vitesco TECHNOLOGIES

ECT 2022

ADVANCED METALLIC SUBSTRATES FOR HD/NRMM APPLICATIONS

(JOINT DEVELOPMENT WORK BY EMITEC & DINEX)

Paresh Laddha

EMITEC

Agenda

1 **Vitesco Emitec Update**

2 **METALIT® Portfolio**

3 **CS Test Program**

4 **Summary**

EMITEC PORTFOLIO

Substrates & Filters, Engineering Services

› Development, Engineering and Production of Innovative Components

- Metal Catalyst Substrates
- Particulate Filter

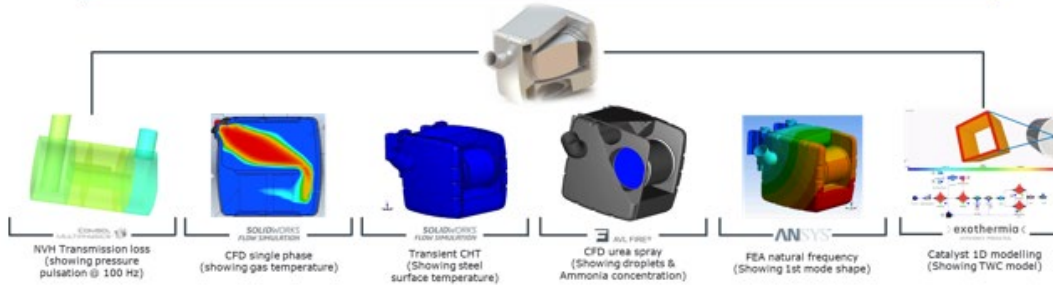
- System engineering support, development and testing services for OEM & system integrators
  - Testcenter
  - Engine- & roller test benches
  - Component test benches

Acknowledgement – Test program support

Dinex Portfolio of Expertise & Products

going the extra mile

Canning & mixer development

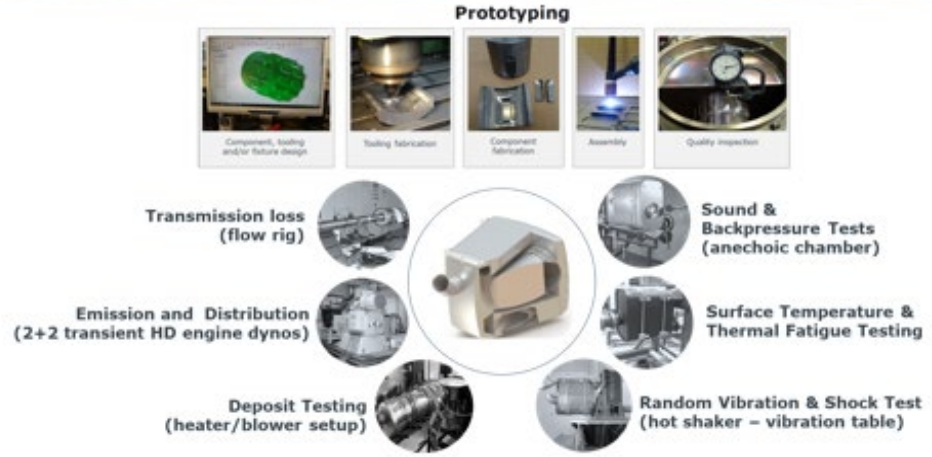


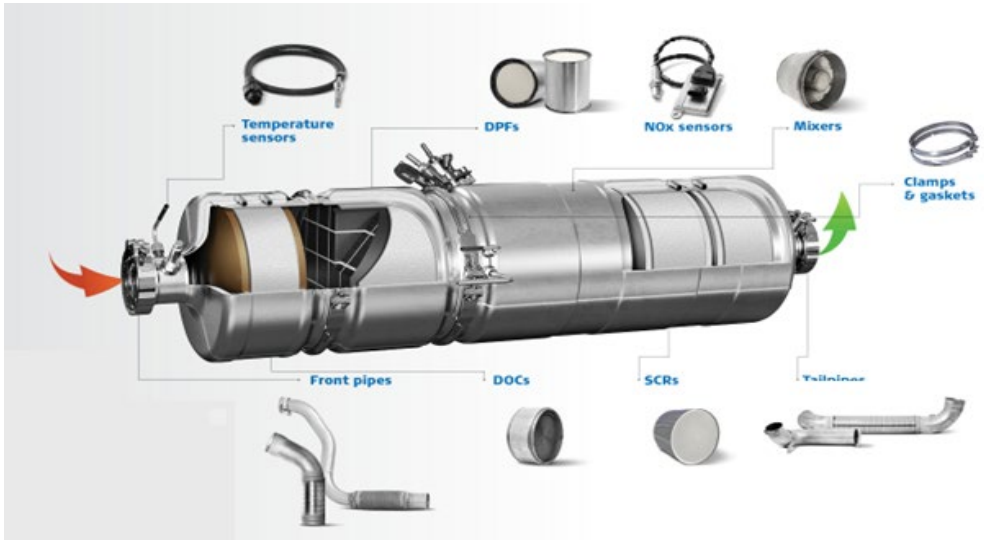
Simulation Capabilities

CFD	FSI	FEA	NVH	Catalyst
Backpressure and spray (HC & urea)	Conjugated heat transfer and thermal stress	Modal analysis, static, forced response, and random vibration	Transmission loss	1D systems simulation for DOC, SCR, DPF and TWC

Catalyst & Coating development

System integration, testing & validation





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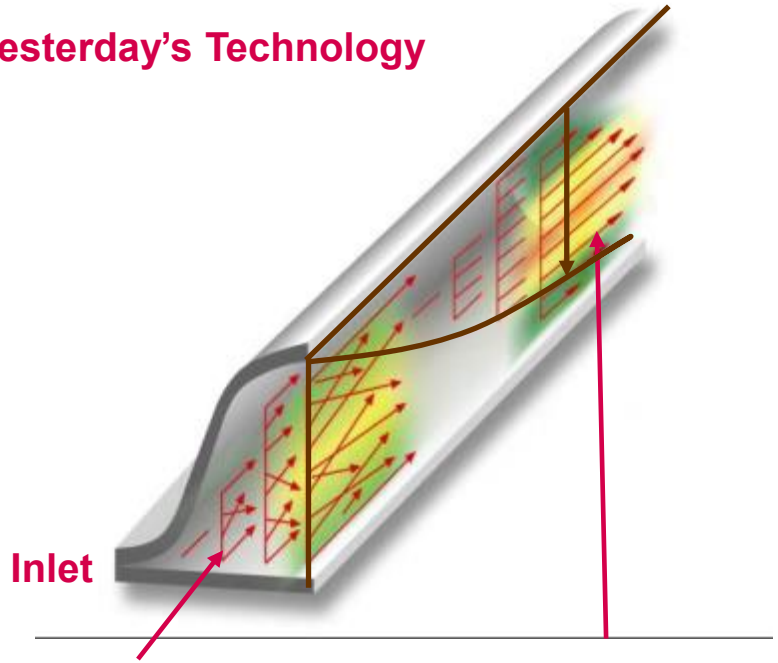
STANDARD SUBSTRATES ARE LAMINAR

Monolithic Honeycomb (ceramic and metal)

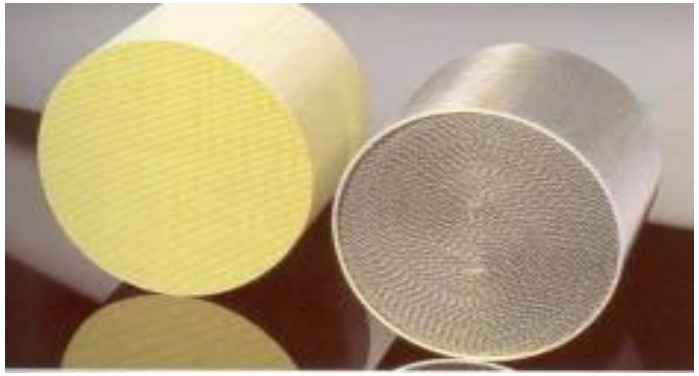
Yesterday's Technology

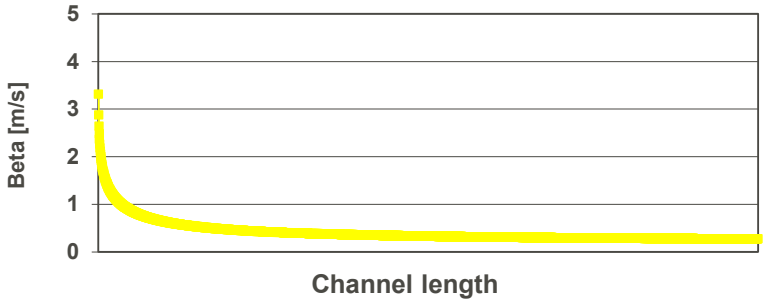


Turbulent-like flow, at inlet, higher efficiency

Laminar flow profile is developed,

Efficiency and Pollutant concentration decrease as a function of channel length.

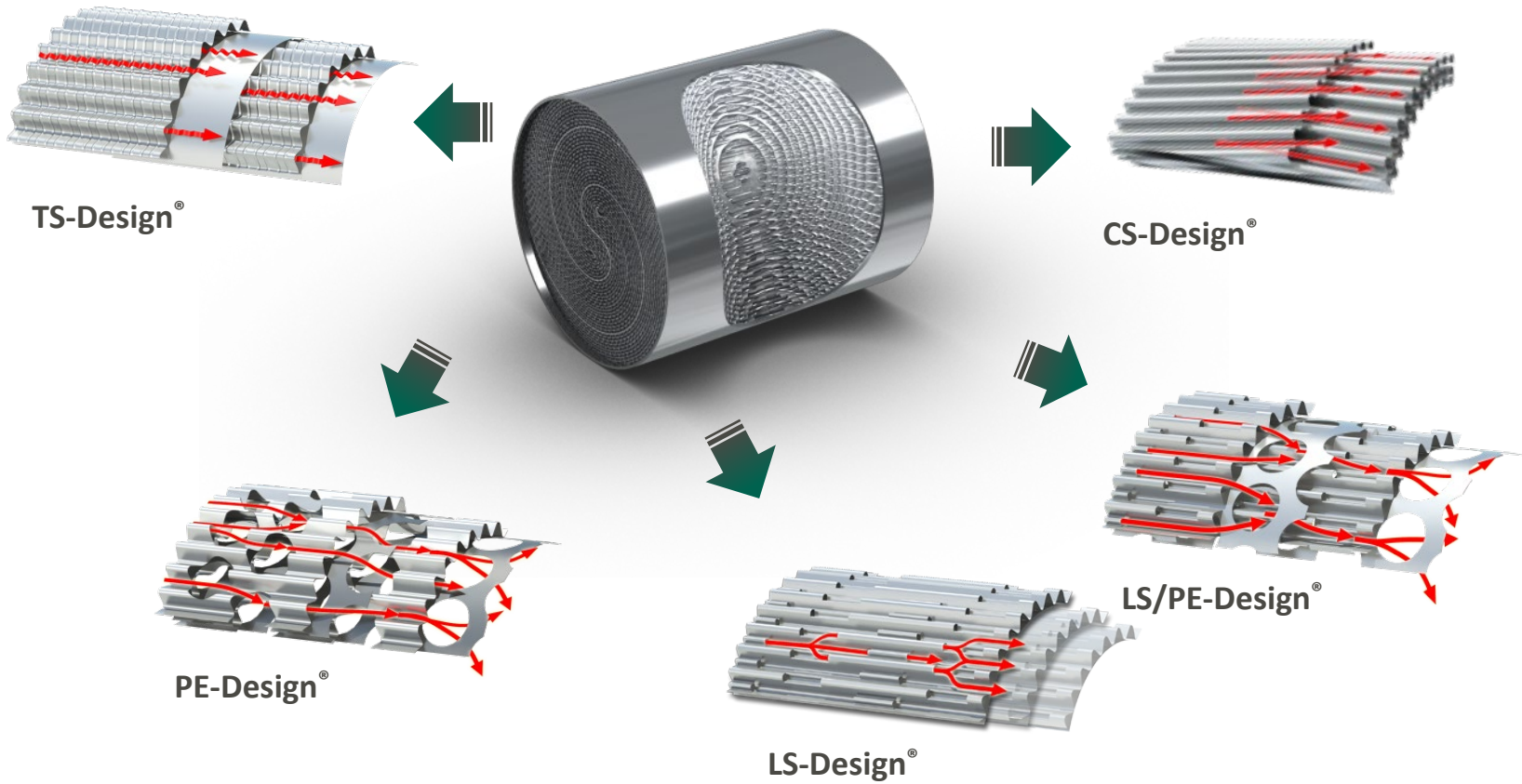




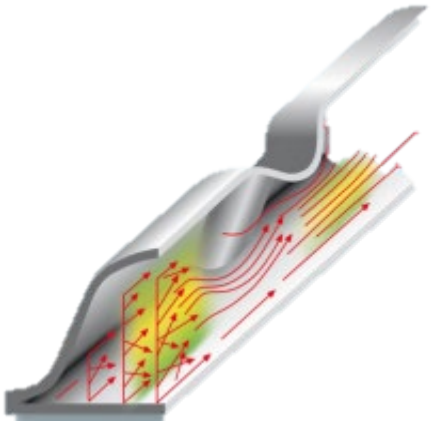
- Laminar flow profile is created a short distance after inlet face
- Mass transfer decreases sharply with channel length
- Conversion rate is limited by diffusion in laminar boundary layer

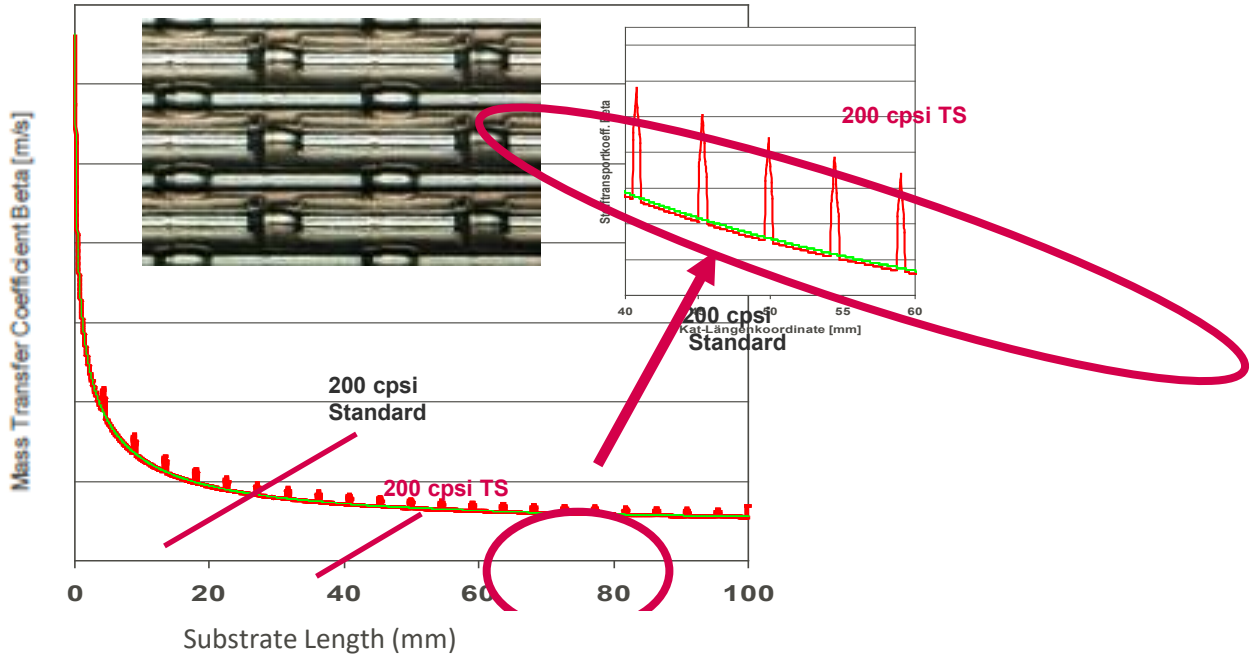
EMITEC METALIT® PORTFOLIO

Structured Substrates



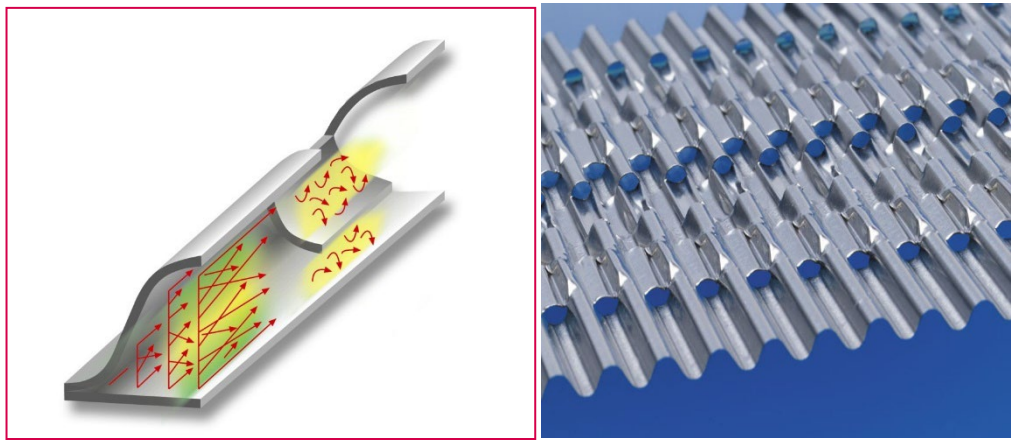
SUBSTRATE WITH TRANSVERSAL STRUCTURES (TS)

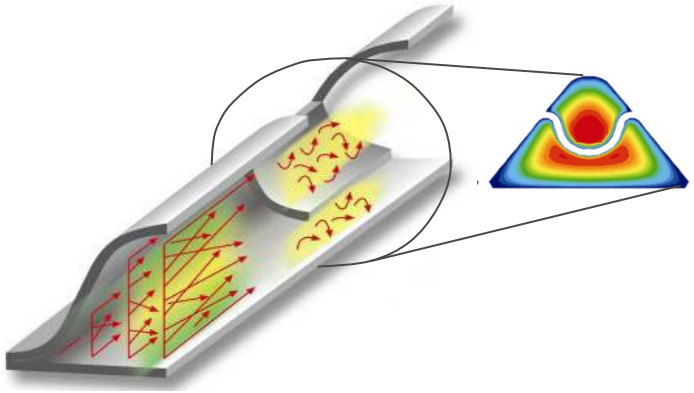


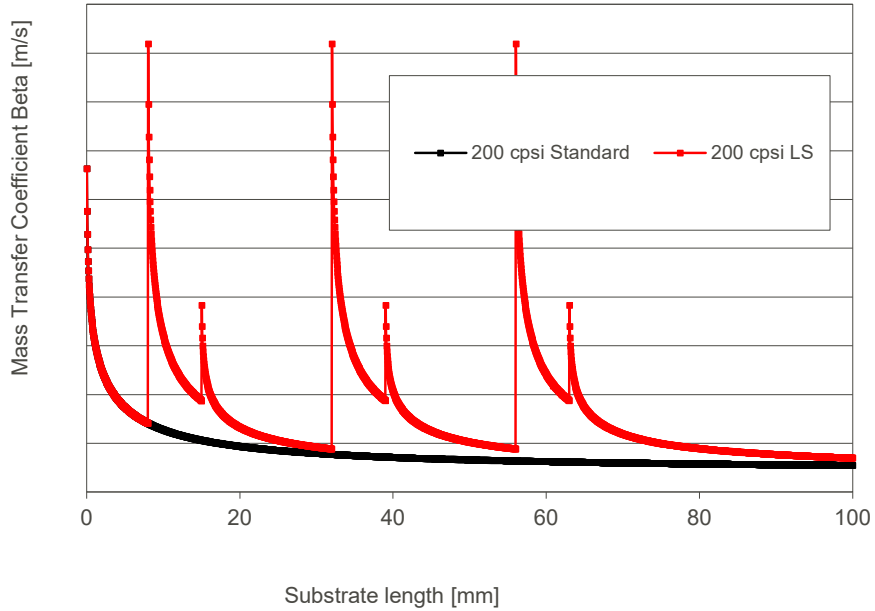


- ~10% efficiency increase / Std
- → Reduce volume @ same performance
- → Reduced thermal mass
- →Reduced cost

SUBSTRATE WITH LONGITUDINAL STRUCTURES (LS)







- ~15% efficiency increase / Std
- → Reduce volume @ same performance
- → Reduced thermal mass
- →Reduced cost

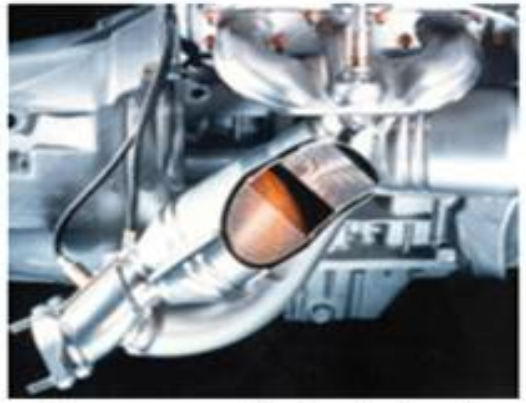
TECHNOLOGY FOR BEST PERFORMANCE AND COST

4 WHEELER METALIT® SUBSTRATE

PassCar

1996

Underfloor catalyst with electrically heated Catalyst EHC



1998

Close-coupled catalyst

2013

Additional Functions needed:

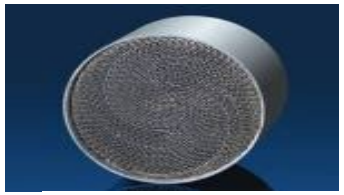
Lambda-sensor

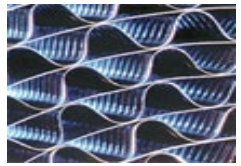
Electrical heating

TECHNOLOGY FOR BEST PERFORMANCE AND COST

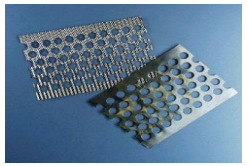
2 WHEELER METALIT® SUBSTRATE

Structured substrate technology experience successfully transferred to India market





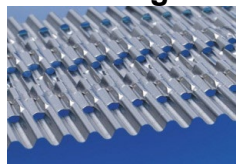
TS-Design®



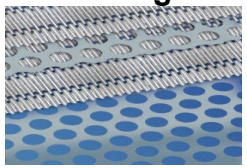
PE-Design®

50 – 100 cpsi

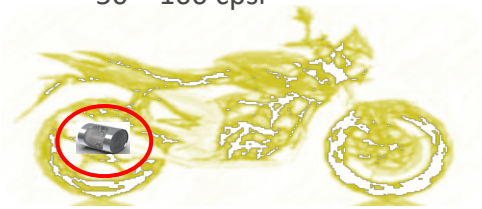
100 – 400 cpsi

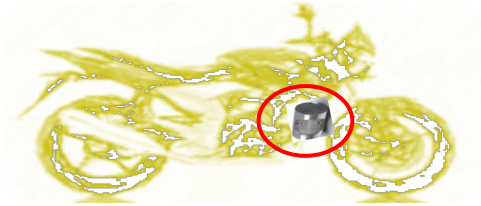


LS-Design®



LSPE-Design®





Structured Foil → Light Weight & Close Coupled

CTF EMITEC

PUNE INDIA

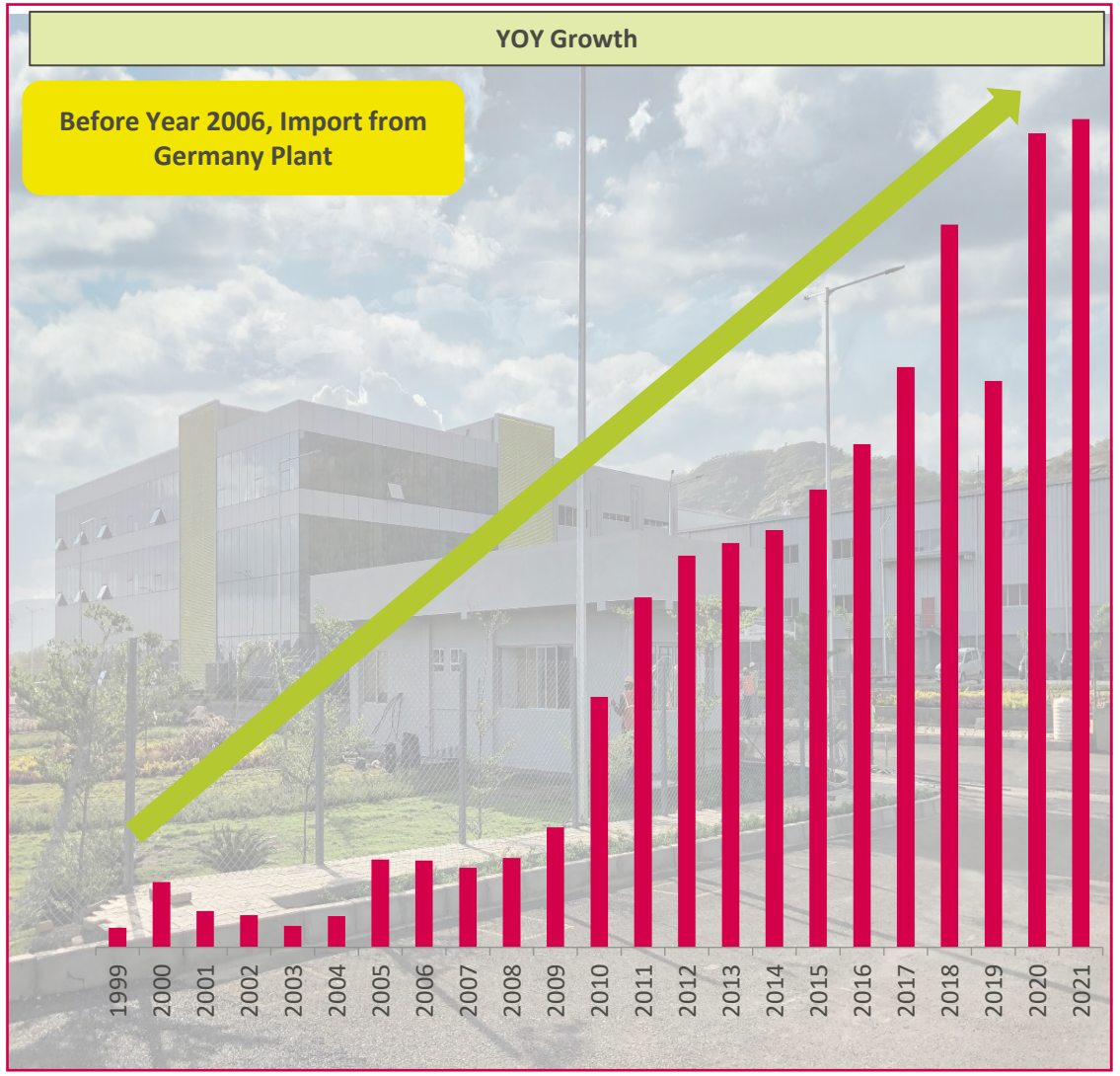
170+ Million Substrates Supplied to the 2/3 Wheeler Industry

Starting BS6, **Annually 25+ million** structured substrates manufactured locally

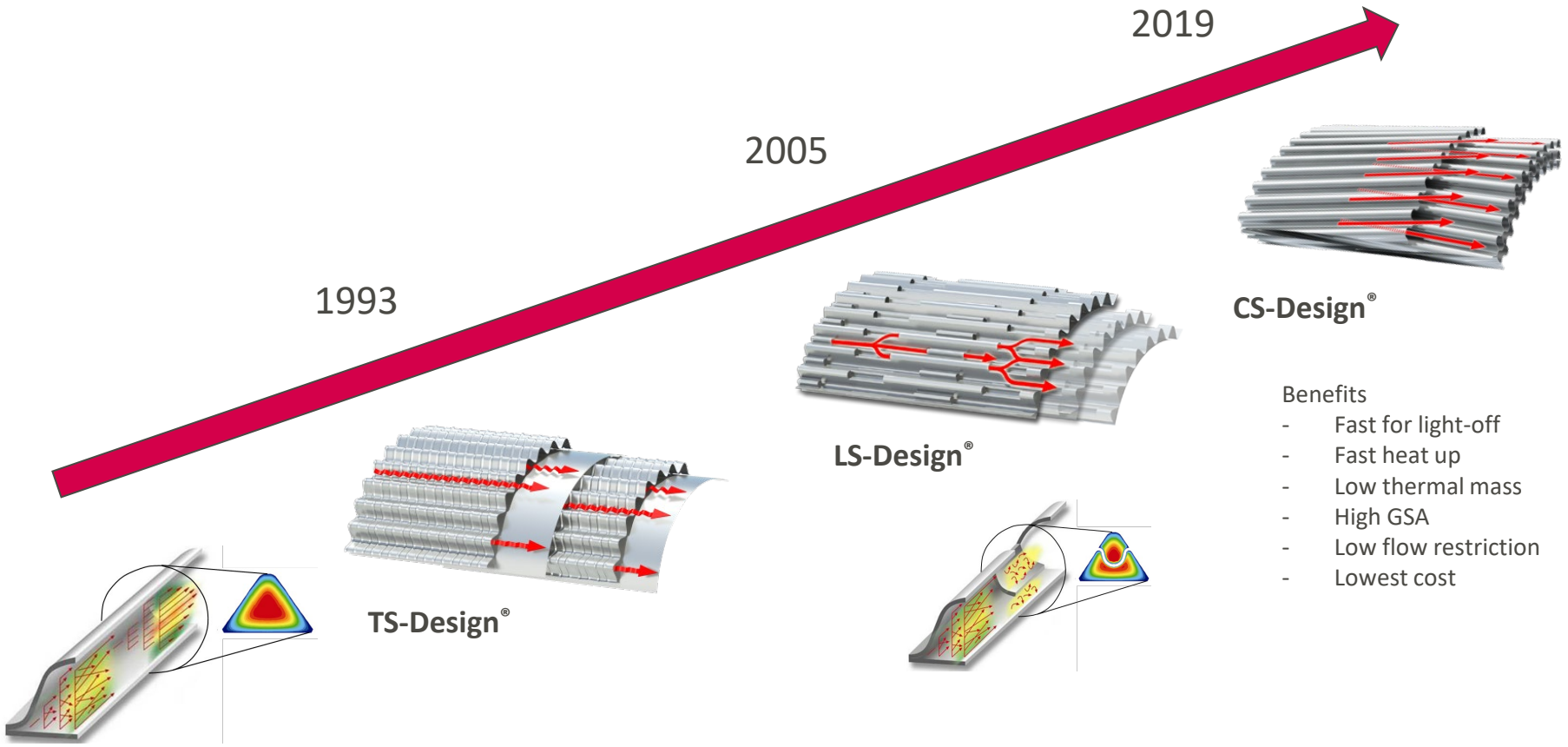
With New Production facility, enabling production of upto 200mm diameter metal substrates

Support and Experience on development programs from Europe for optimal After-treatment design

Focus on HD / NRMM applications for future Indian emission legislations



EVOLUTION OF ADVANCED SUBSTRATE TECHNOLOGY



Benefits
- Fast for light-off
- Fast heat up
- Low thermal mass
- High GSA
- Low flow restriction
- Lowest cost

CROSSVERSAL DESIGN (CS)

What means Crossversal Structure?

- The CS structure consists only of corrugated foils. Flat foil layers, as mandatory for the standard design, are not needed.
- By inclining the channels against each other no additional structure support of a flat layer is needed.
- The inclination angle is approximately ~5 degree

Crossversal Design – Benefits at a glance

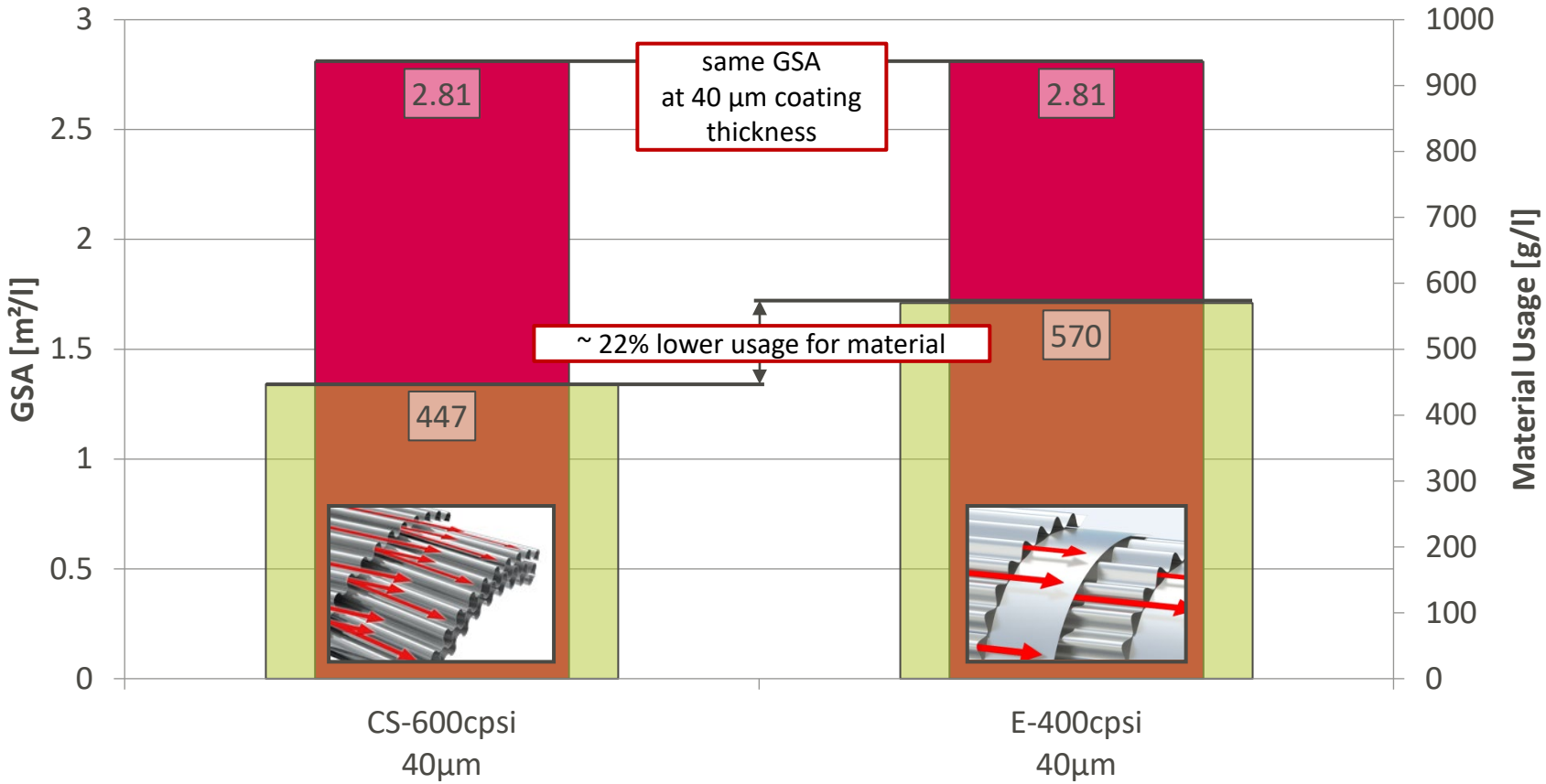
› Material cost savings at same or better performance

› Compensation of specific lower geometric surface area by higher cell density and improved mass transfer

› Perfect coating distribution due to missing gusset areas

CS STRUCTURE: WEIGHT & SURFACE AREA

600CS vs. 400 Std.



Agenda

1 Vitesco Emitec Update

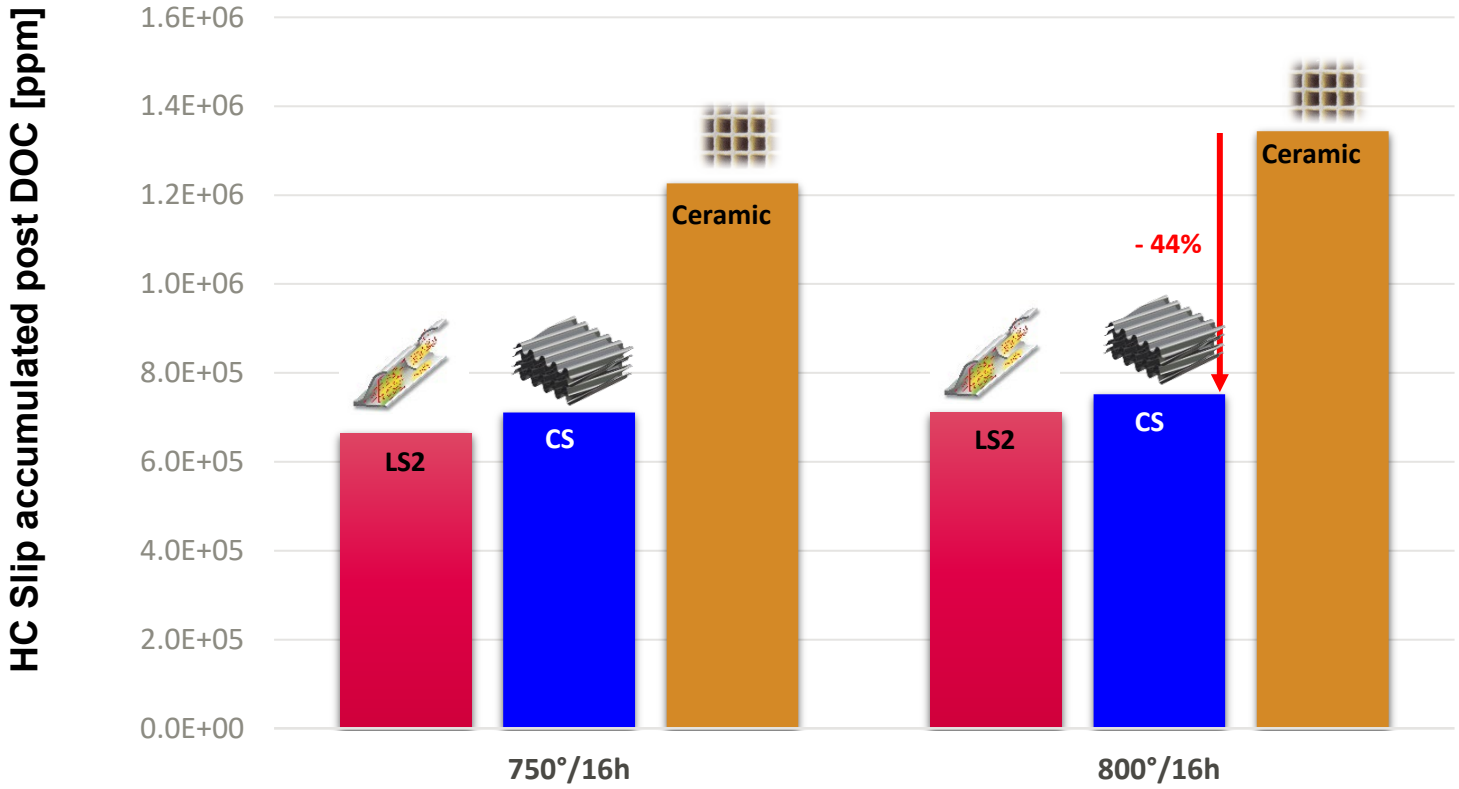
2 METALIT® Portfolio

3 CS Test Program – Emitec

4 Summary

HC SLIP POST DOC - WHTC CYCLE ACTIVE REGENERATION

Comparison – Cordierite and METALIT® Structured Substrates

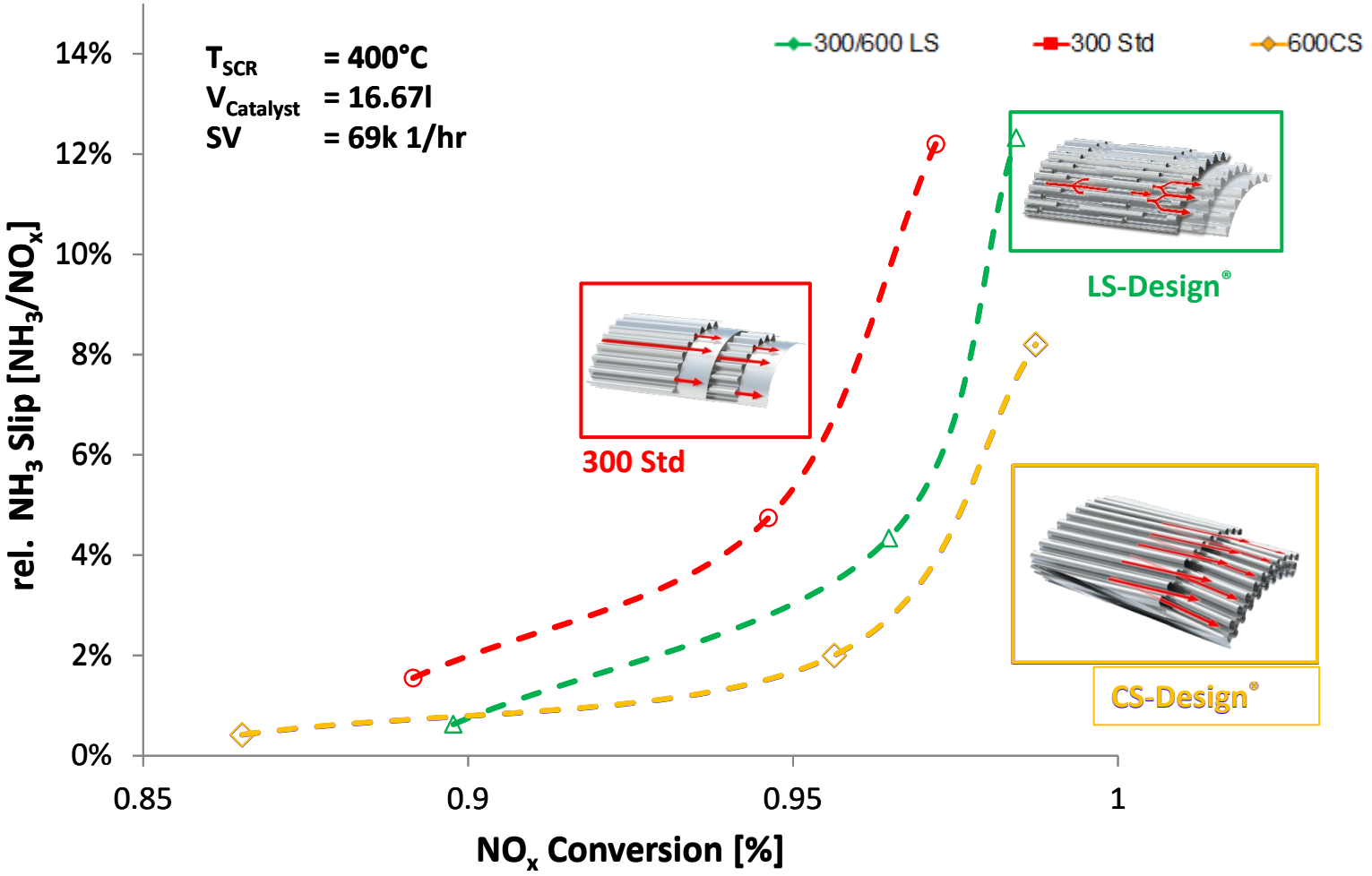


8-Cylinder 302kW, 12L EU6 engine. Hydrothermal aging

Catalyst Volume. PGM amount on metallic ~20% lower than on ceramic

NOX– CONVERSION RATE VS NH_3 SLIP

Comparison – METALIT® Structured Substrates - 400°C (massflow: 1,500 kg/h)



Agenda

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3 CS Test Program – Close coupled SCR by Dinex

4 Summary

OVERVIEW

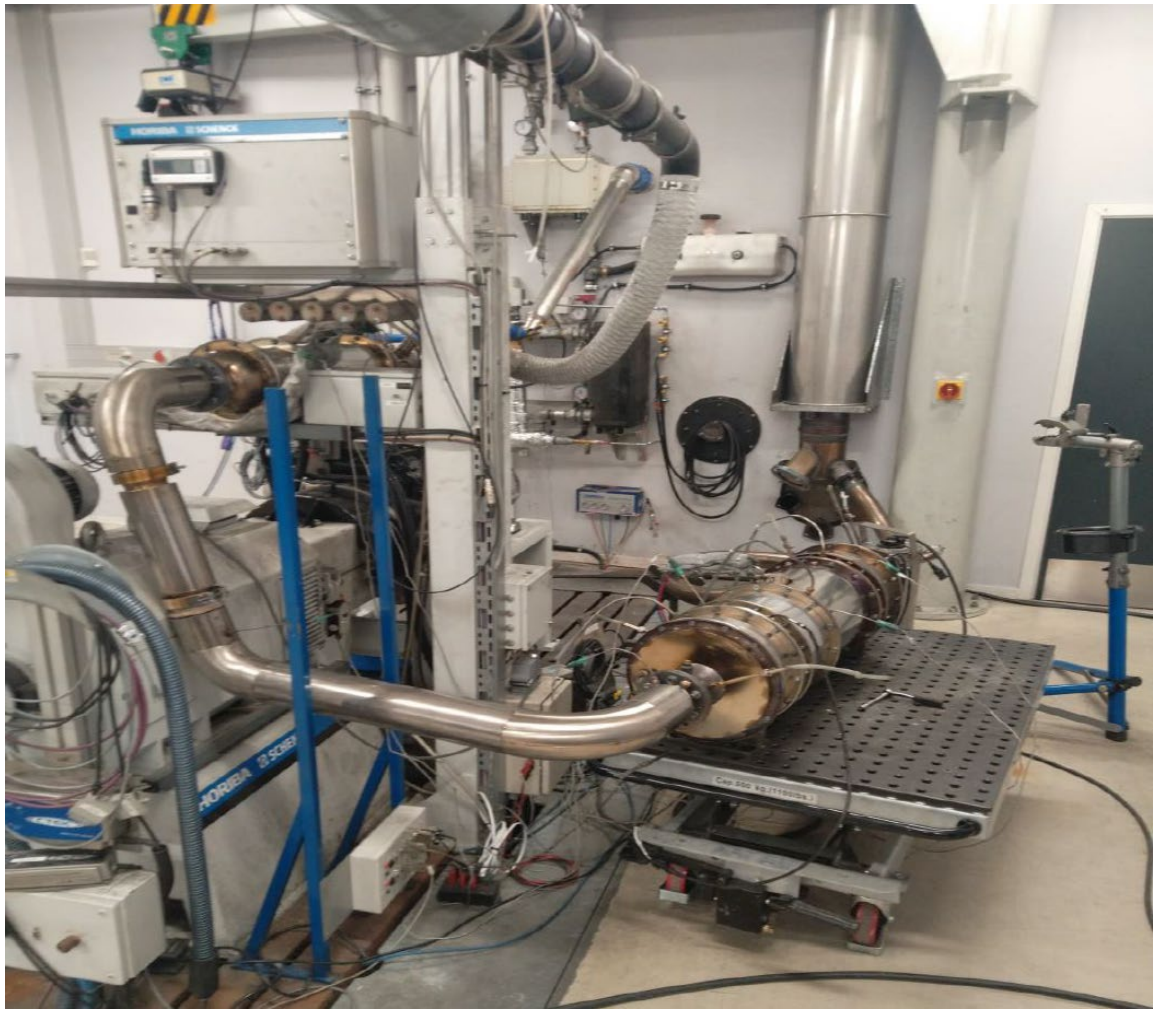
ccSCR Test program

Test setup:

- AGCO 44LFTN engine
  110kW @ 1900rpm and 650Nm
- T250 engine dynamometer
- AVL SESAM i60 FTIR in tailpipe
- AVL SESAM i60 FTIR in downpipe
- Albonair air assisted, urea dosing system.

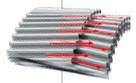
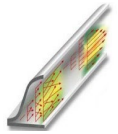
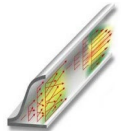
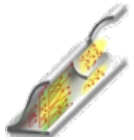
test program

- SCR mapping / ANR sweep
- ANR settings for WHTC
- Run cold / warm WHTC warm



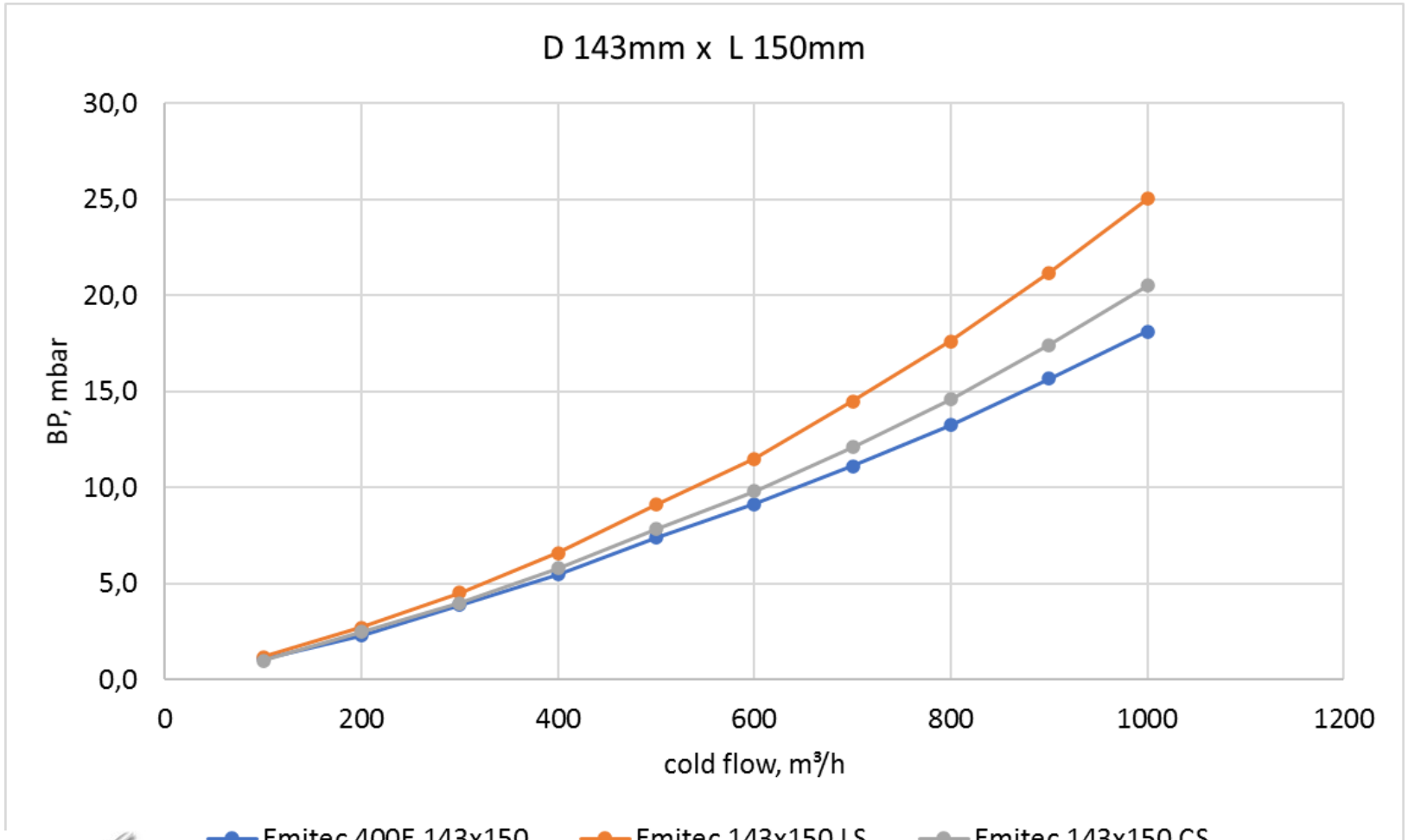
SUBSTRATE

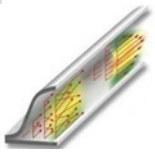
Comparison – Cordierite and METALIT® Structured Substrates

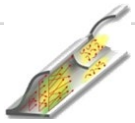
			Coridierite	Metalit® CS-Foil (tested)		Metalit® Standard			Metalit® LS Foil [1]	
						 				
			ø5,66" x 6"	ø143x150		ø143x150			ø143x150	
Discription Technology				CS-400	**CS-600**	E-300	**E-400**	E-600	**LS 300/600 (E)**	LS 400/800 (E)
Drawing				620616	620617					
Cell densitye entrance	[cpsi]		400	200	300	300	400	600	300	400
Tooling for corrugated foil layer	[cpsi]			400	600					
Flat foil layer				no		yes			yes	
Wall thickness / Foil thickness			4 mil	40µm		40µm			40µm	
Substrate Diameter	[mm]		143,76	143	143	143	143	143	143	143
Substrate Length	[mm]		152,40	150	150	150	150	150	150	150
Substrate Volume	[ltr]		2,47	2,41	2,41	2,41	2,41	2,41	2,41	2,41
Physical Properties (bare substrate)										
GSA	[m^2]		7,17	5,62	6,93	7,13	8,18	9,78	7,13	8,18
CP	[J/K]		581	507	626	711	820	995	711	820
OFA	[%]		82,8	95,3	94,2	93,2	92,2	90,5	93,2	92,2
Mass of Substrate	[g/ltr]		210-270	341	422	495	570	696	497	570

METALIT® SUBSTRATE

Comparison – Backpressure





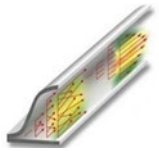


Lower Back-Pressure was observed for 600CS as compared to 300/600LS structure

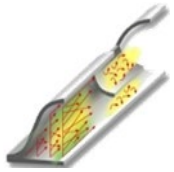
All three metalit structures show a similar DeNOx characteristics on the engine bench

METALIT® SUBSTRATE

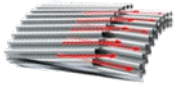
Comparison – ANR sweep – 130kg/h, 195°C SCR_{inlet} SV_{std} 43.507 /h



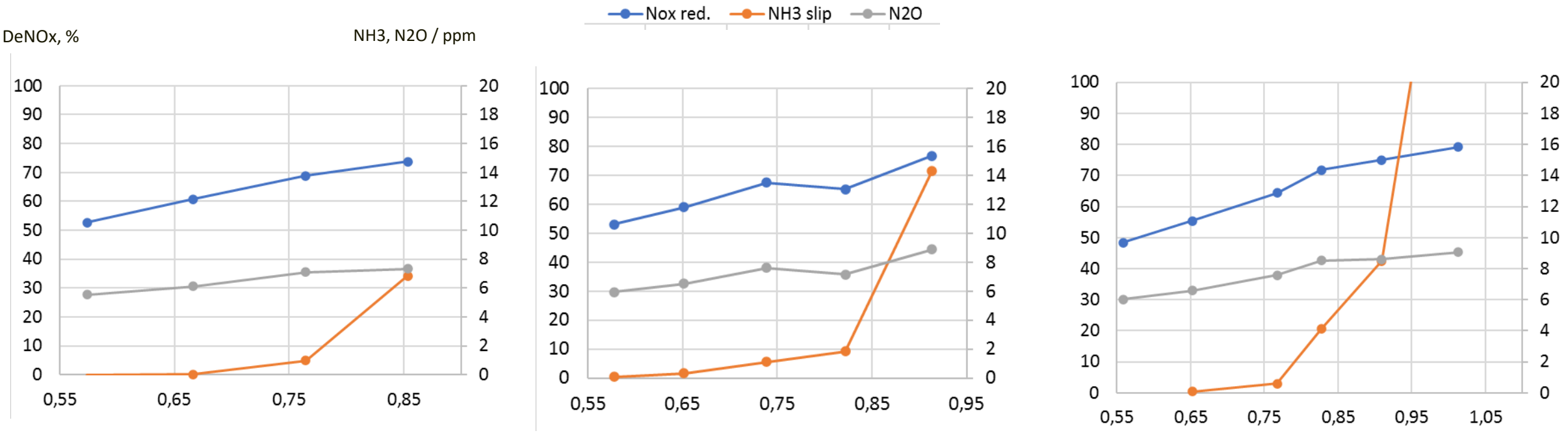
143 X 150 400 E



143 X 150 300/600LS



143 X 150 600CS



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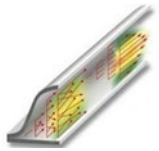
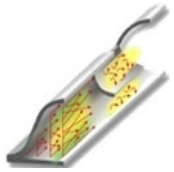
METALIT® SUBSTRATE

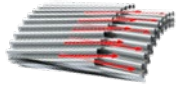
Comparison – ANR sweep – 300kg/h, 330°C SCR_{inlet} SV_{std} 100.402 /h



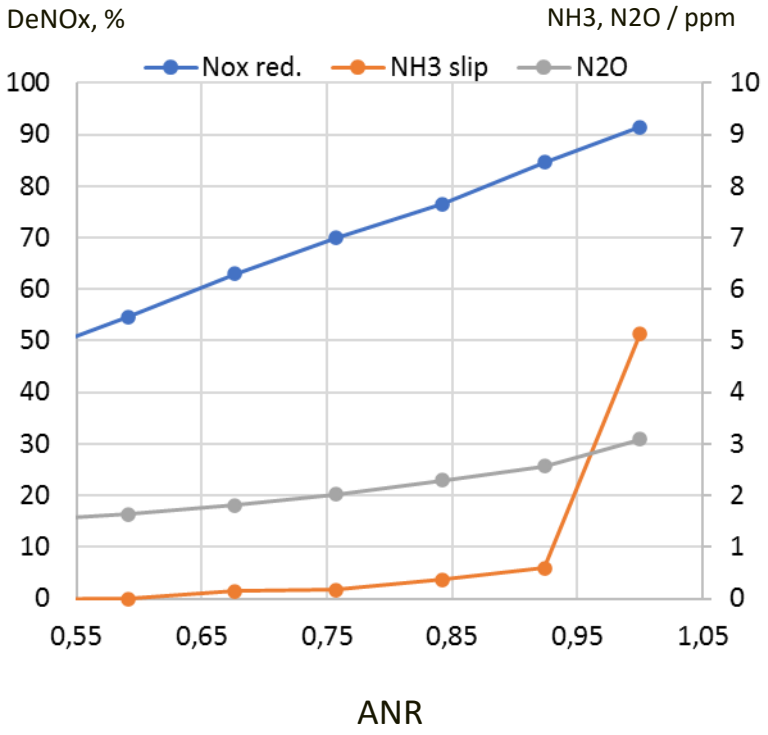
143 X 150 400 E

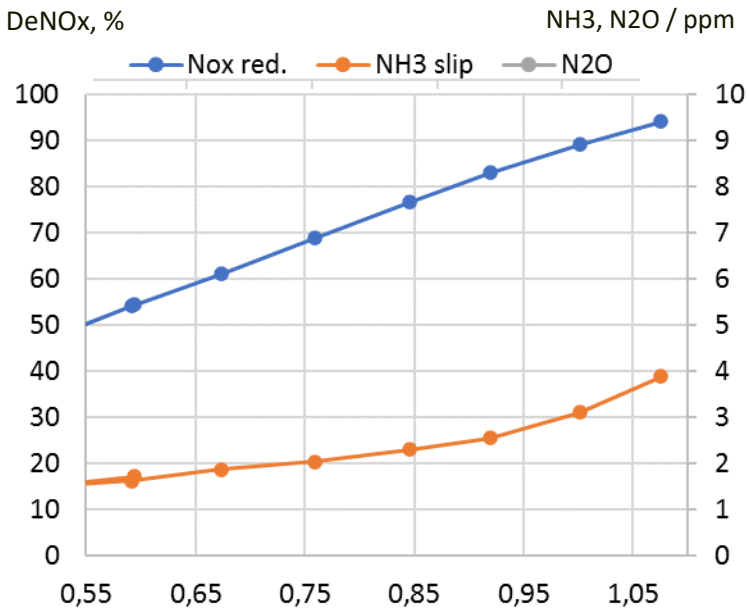


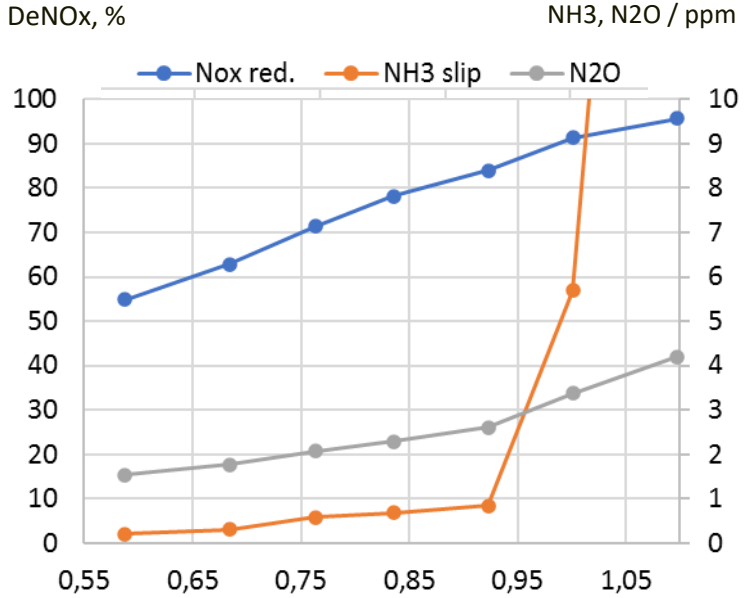
143 X 150 300/600LS



143 X 150 600CS

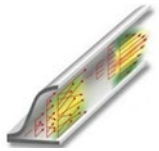




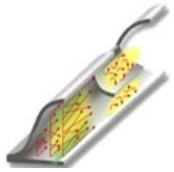


METALIT® SUBSTRATE

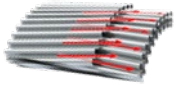
Comparison – ANR sweep – 400kg/h, 385°C SCR_{inlet} SV_{std} 133.869 /h



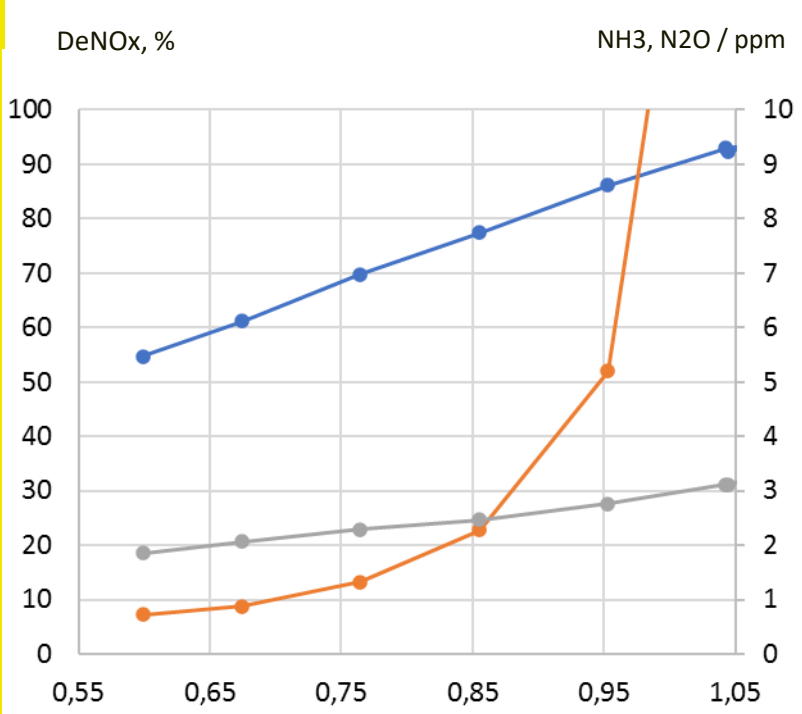
143 X 150 400 E

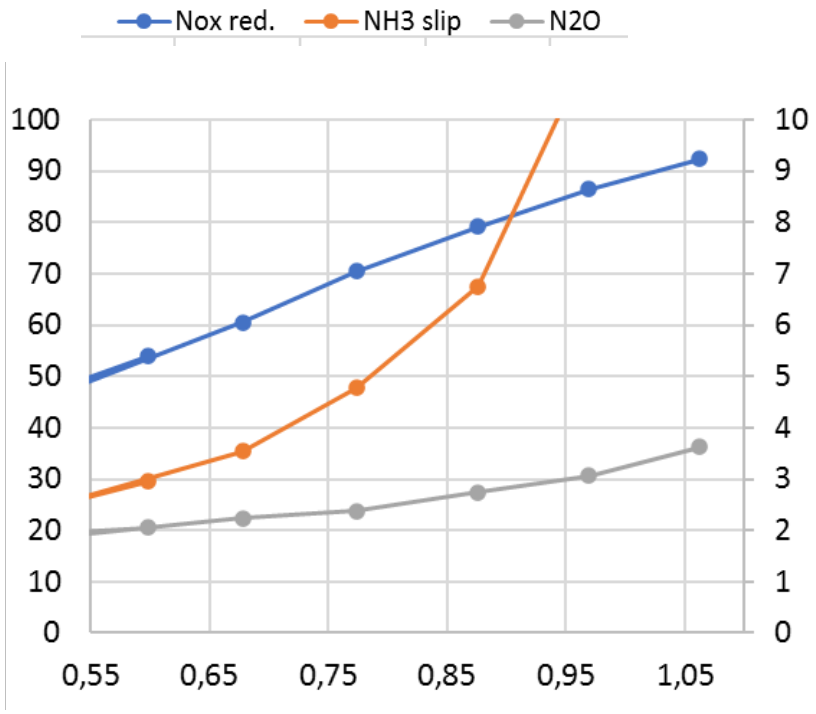


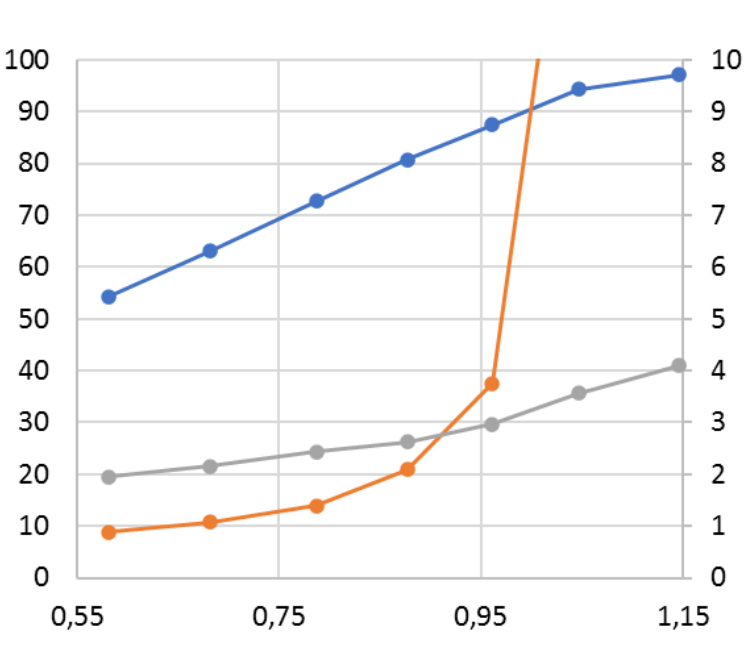
143 X 150 300/600LS



143 X 150 600CS

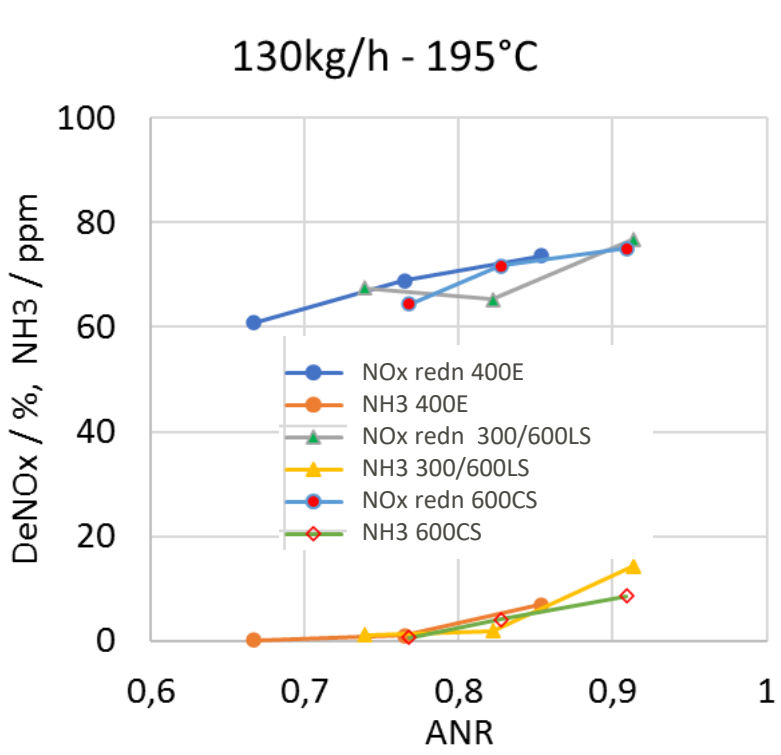


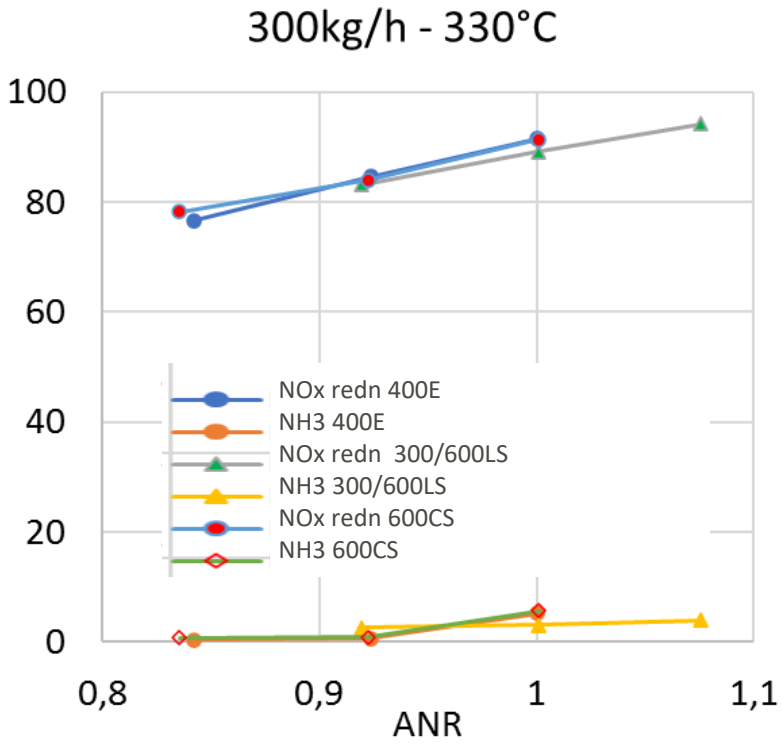


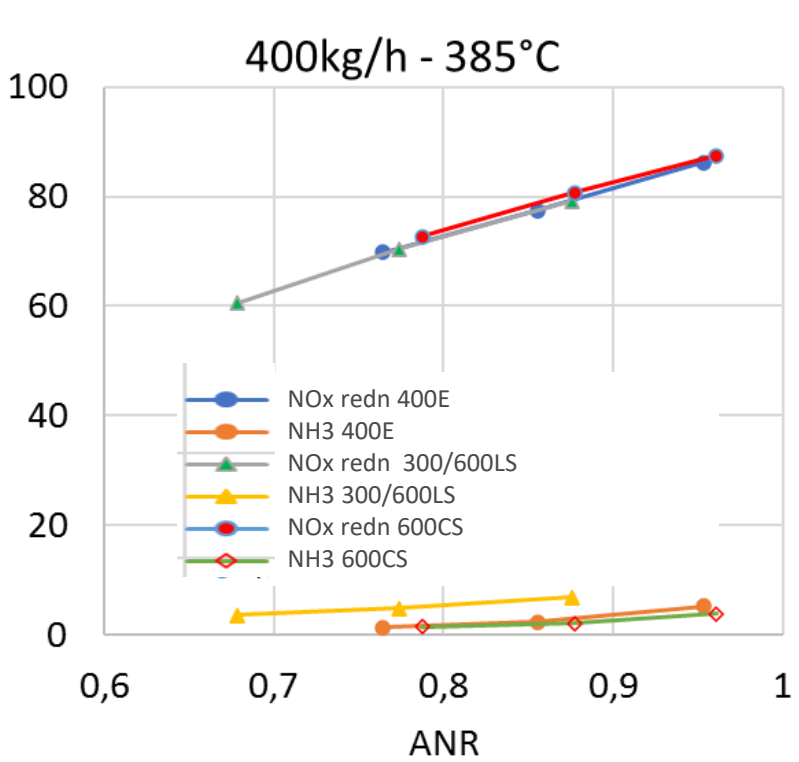


METALIT® SUBSTRATE

Comparison – max. efficiency test







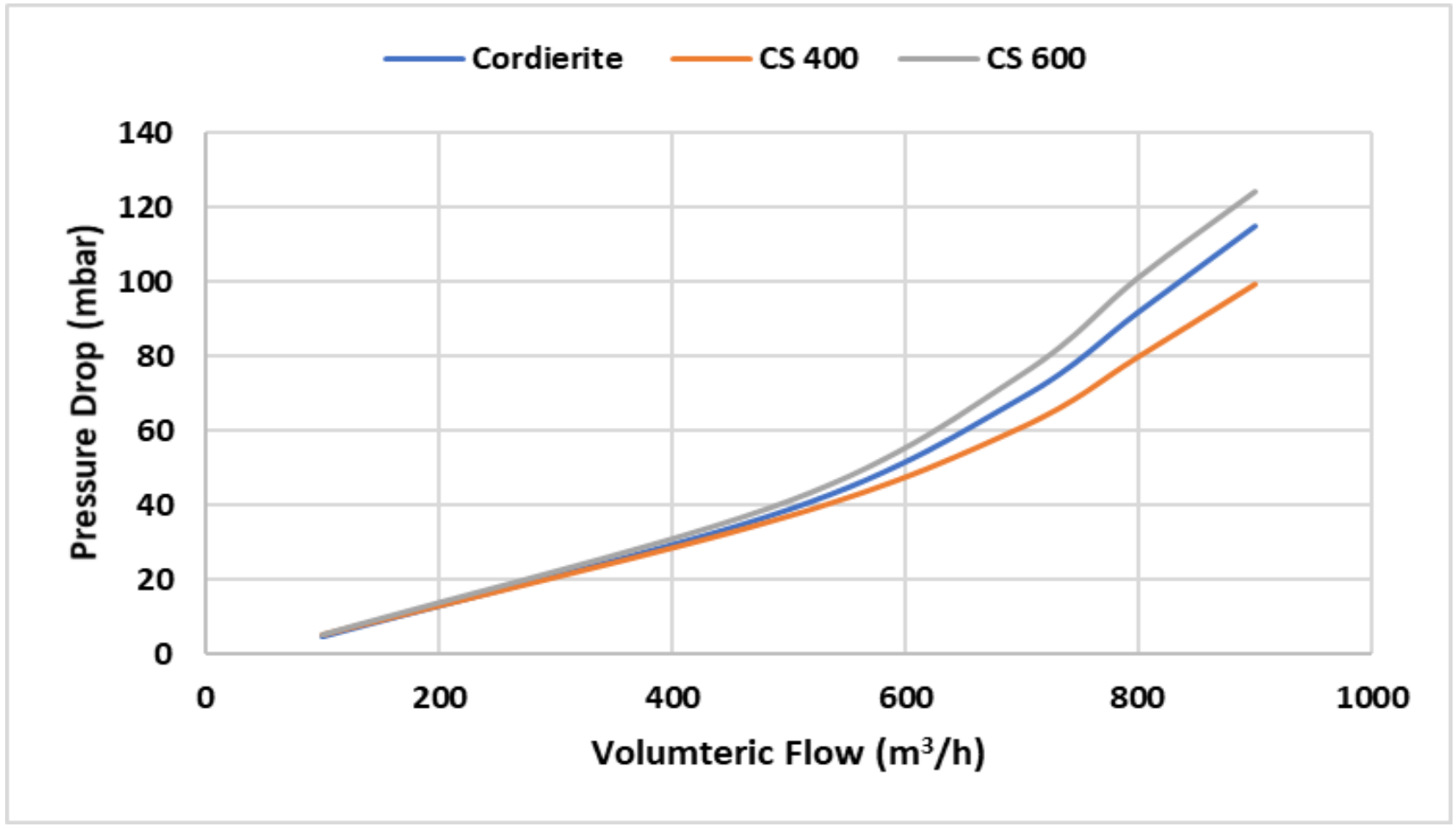
METALIT® SUBSTRATE

Summary - I

- Lower Back-Pressure was observed for 600CS as compared to 300/600LS structure
- All three metalit structures show a similar DeNOx characteristics on the engine bench
- ANR sweep data shows
  - Lower NH_3 slip was observed for 400E and 600CS as compared to 300/600LS
  - Better NOx conversion observed with 600CS for higher mass flow rate, because of higher cell density
- CS structure with high cell density will be compared with Cordierite substrate

METALIT® SUBSTRATE - CS

Comparison – Back Pressure comparison on Engine Test bench



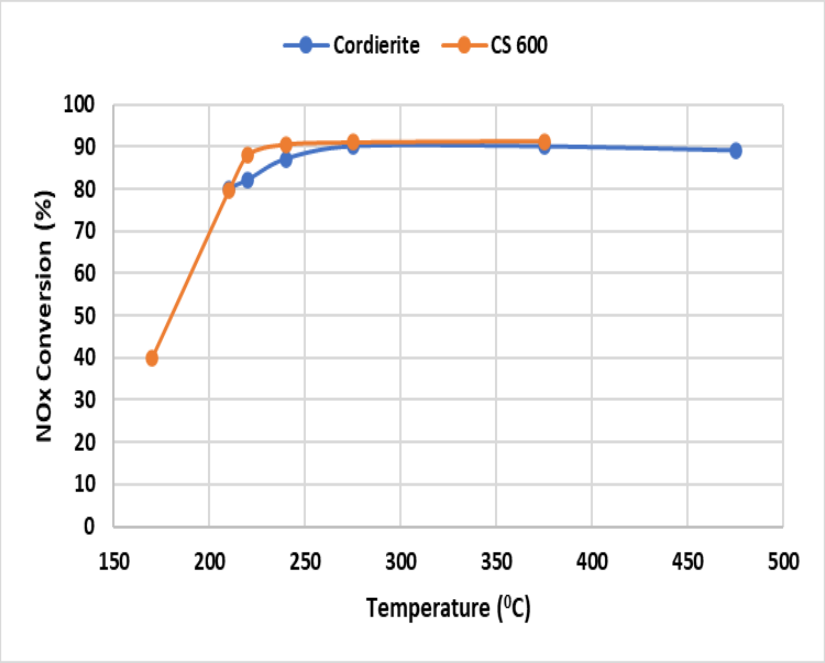
- SCR Loading on all substrate are at nominal level.
- CS400 has shown lower back pressure in comparison to 400 cpsi Cordierite
- CS600 with higher cell density, slightly increase in back pressure than 400 cpsi Cordierite

METALIT® SUBSTRATE - CS

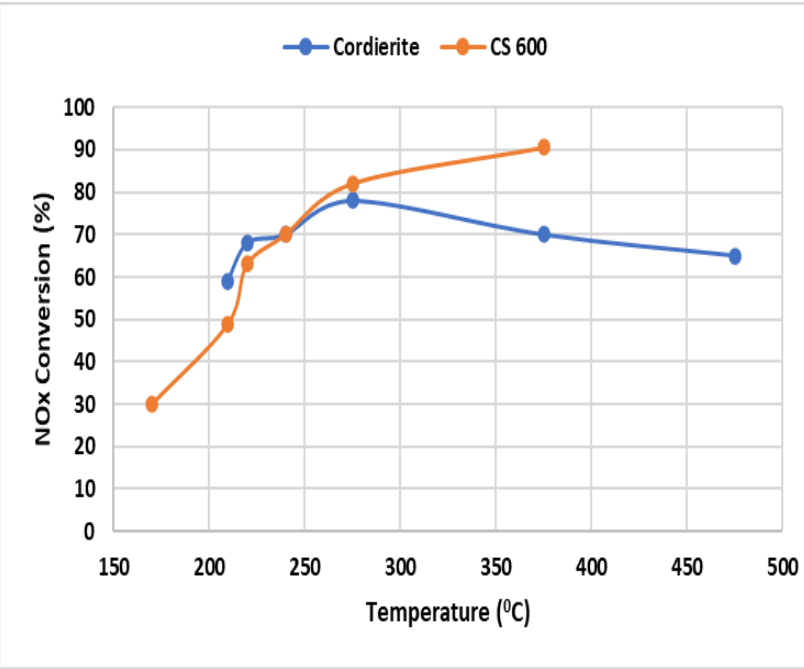
Comparison – Nox Conversion

› Nox Conversion at 10 ppm NH3 Slip .

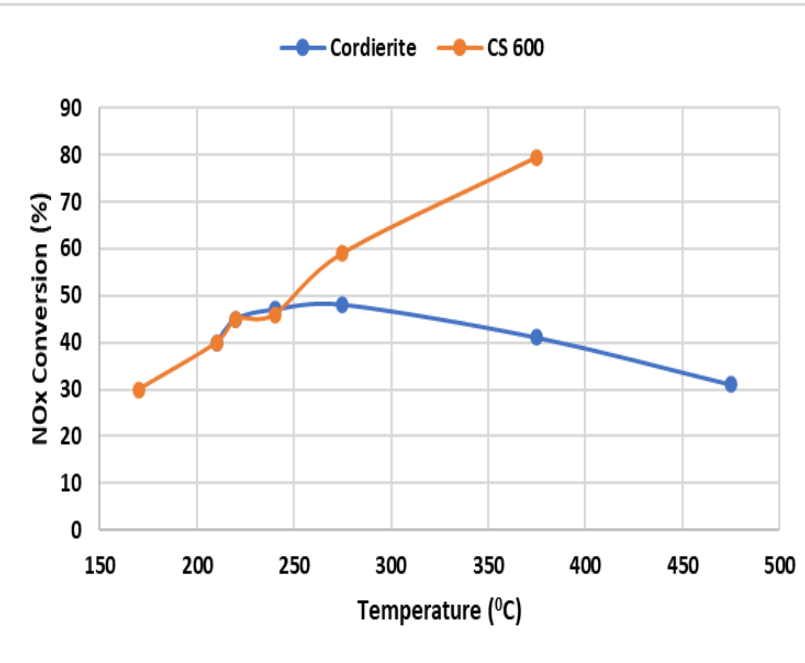
Space Velocity : 50,000 h^{-1}



Space Velocity : 100,000 h^{-1}



Space Velocity : 150,000 h^{-1}



› At low Mass flow rate, NOx conversion was comparable.

› At higher mass Flow rate, better conversion was observed for CS structure.

METALIT® SUBSTRATE - CS

Summary - II

- The Metalit CS600 and cordierite 400cpsi is at same washcoat loading, slightly higher in back pressure
- At low Mass flow rate, NOx conversion was comparable for Emitec 600CS and Cordierite 400cpsi
- At higher mass Flow rate, better conversion was observed for Emitec 600CS structure.
- Since, ccSCR bricks need to be small in volume to fit into the limited space at close coupled position
  → a high cell density structure with similar back pressure is the preferred solution
  → the Emitec Metalit CS600 is optimal choice

THANK YOU