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Development of LNT/cDPF after Treatment System on LCV for Indian Road Condition

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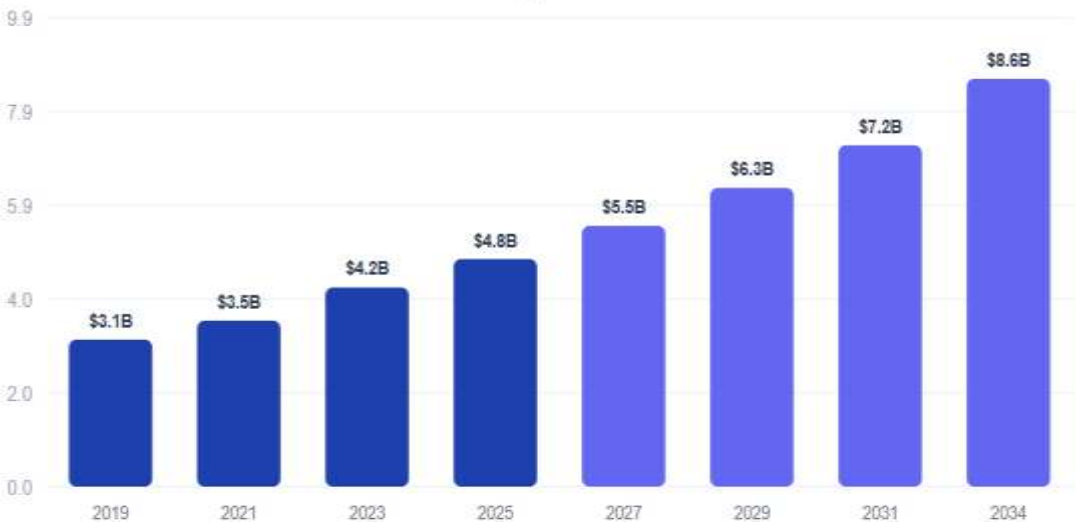
Presentation Outline:

- Perspective on emission category of vehicle using LNT+ cDPF system
- Background of this development
 - Optimum De-SOX & De- NOx frequency for best-in-class fuel efficiency benefit
 - Optimized back pressure through monolith cell structure of DPF
 - Higher soot loading than conventional DPF to trigger delayed active REGEN
 - Achieving longer REGEN interval
 - Better passive burning resulting in less HC slip
 - Lower heat transfer rate material advantageous to achieve faster soot burn rate
- Conclusion

Introduction:

N1 category vehicle, LNT + cDPF system as a preferred solution

Lean Nox Traps Lnt Market Size & Forecast
CAGR: 6.7% | USD Billion



Diesel is moving towards LNT-led solutions

Need of cDPF in N1 vehicle.

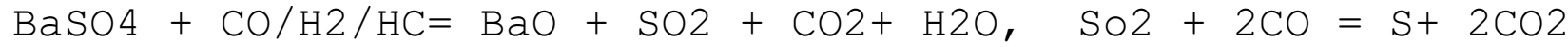
- cDPF needed to meet the PN criteria. Coating provides better filtration efficiency,
- For India's N1 diesel segment, cDPF plays important role. The REGEN interval has to be in sync w

Benefits of LNT system over SCR system in N1 Cat

Factor	LNT(Lean Nox trap)	SCR
System complexity	Simpler - Less Hardware & Sensors	Complex - High no of Hardware & added sensors
Exhaust Temp. sensitivity	Largely Low Temp application - suitable for SCV segment Fall in preferred LNT temp range	Suitable for passenger application with high speed& high Exhaust Temp.
Operating cost	Lower, No DEF refill	Higher, DEF refill & maintenance
Why LNT wins in N1	LNT vehicle cost are lower, & ease of maintenance (Filters)	

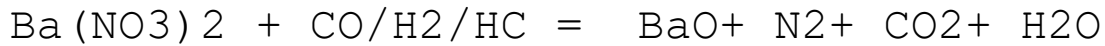
- Urban duty cycles favor simpler aftertreatment
- The development trend for MIDC+ and WLTP is with 1

Optimum De-SOx & De- NOx frequency for best-in-class FE



De-SOX removes stored sulfur sulfates and restores NOx control

De-Nox regeneration:



De-NOx reduces stored nitrates to N2 and restores LNT NOx storage capacity

Optimized
De-Nox interval

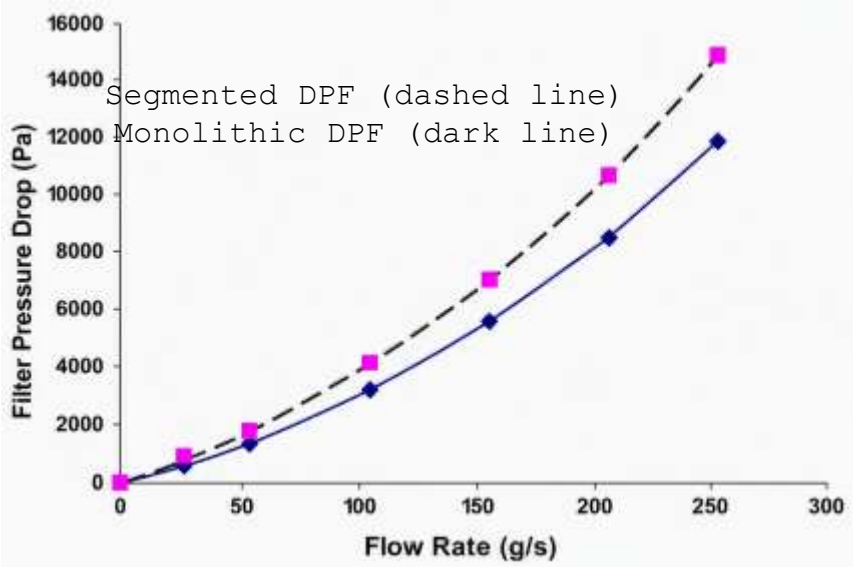
Combustion Mode	Count of time
Lean Mode	94.6%
Rich Mode- De-NOx	5.4%
Grand Total	100.0%
Combustion Mode	Count of time
Lean Mode	95.24%
Rich Mode-De-NOx	4.76%
Grand Total	100.00%

Highlights

- De-Nox temp. interval for maximum conversion in between 250 to 350 °C
- Refine calibration for catalyst temperature, soot load, and exhaust thermal behavior
- Lambda(λ) between 0.92 to 0.98 consider for better De-Sox, at >650°C
- De-Nox interval improved by 12% , increase fuel efficiency
- Less sensitivity to Sulphur , reduced SOx poisoning
- Use accurate model prediction to better control regeneration timing and frequency

Optimized back pressure through monolith cell structure of DPF

Material Properties	Units	Aluminum Titanate (AT)	Silicon Carbide	Remark
Structure				Low pressure drop in monolithic structure
Thermal Conductivity	W/m-K	1	10 - 20	High heat retention in AT
Coff. thermal Expansion (x 10 ⁻⁷ , 25 - 1000 °C)	/°C	< 13	45	Low thermal expansion in AT
Specific Heat Capacity @ 500 °C	J/cm3 /°C	3.4	3.63	Temp. rise faster in AT
Intrinsic Density	g/cm3	3.2	3.4	Sic is denser than AT
Thermal Mass		Low	High	

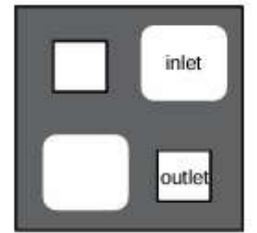


- Catalyst Size= 5.66"XL", CPSI 3
- Flow temp. 300°C
- 15% higher filtration wall area
- 30% less pressure drop in AT.

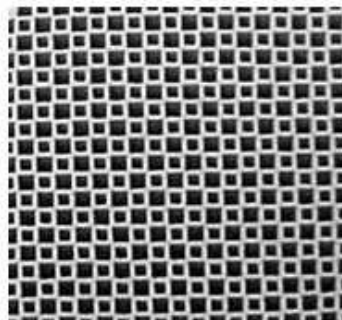
Higher soot loading in AT than conventional Si-C cDPF

- Thin wall & ACT design to enable high ash capacity
- Reduced soot loading rate enables comparable bulk density

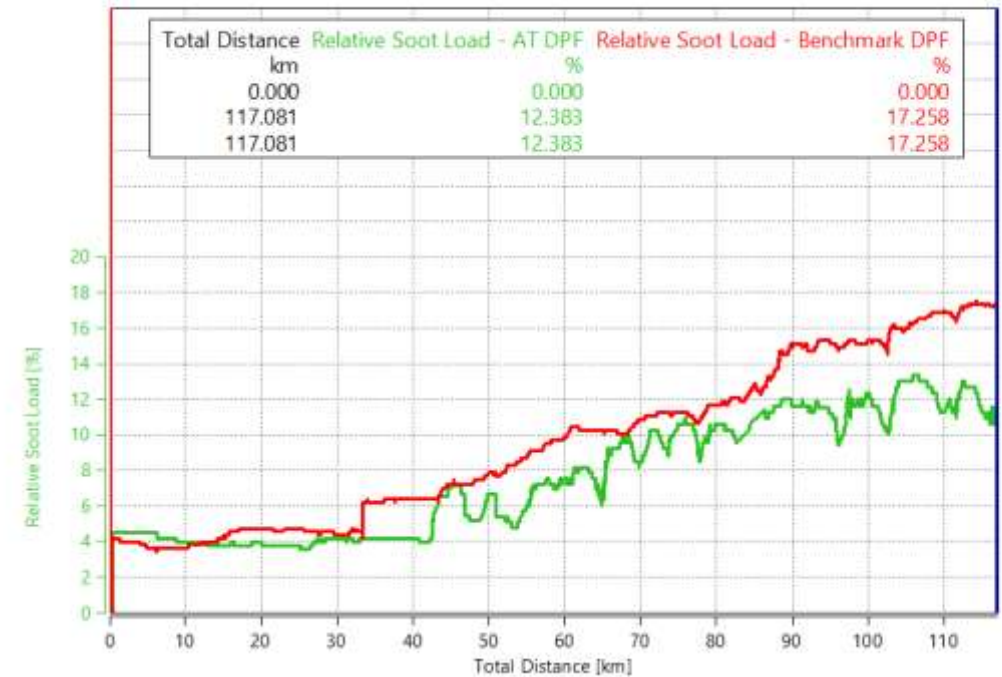
Cell design for high ash capacity



Asymmetric Cell Technology (ACT)



- 8% more open frontal area(OFA)
- 12% more filtration surface area
- Lower thermal mass of AT than SiC
- ACT homogenizes soot and gas flow, reducing thermal gradients.

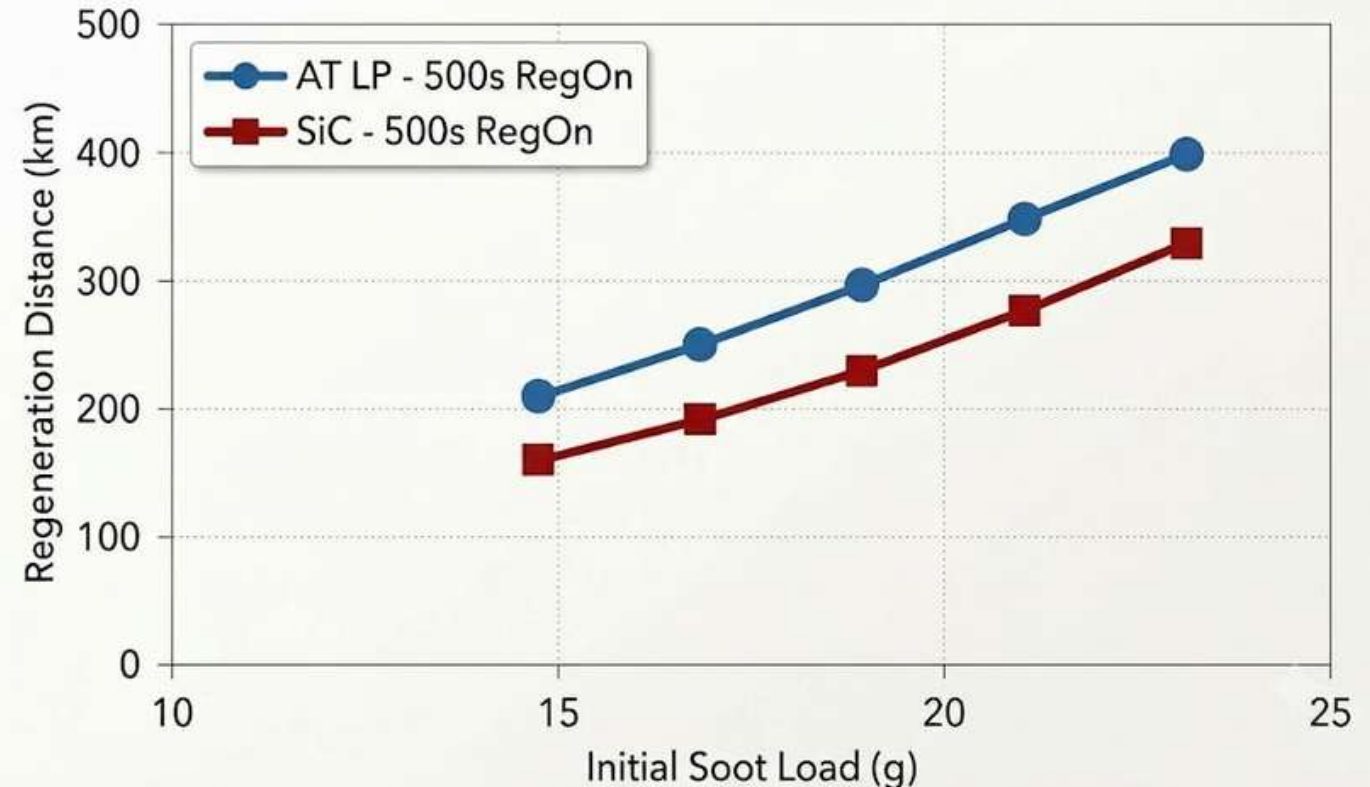


- AT DPF exhibits lower soot loading (12% vs 17%) over same distance
- Lower loading rate indicates higher soot storage capacity
- Higher soot capacity enables longer regeneration intervals

Achieving longer active REGEN interval

- AT has better regeneration efficiency in this city-cycle test.
- For the same target soot load, SiC needs nearly 30% more active Regen than AT.
- AT performs better in longer intervals
- More active regenerations mean higher fuel penalty and greater **oil dilution risk**

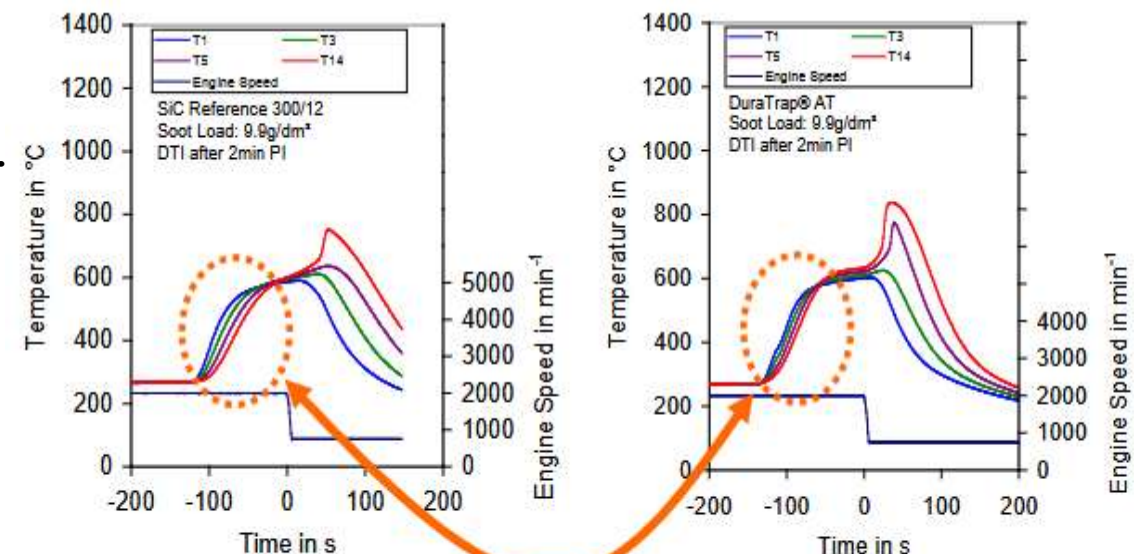
DIESEL PARTICULATE FILTER (DPF) REGENERATION PERFORMANCE COMPARISON
(AT LP vs. SiC - 500s Regeneration)



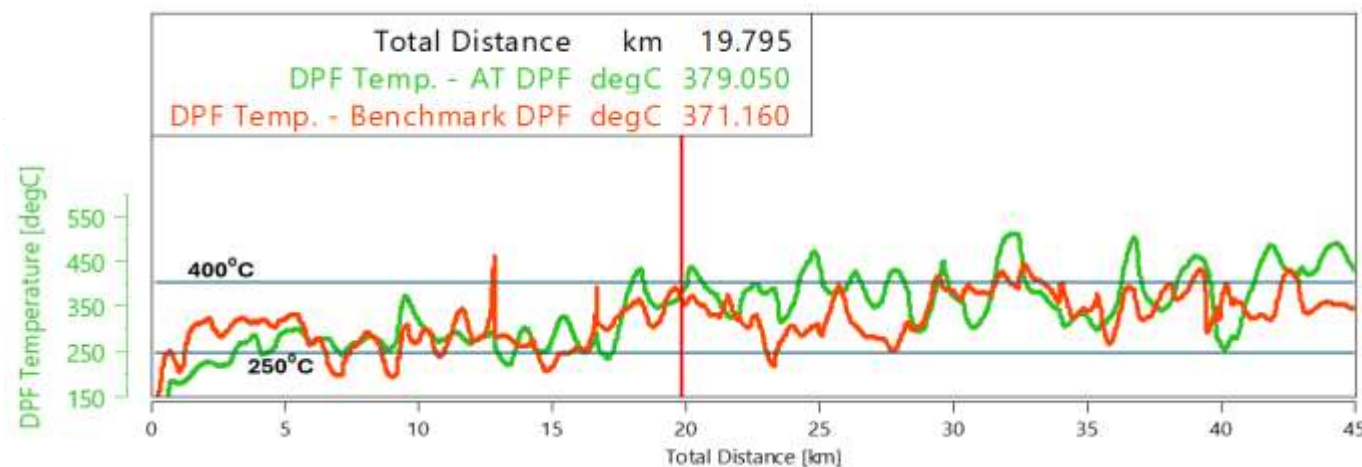
Comparison of regeneration distance in Ci
w/ 500s regeneration

Better passive burning resulting in less HC slip

- AT have low thermal mass , faster light off temp.
(250 to 400° C)
- AT shows advantage in passive burning, helping
reducing REGEN frequency.
- AT supports faster soot oxidation, which lowers
HC slip.
- AT reaches the regeneration temperature window
more quickly than SiC.
- AT provides higher regeneration efficienc
city-cycle conditions.

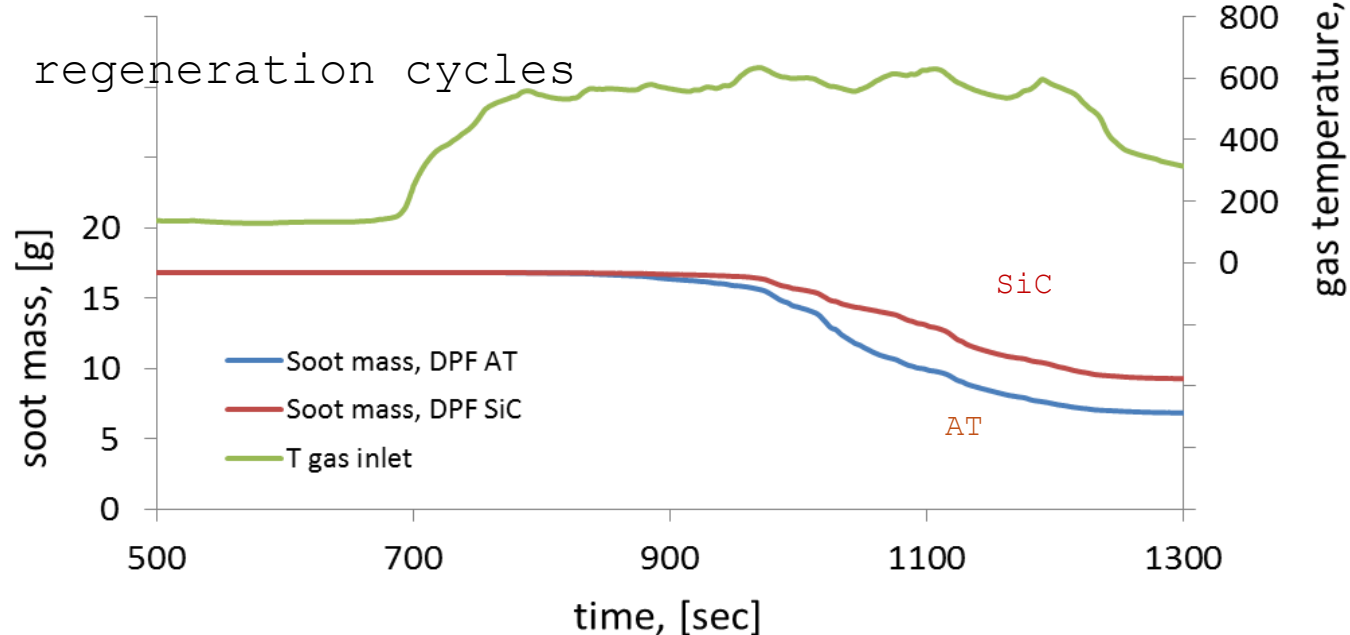
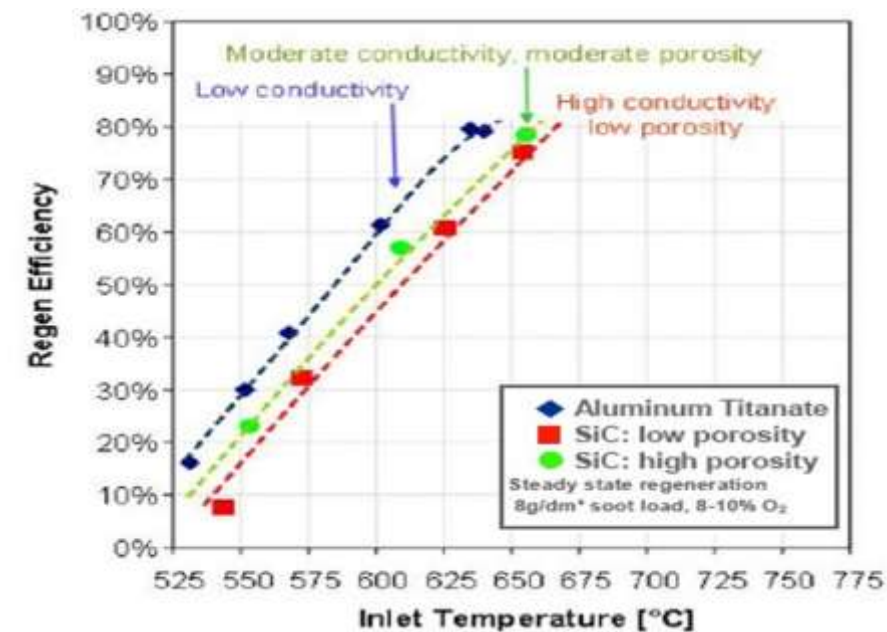


Slower heat up for SiC filter



Lower heat transfer rate material advantageous to achieve faster soot burn rate

- AT DPF shows faster soot oxidation, in identical cycle
- Lower thermal conductivity helps retain heat
- Higher local temp. accelerates soot burn rate
- AT achieves greater soot mass reduction
- Faster soot burn enables shorter & more efficient regeneration cycles



Example :

City Cycle w/ regeneration
on for 500s

Initial soot load 8g/l

Conclusions

- Optimized De-Sox & De-NOx model to get 12% less De-Nox interval
- ACT cell structure have 8% more OFA & 12% more filtration area
- Monolithic structure have low pressure drop than segmented
- AT DPF have 15 to 18 % more soot loading capacity than SiC
- Combination of LNT/cDPF have better emission control in N1 segment

THANK YOU