOx concentration, lower NOx conversions
NOx conversions are capacity limited



<u>Conditions</u> (Synthetic Gas Reactor)	
Aging:	700 °C Air/H ₂ O
Lean A/F	34s
Lean Time	90s
Rich A/F	13
Rich Time	4s
NOx	300 or 100ppm
SV	30K/hr

NOx conversions are sensitive to rich exhaust composition
More impact at low temperature and on Ba + alkali metals

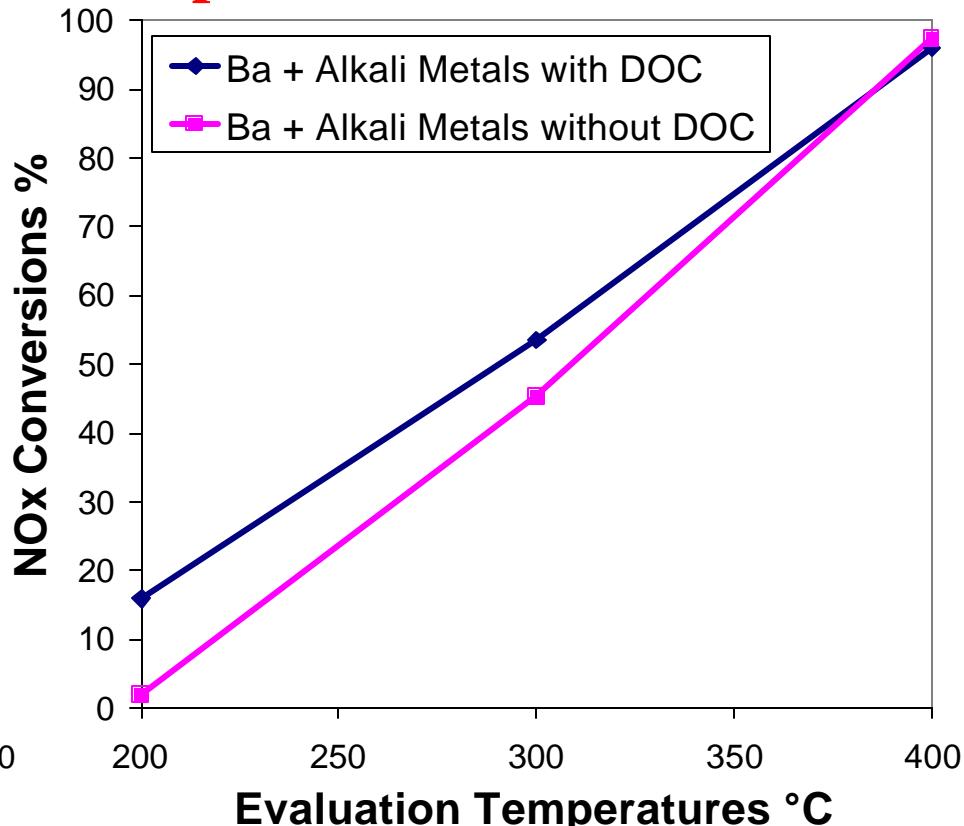
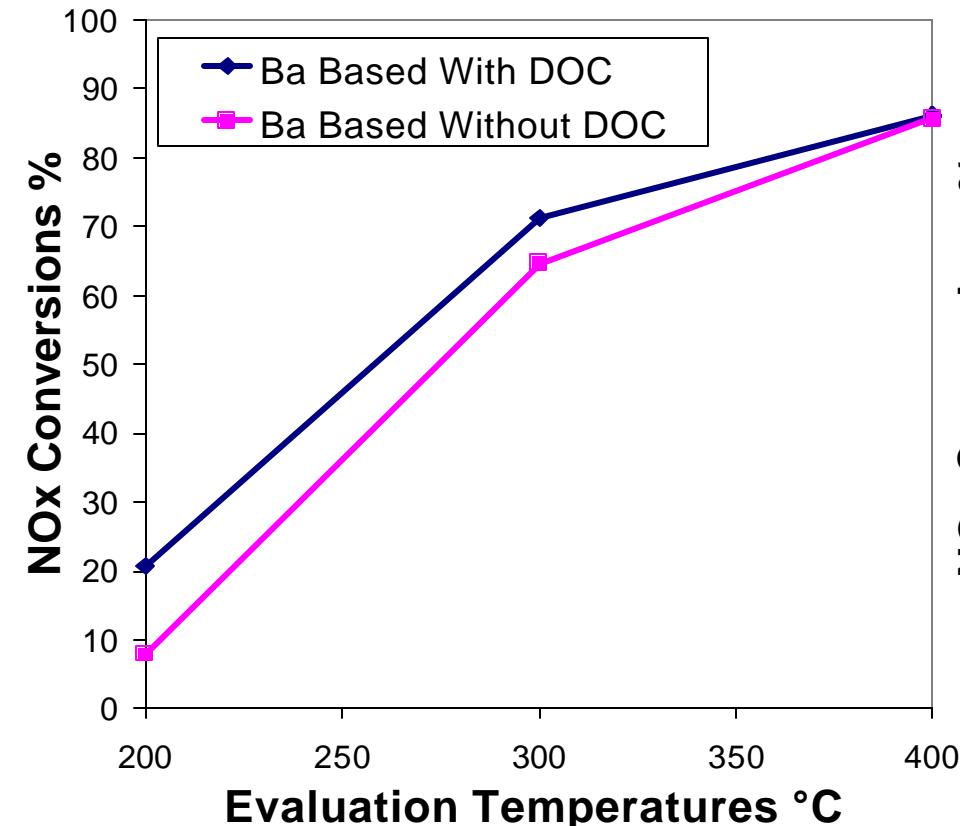


Aging: 700 °C, air/H₂O for 16hrs

Test: Gas bench A/F=34/90s|A/F=13/4s, 100ppm NOx

Presence of an upstream diesel oxidation catalyst is beneficial

No raw diesel fuel please !

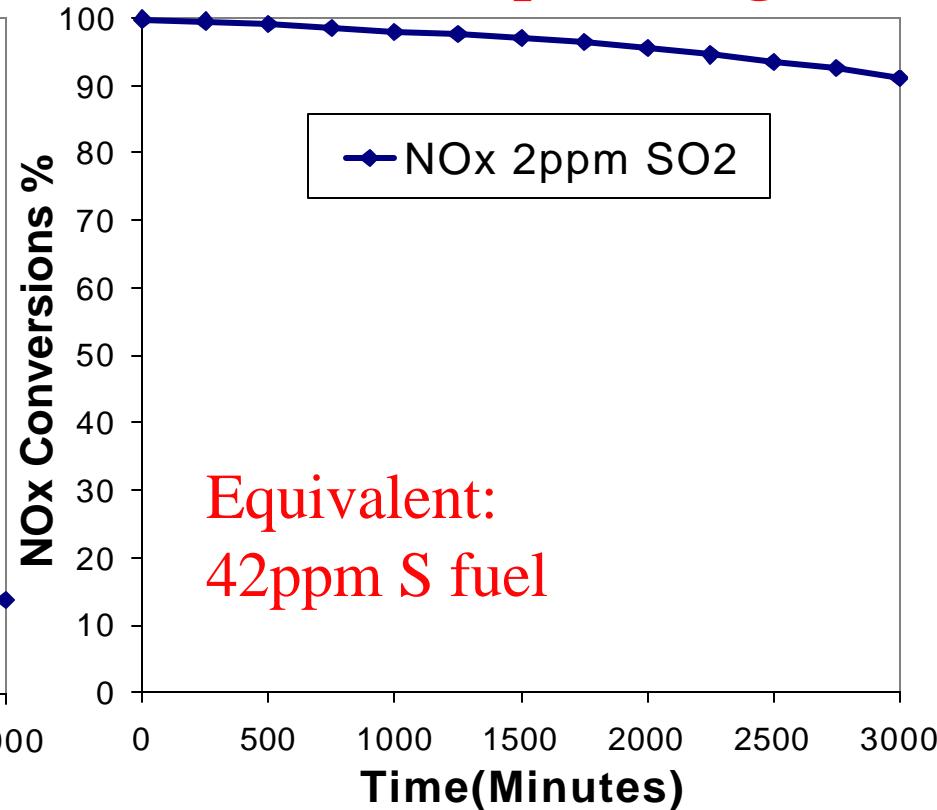
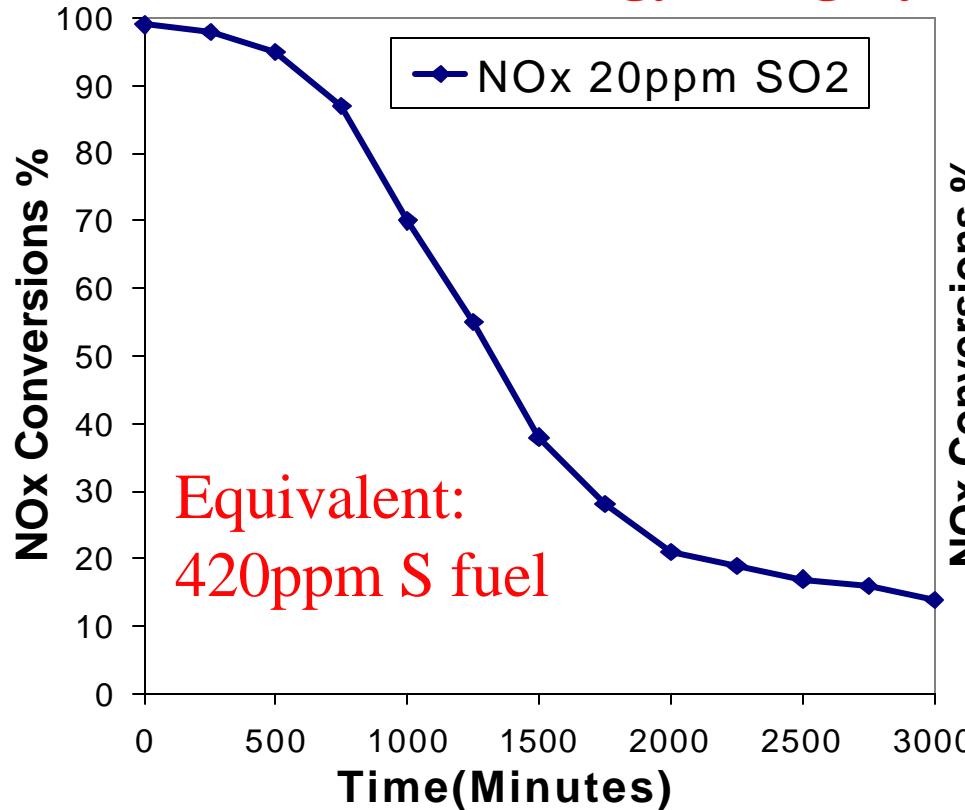


Aging: 700 °C, air/H₂O for 16hrs

Test: 1.9L Diesel Engine, 1.7L catalyst volume

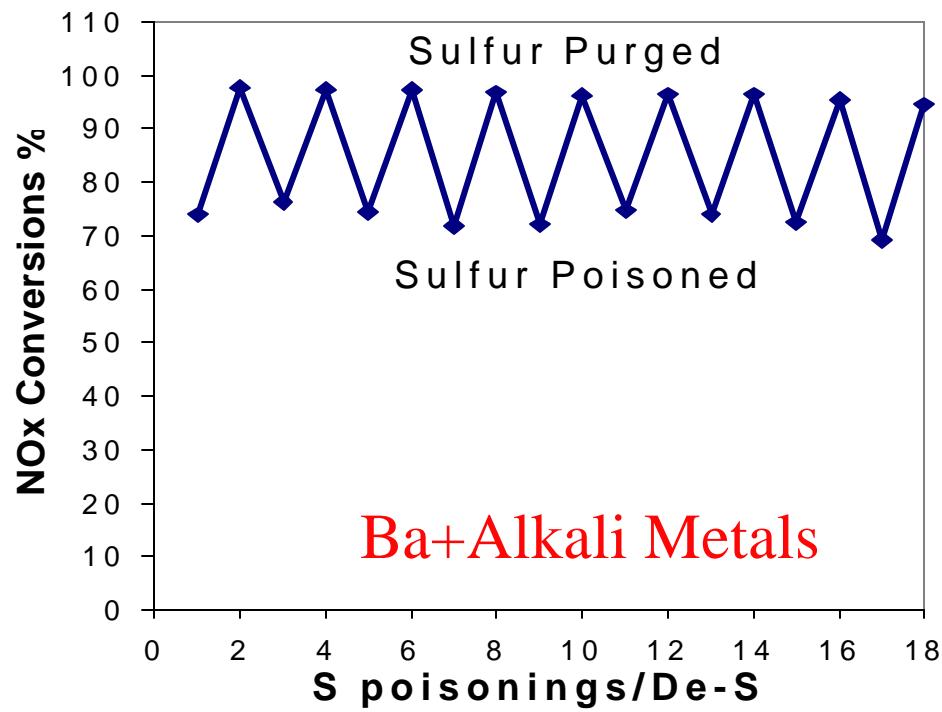
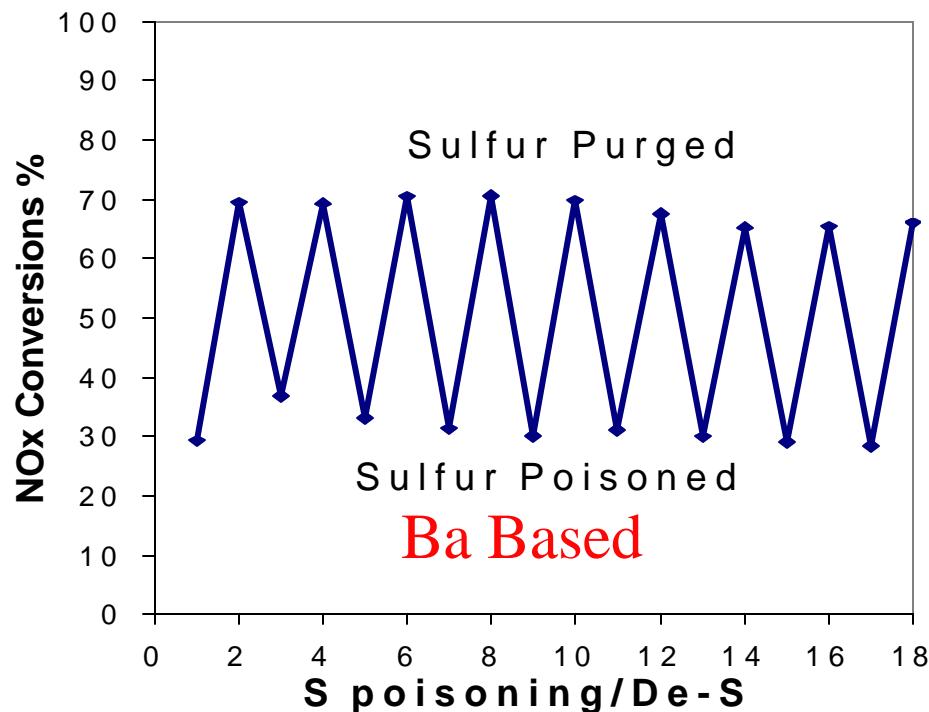
Higher sulfur content, faster de-activation

Technology is highly sensitive to sulfur poisoning



Aging: 400hrs(engine aged), De-S, then 30s/2s at 350 °C for 50hrs
Test: Gas bench 350 °C, 30s/2s, 500ppm NOx, SV=30K/hr

Ba+alkali metals NOx adsorber is more tolerant to sulfur poisoning

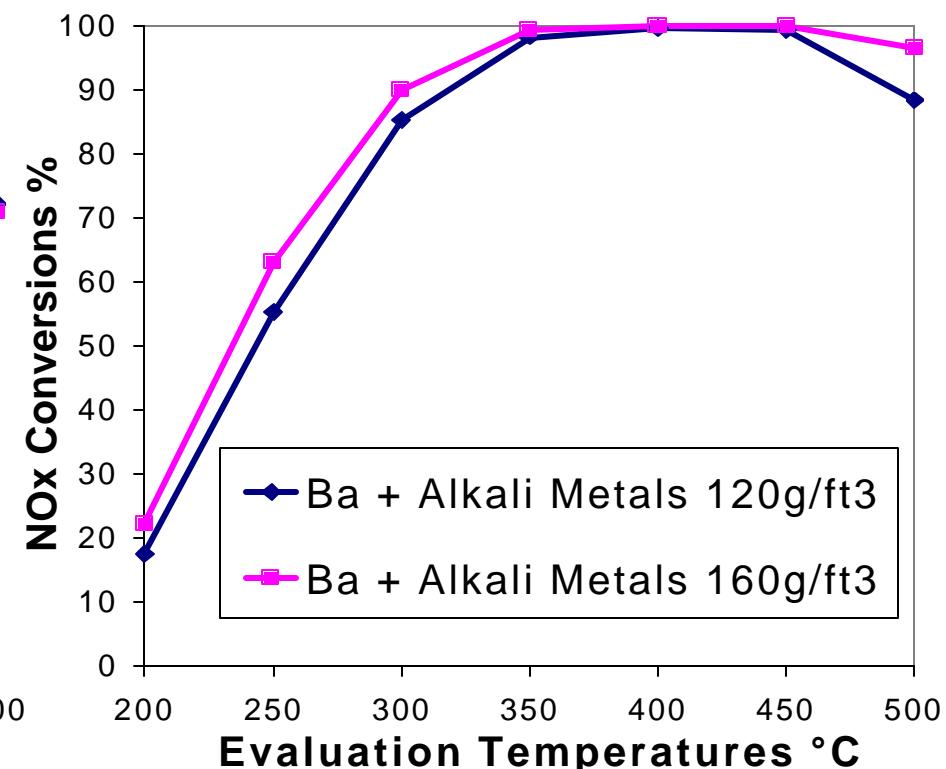
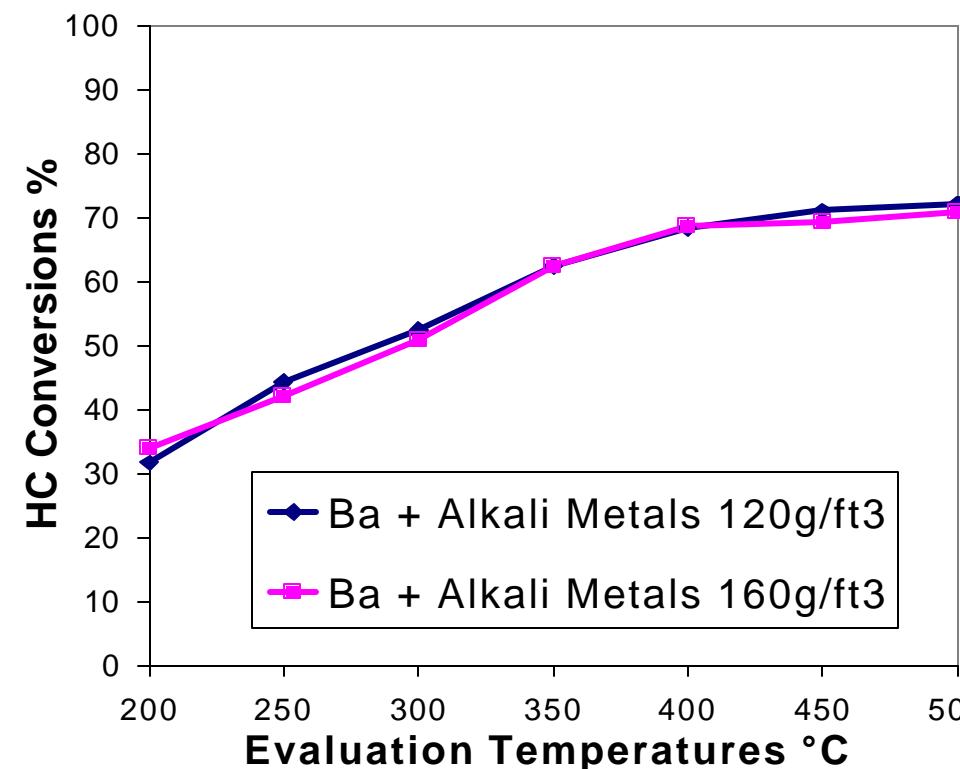


Aging: 700 °C, then 20ppm SO₂, 30s/2s at 400 °C for 5hrs

De-S: 700 °C A/F=13 for 10min, Gas Bench

Test: 350 °C A/F=20/30s|A/F=12/2s, 500ppm NOx, SV=30K/hr

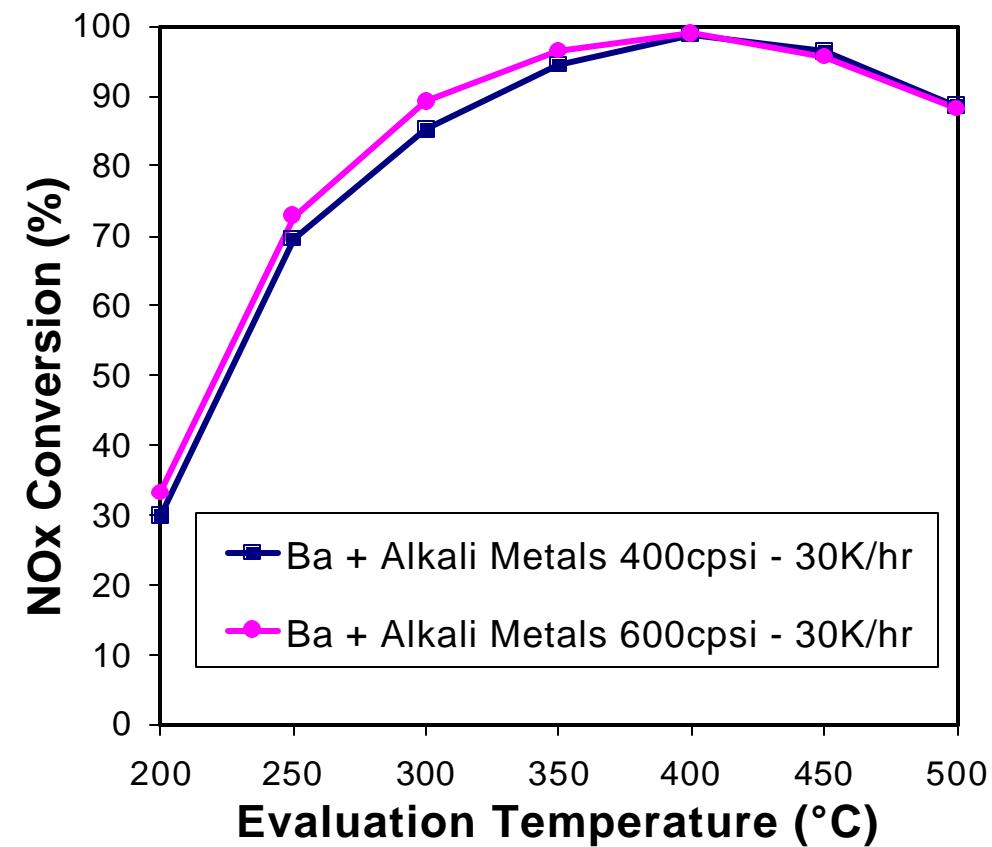
Small benefit for low temperature NOx conversions



Aging: 700 °C air/H₂O for 16hrs

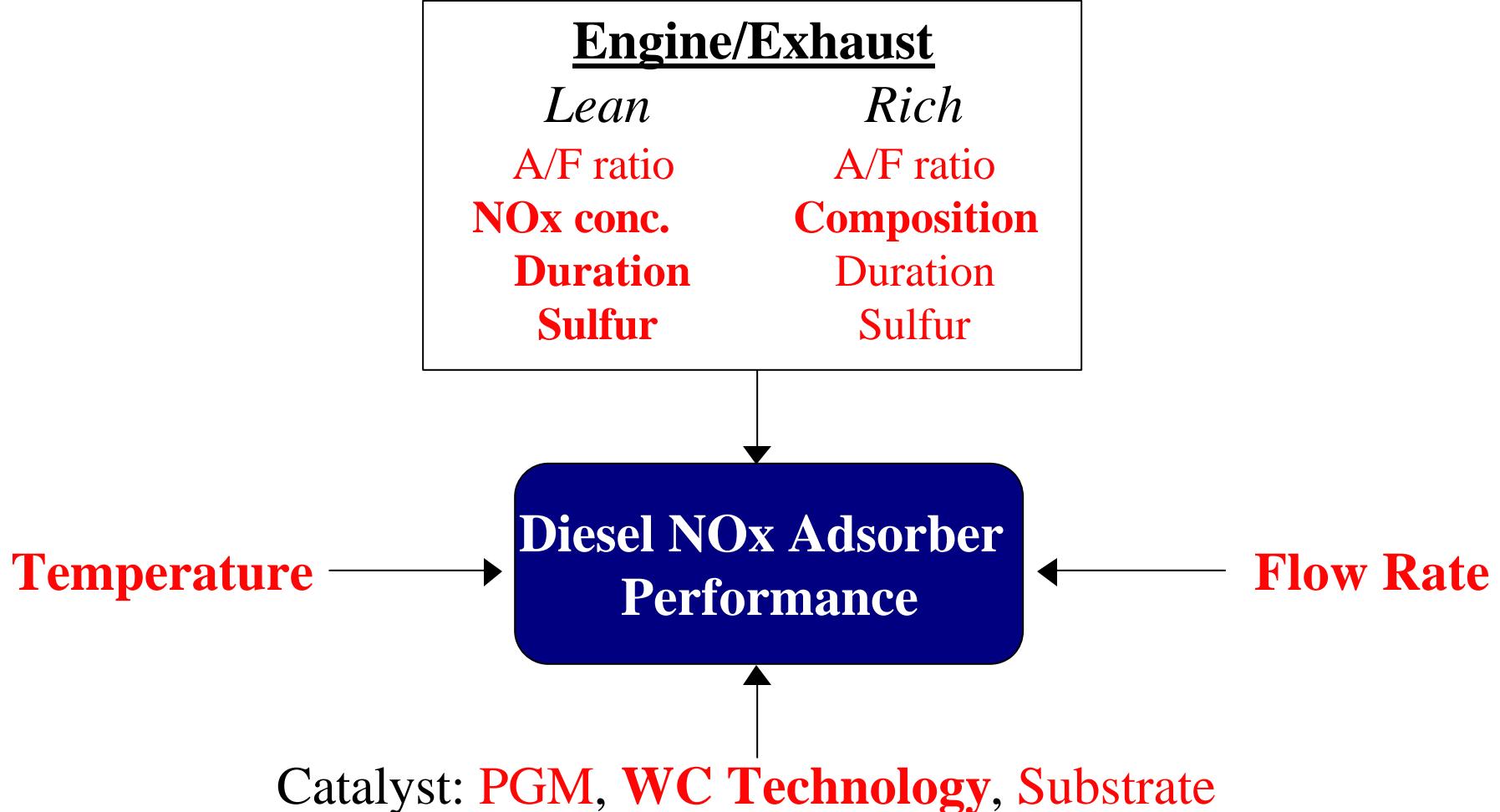
Test: Gas Engine A/F = 21/30s|12/2s, 500ppm NOx, SV=30K/hr

Little or No Impact with Higher Density Substrates



<u>Conditions</u> (Synthetic Gas Reactor)	
Aging:	700 °C Air/H ₂ O
Lean A/F	34
Lean Time	90s
Rich A/F	13
Rich Time	4s
NOx	300ppm
SV	30K/hr

Catalysts: the same amount of washcoat



Key: Catalyst, NOx Capacity, T, S, Regeneration, HC/CO/NOx/PM

- ◆ Mark Thomason: Delphi Catalyst R&D Laboratories (**Gas Bench**)
- ◆ Mark T. West: Delphi Catalyst R&D Laboratories (**Sulfur Poisoning**)
- ◆ Frank Hu: Delphi Flint Testing Laboratory (**Diesel Engine**)
- ◆ Greg Denison: Delphi Automotive Research Laboratory (**Gas Engine**)
- ◆ Mikhail Rodkin: Delphi Catalyst Management (**Tulsa, Sponsor**)
- ◆ Hank Sullivan: Delphi Exhaust Management (**Flint, Sponsor**)