Content prepared and submitted for;

ECMA
Clean Air Today, Cleaner Air Tomorrow

16th International Conference

ECT 2025

7th and 8th October 2025, Hotel Vivanta Taj, Dwarka, New Delhi

"Driving Innovations in Emission Control for Sustainable Tomorrow"

Donaldson Company Inc.

Donaldson Emissions Global.

Donaldson
FILTRATION SOLUTIONS

Advancing Filtration for a Cleaner World | EMISSIONS

DONALDSON COMPANY

1915

Founded

$3.59 BILLION

Sales

14,000+

Employees

46 Plants

Diversified Markets

20 Distribution Centers

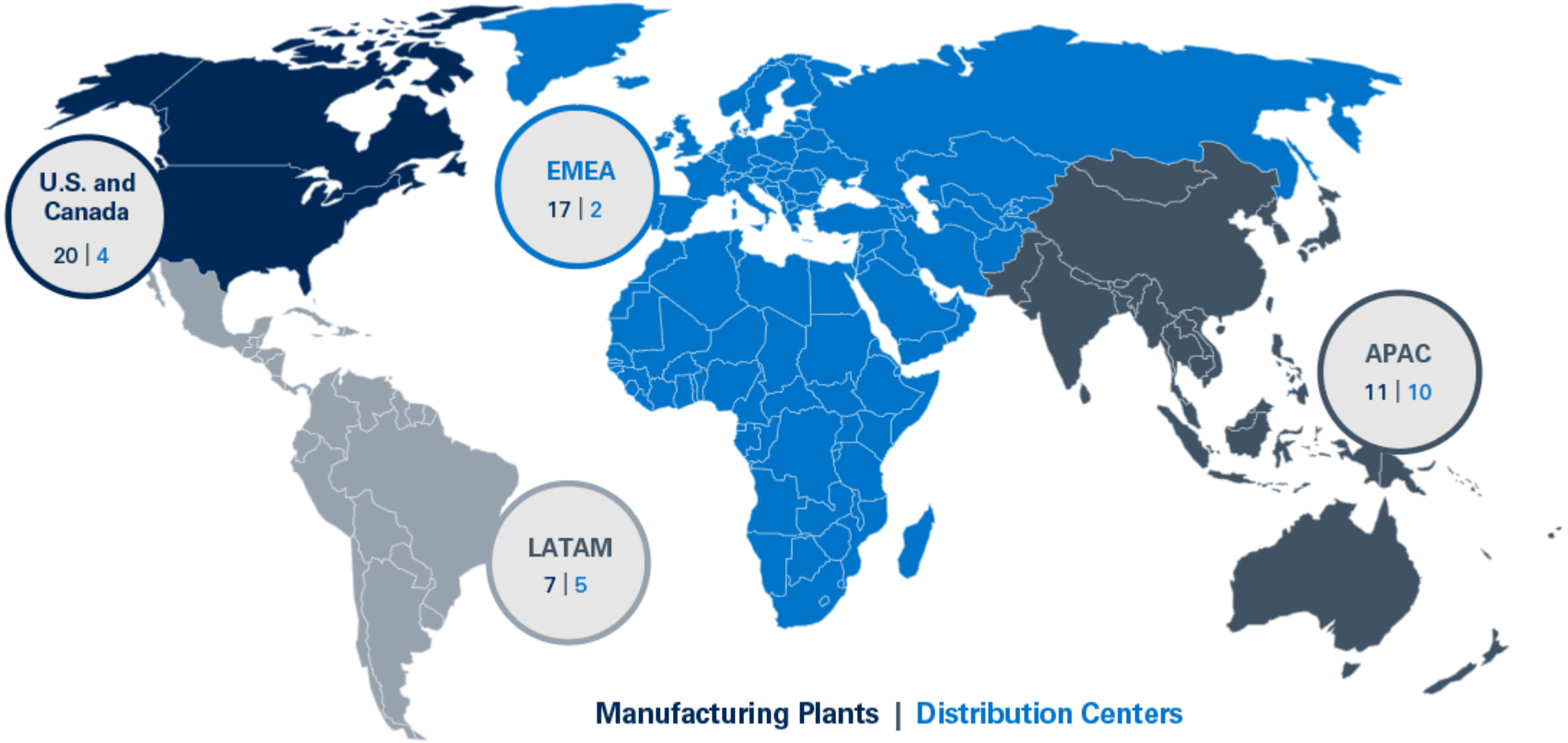
World-class R&D Centers

Donaldson. FILTRATION SOLUTIONS

Extensive Global Footprint

Donaldson FILTRATION SOLUTIONS

Global Reach, Local Touch



Donaldson Emissions – Mobile Solutions.

- ✓ We are organized globally to support differing global (unharmonized) regulations
- ✓ Exhaust & Emissions Engineering:
  - Bloomington – USA
  - Leuven – Belgium
  - Domjean - France

Exhaust & Emissions Manufacturing:

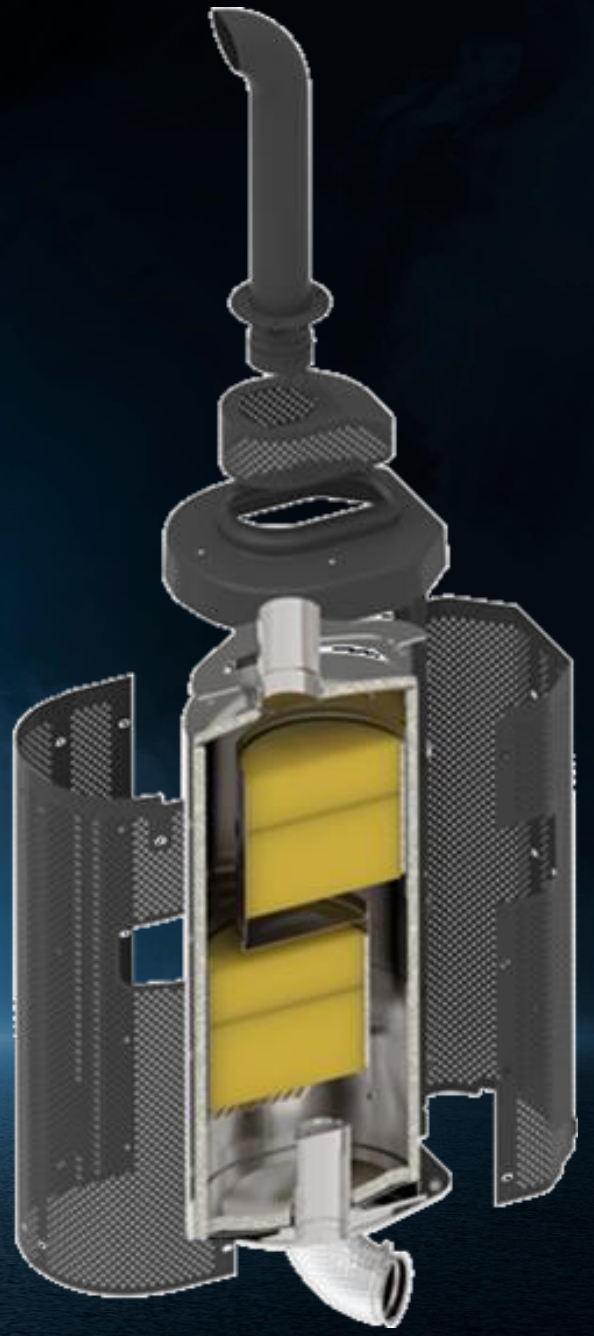
- Auburn – USA
- Domjean - France
- Establishing footprint in India.

DONALDOSN EMISSIONS

✓ **PAVING THE ROAD TO OFF-ROAD ULTRA LOW TAILPIPE EMISSIONS**

PRODUCT PORTFOLIO:

- Emission solutions
- IP protected high-efficient mixer solutions
- 161 granted patents emissions
- Acoustic solutions
- Thermal solutions
- Accessories



Full System Support

Customer

DCI Emissions

Raw emissions

Technology choice

Substrate and Catalyst choice

Canning and mat calculations

Concept CAD & packaging

Simulations [CFD+FEA]

Optimization & design freeze for PoC

Functional and structural validation

Reporting and customer sign off

Tooling and manufacturing

Quality consistency

System field support

Engineering Expertise

Donaldson FILTRATION SOLUTIONS

DCI Emissions Differentiator

Industry Foresight

Engineering Expertise

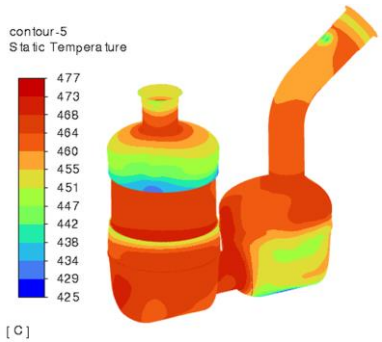
Close looped development

New technology evaluation

Close knit industry partnerships

Smart Material Choices

System thermal Inertia



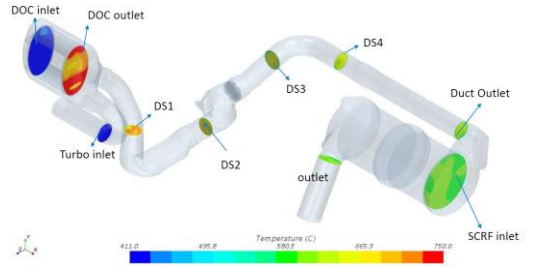
Canning Expertise

Leak Free and optimized connections

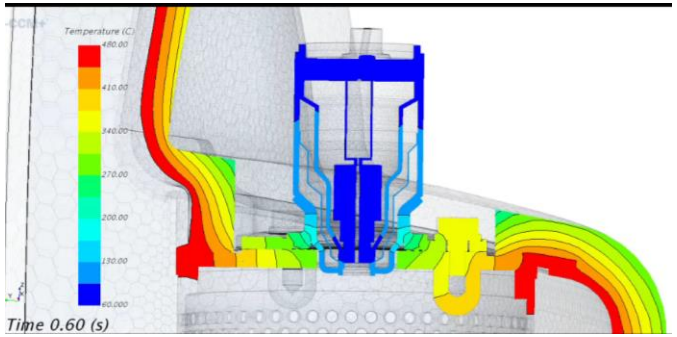
System Thermal Management

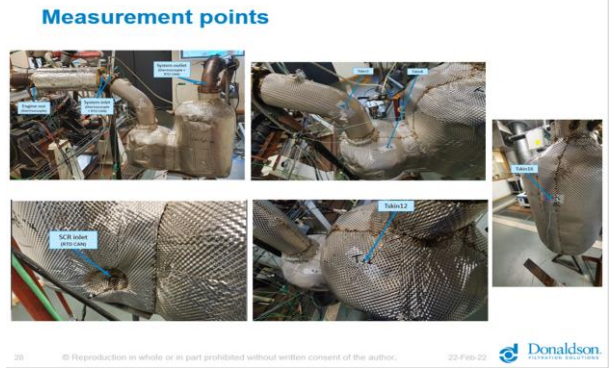
Thermal Management

Thermal CFD

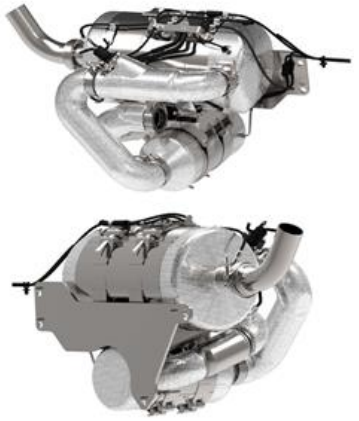


Section	Mass flow averaged Temperature (Degrees)
Turbo inlet	411
DOC inlet	419
DOC outlet	726
DS1	698
DS2	671
DS3	646
DS4	635
Duct outlet	614
SCRoF inlet	594
outlet	514

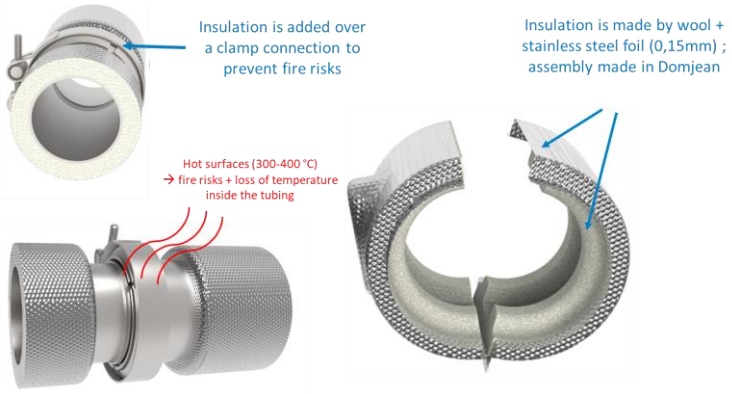




Optimzed insulation & heat shields



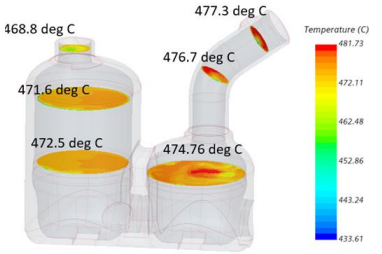
Insulated sliding clamps

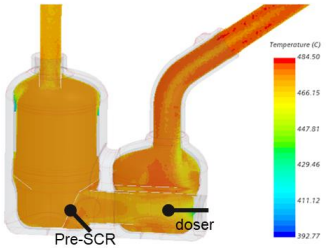


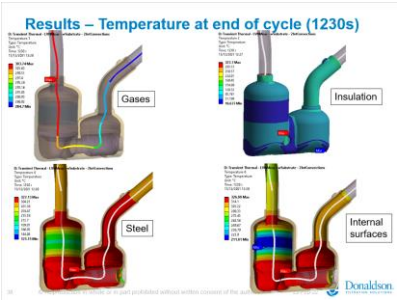
System Thermal Intertia

GLOBAL TECHNICAL (GT) GROUP

Fluid Temperature







- FEA study completed - Completed
- CHT to include susbtrate thermal interia – in progress
- Bench validation & optimization – In progress

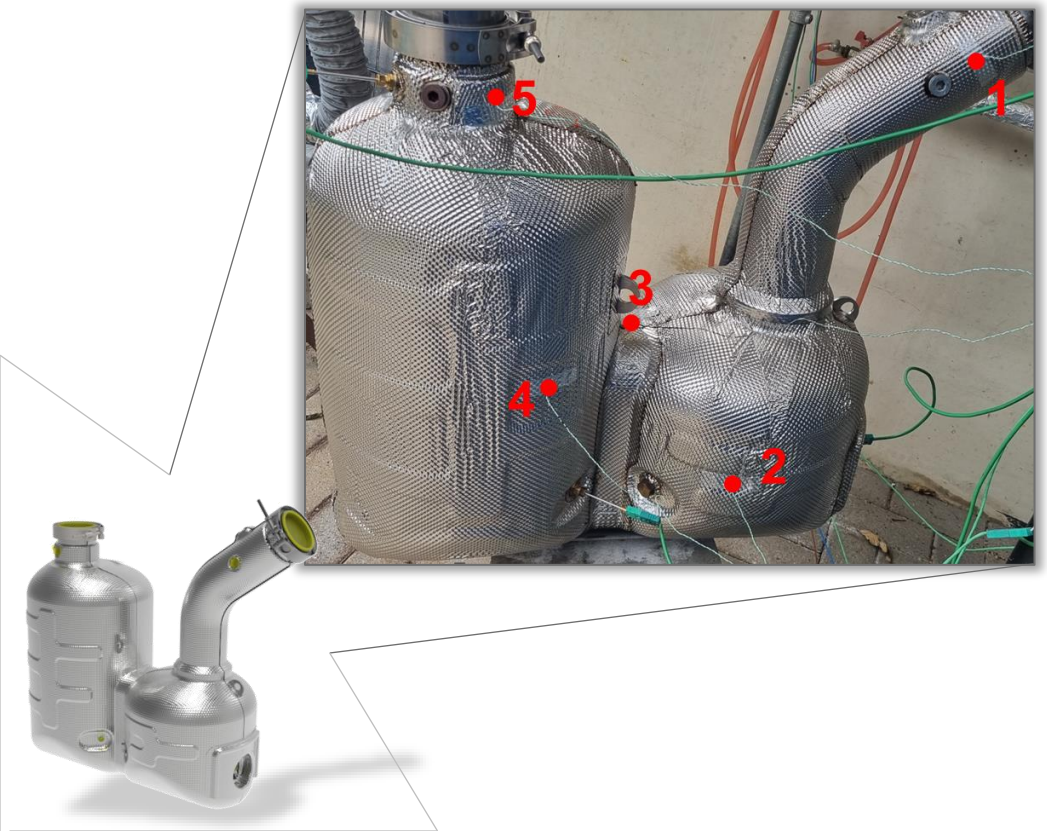
System Thermal Inertia

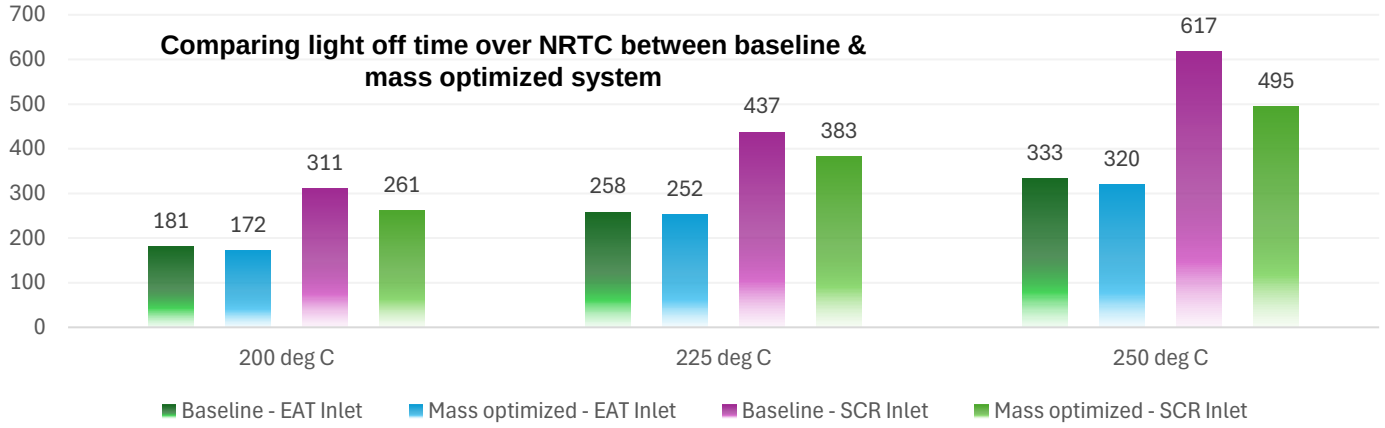
Tested across different steady state loads with 10% mass reduction between systems.

Donaldson FILTRATION SOLUTIONS

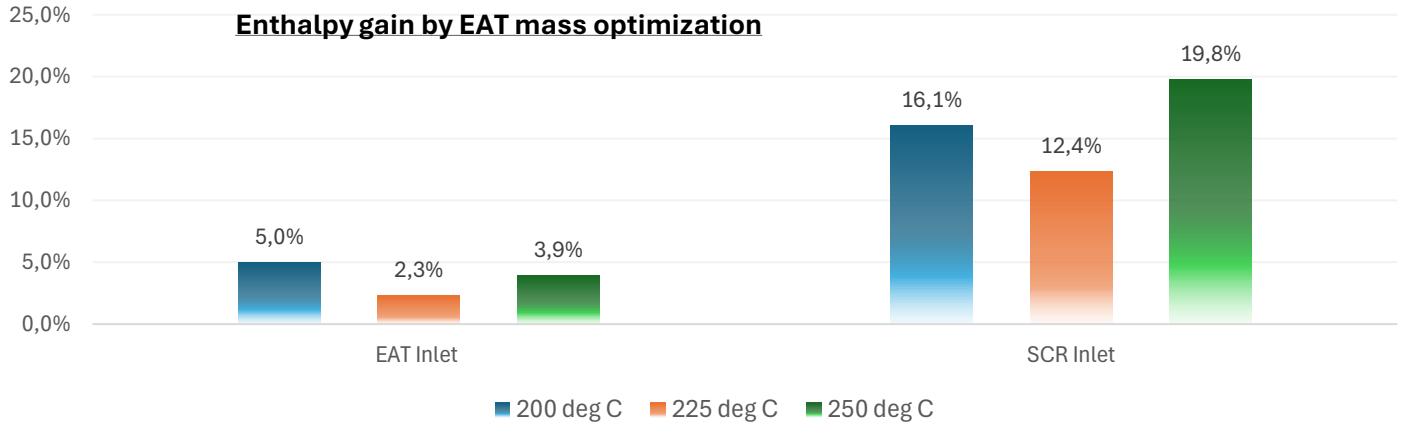
Objective:

- Reduce thermal inertia of EAT system
- Optimize from child part level up
- Ensure EAT structural health is retained over FUL





- EAT mass optimization transcends mere cold start performance.
- Optimizing system thermal inertia enables better fluid efficiency
  - ✓ Reduced Fuel + DEF usage across machine operating loads
- Cold start performance is an added benefit achieved by this approach



Optimizing Thermal Retention

Donaldson FILTRATION SOLUTIONS

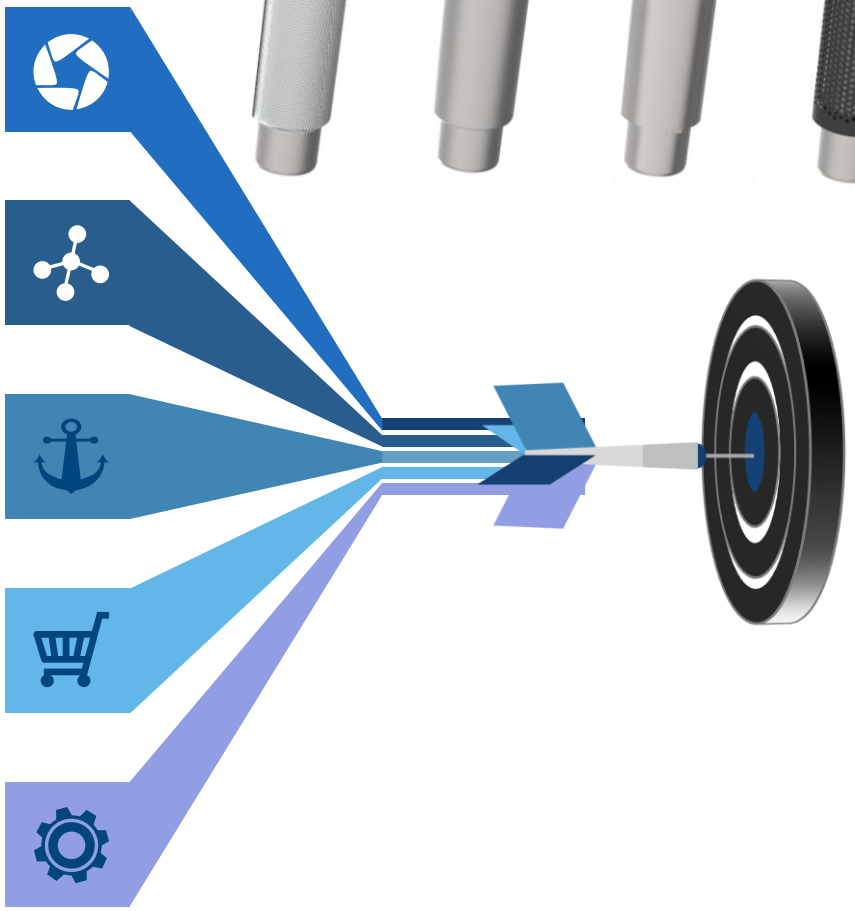
Test DoE
24 configurations tested retaining test boundaries

Fabrication methods
Convective & conductive heat transfer impact evaluated

Insulation type / choices
Different wool types and included black paint in the study

Type of profile
Different heatshield perforation types were considered

Material specifications
Different blanket density & thickness were considered



We engineer advanced thermal management solutions that aid peak thermal retention & energy efficiency.

Close looped development

DCI Emissions Differentiator

Industry Foresight

Engineering Expertise

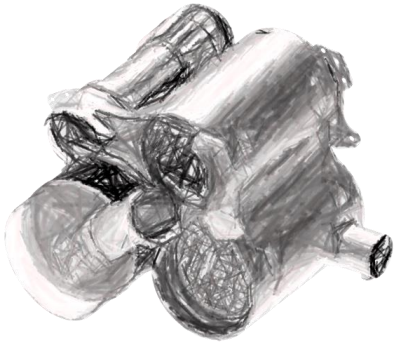
Close looped development

New technology evaluation

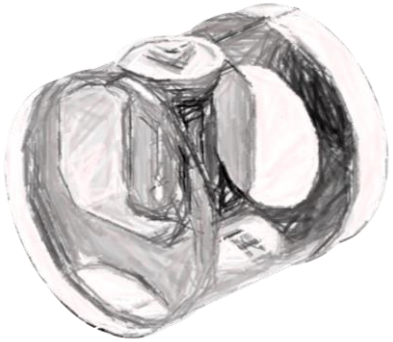
Close knit industry partnerships

IP protected mixer portfolio

Fluidic, modular and tailored to suit packaging constraints



Concept proven for customer specs [Tier-5 ready]



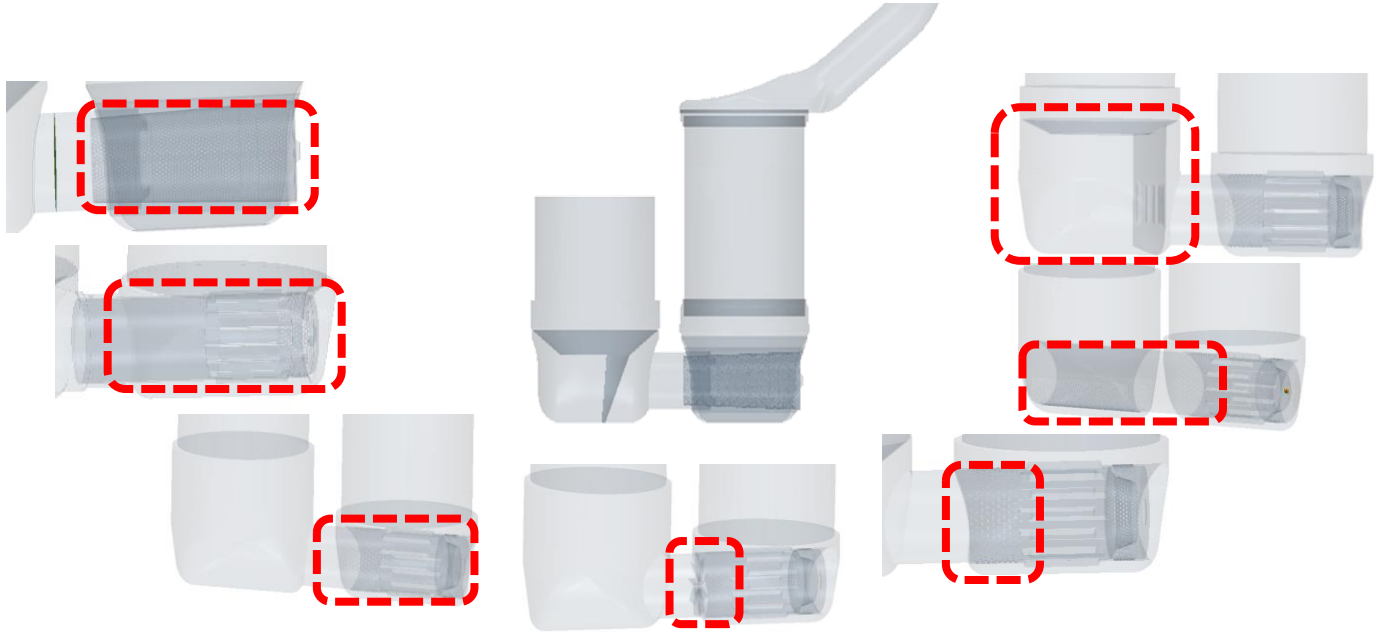
Continuous learnings and improvements

Competitor benchmarking

Mixer Development

Donaldson FILTRATION SOLUTIONS

IP protected | Field validated | Dosing Module Agnostic | Tier-5 Ready Mixer solutions



Continunous improvement

Learning on the go

Localized design iterations & optimizations

Documentation of every fine tunings

Deep dive of understanding on each minor design changes

achieve industry best & improve further

New Technology Evaluation

Donaldson FILTRATION SOLUTIONS

DCI Emissions Differentiator

Industry Foresight

Engineering Expertise

Close looped development

New technology evaluation

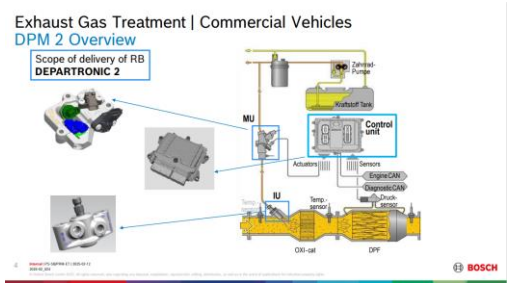
Close knit industry partnerships

Heated dosing module

Albonair

Hydrocarbon injection

BOSCH



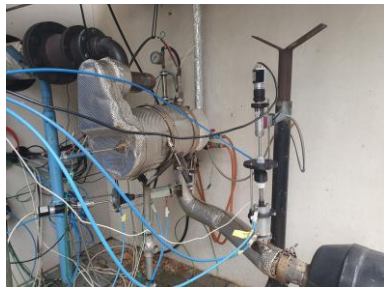
Electric Heater

EMITEC

Coated Mixer

INTERKAT

Impact analysis of dosing module on mixer



In pipe HC Injection

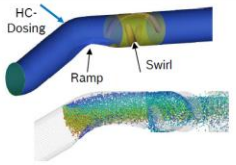
Acknowledgements on DCU support & know-how transfer:

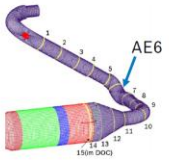
BOSCH

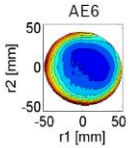
Donaldson FILTRATION SOLUTIONS

HCI / Meeting Bosch – Donaldson
HCI Calibration - Development Process

- Optimization Gas Flow

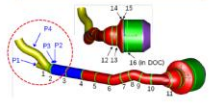


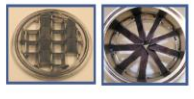




- Optimization Spray Quality

Variation Dosing Position	Variation Mixing Length	Mixer (optional)

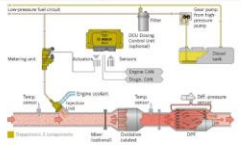




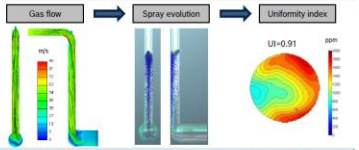
5 BOSCH

HCI / Meeting Bosch – Donaldson
Catalyst Burner with HCI (DPM2)

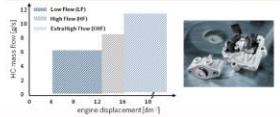
DPM2 system layout



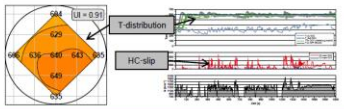
Gas flow and spray simulation



DPM2 flow variants

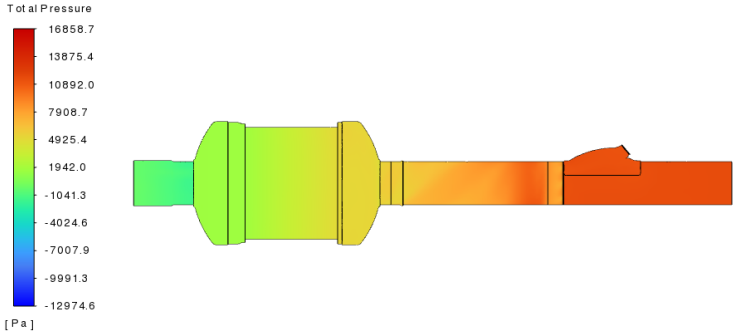


Validation at engine test bench

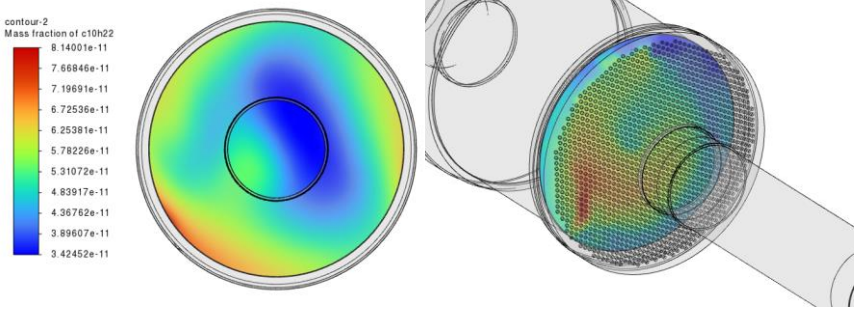


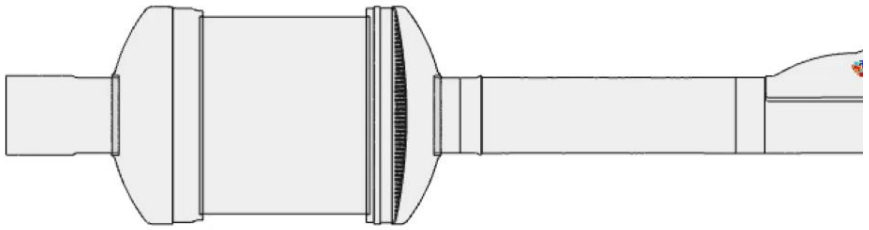
HCI is not a "plug and play" technology. Both the gas flow and the spray quality has to be optimized to achieve an equal temperature distribution and less HC-slip.

6 BOSCH

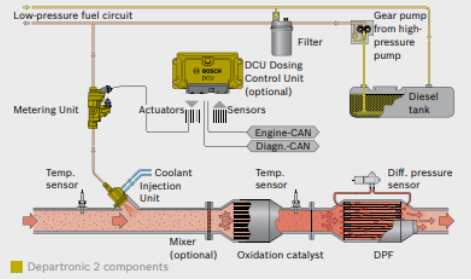


$C_{10}H_{22}$ Uniformity Contour



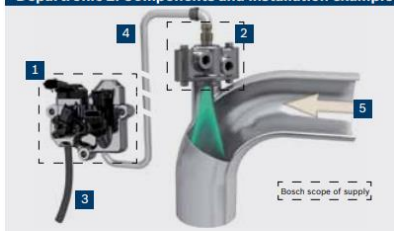


Departronic 2: System integration, example



HC-Injection in EAT to support cold start is being validated in DCI demonstrator.

Departronic 2: Components and installation example



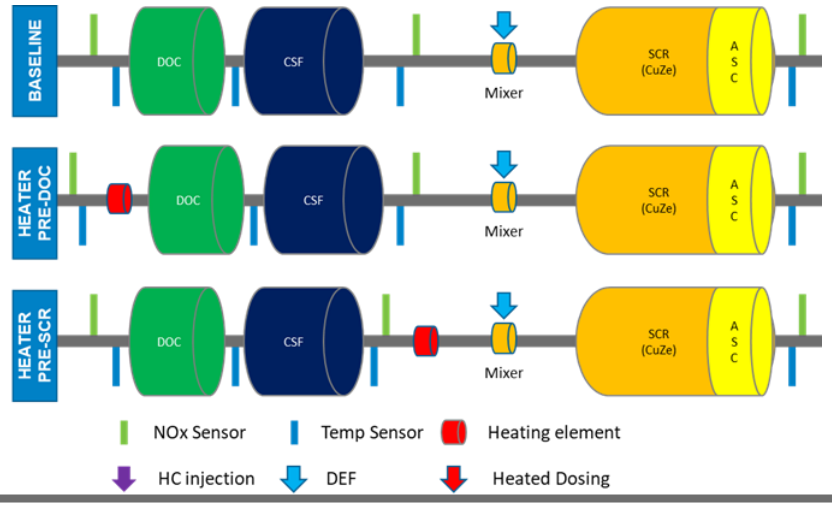
1. Metering Unit with shut-off valve, dosing valve and pressure sensors for quantity control and diagnosis
2. Injection Unit with water cooling to prevent fuel ageing
3. Flexible fuel-supply line
4. Steel pipe
5. Exhaust gas

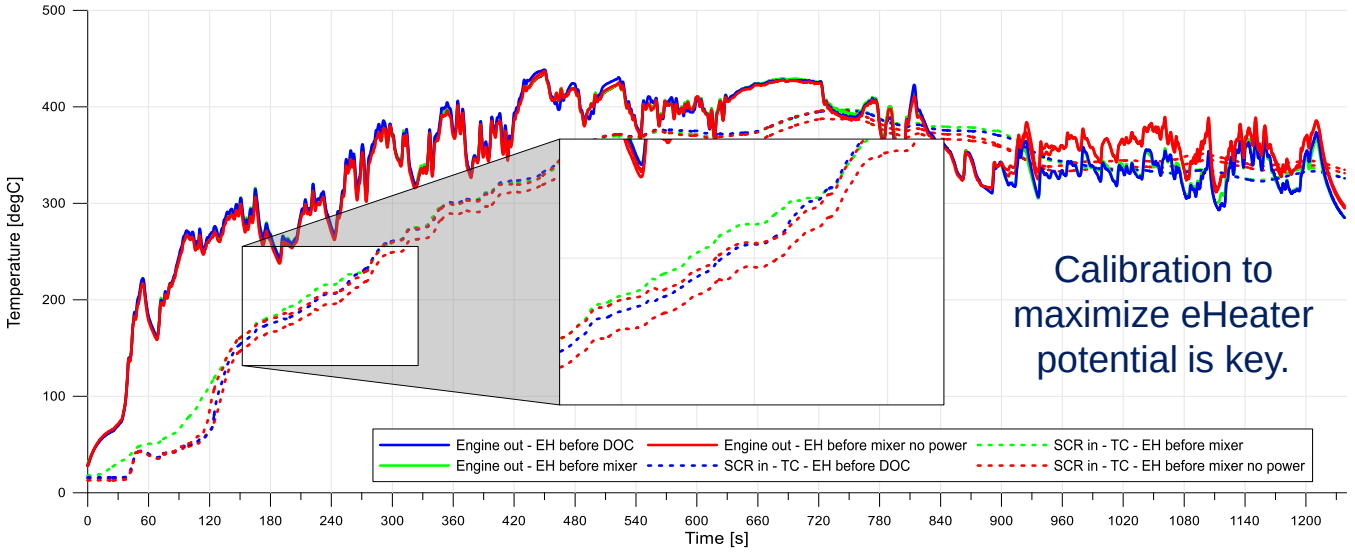
eHeater Integration

Acknowledgements on sample support & know-how transfer: EMITEC

Donaldson FILTRATION SOLUTIONS

DoE performed with EMITEC eHeater



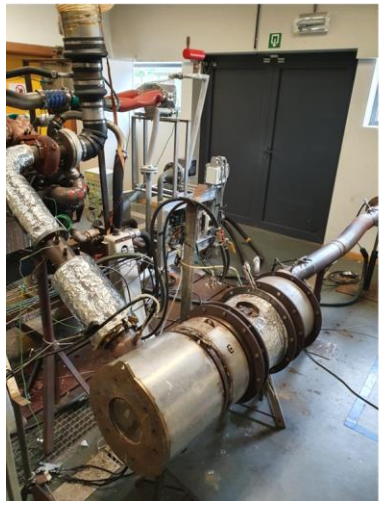


Calibration to maximize eHeater potential is key.

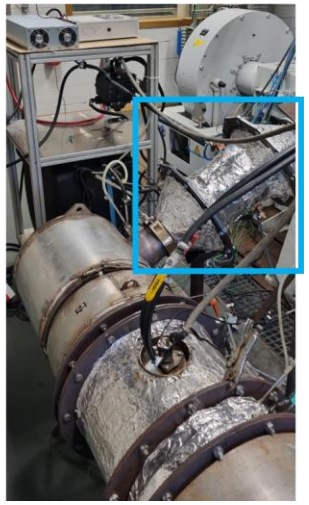
Test conditions: P(W) = 24V x 120A = 2880W ≈ 2.9kW [*eHeater maintained at low operating condition against its full capacity (at 4,5% of engine power).]. We have used a proto uncoated EHC for 1st trials.

eHeater thermal gains are not be limited for cold start
Potential for keep warm operations & regeneration aid

Baseline (no EH)

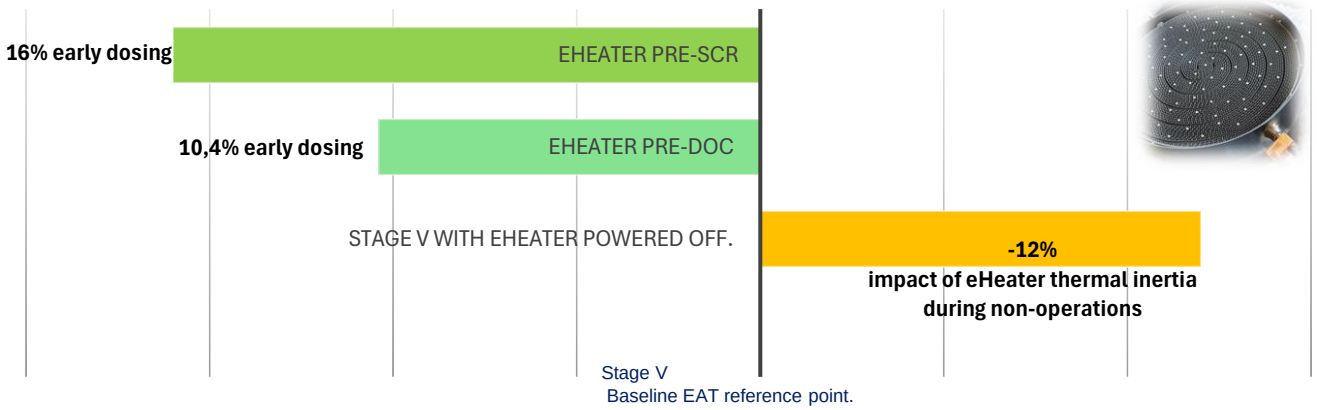


EH before DOC

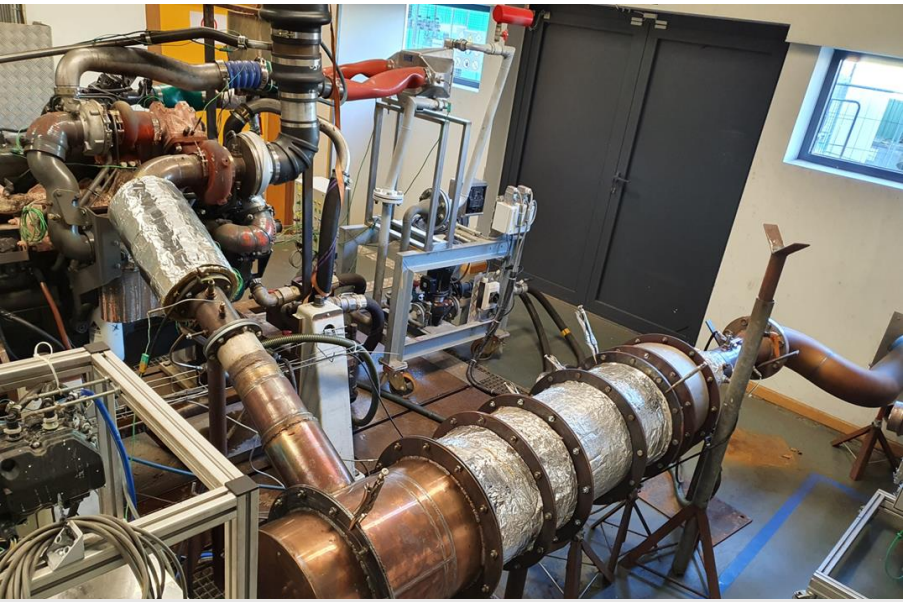


EH before mixer

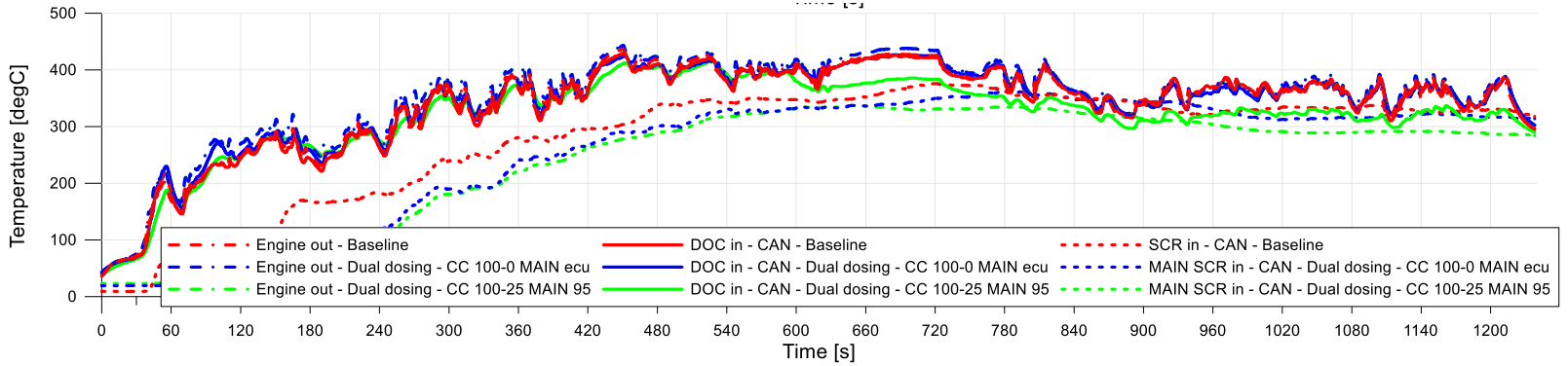
Thermal gains - addressing cold start with eHeater

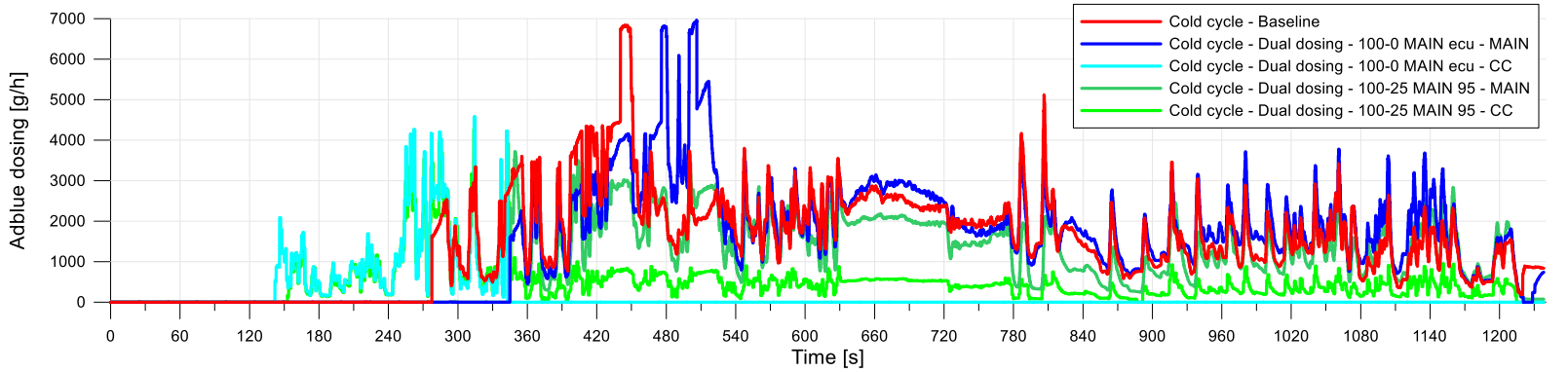


DCI Tier-5 Demonstrator

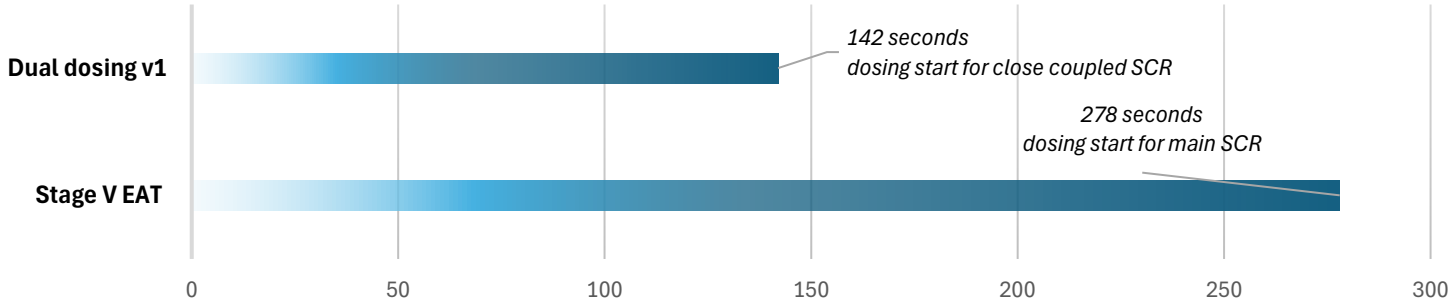


Stage V baseline EAT optimized for dual dosing setup and tested on an 8,4L engine without any cal modification





COLD START GAINS - DUAL DOSING SYSTEM DEMONSTRATOR

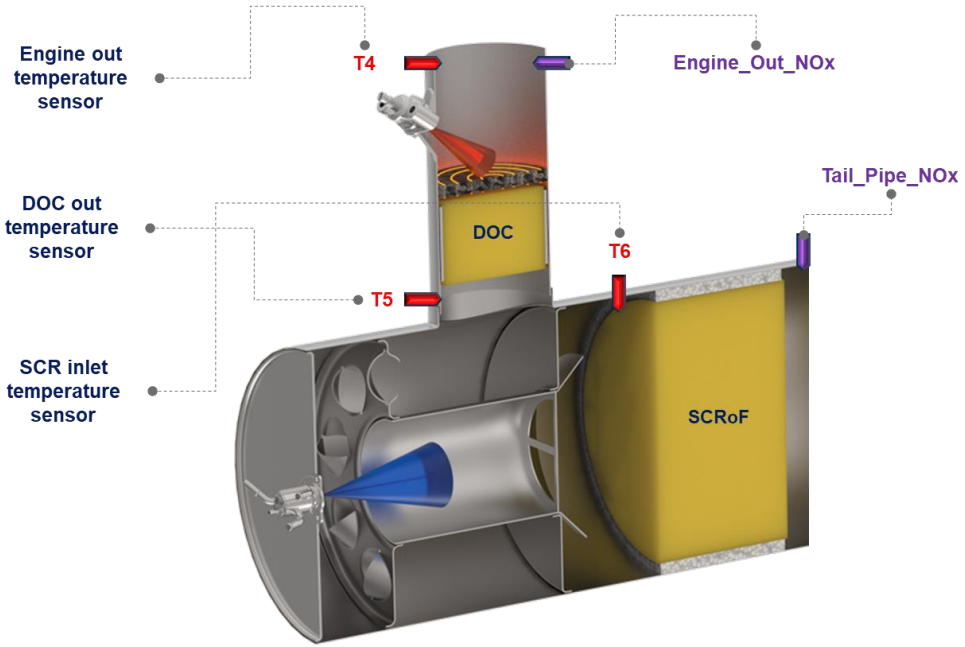


- **The technology to achieve Tier-5 is available**
- **No silver bullet regards to technology choice**
- **Application-based technology choice would be ideal**
- **Vehicle packaging to accommodate EAT systems**
- **Emission System Calibration included with new thermal solutions is the critical concern.**

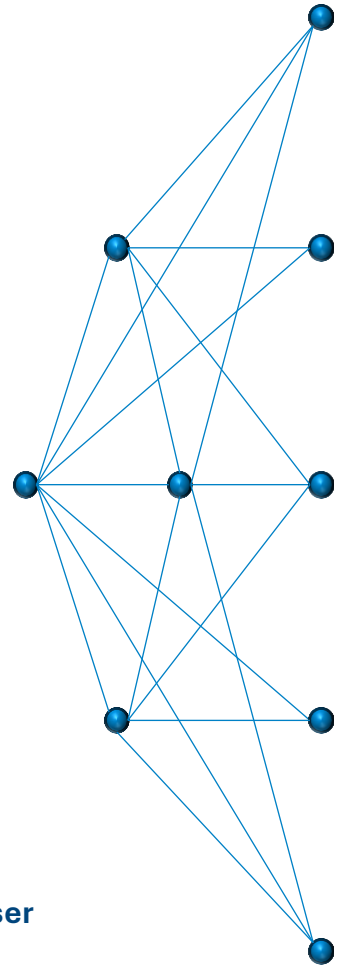
DCI - Heated Mixer [ATMU]

DCI Active Thermal Management Unit - ATMU

- **End user pain point to be addressed:**
  - ✓ **Avoid machine derate due to EAT system issues !**



DCI-ATMU is a self-flush, modular EAT concept, addressing the end user pain point & future proofing regulatory compliance.

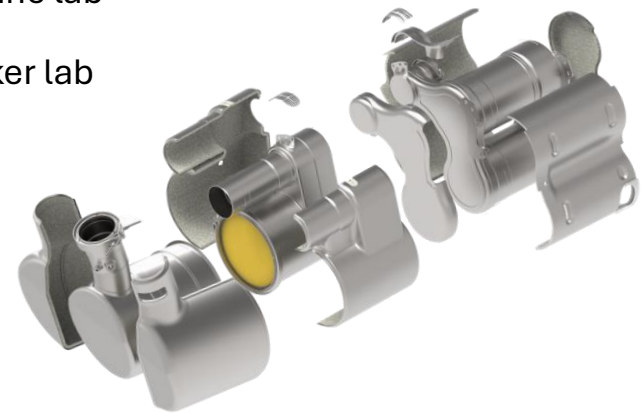


- **Rapid Heat up & Keep Warm support system**
- **Regeneration support for high dense fuels [B100 …]**
- **Compact and robust mixer with > decade long field experience**
- **Extremely modular – application-based technology choice possible**
- **If close looped right, can enable Tier-5 compliance and self-troubleshooting to avoid machine derate**


H2-ICE BUSINESS AWARD
We have successfully started supplying H2-ICE EAT solutions for our lead customer
HYDROGEN
H2

Why Donaldson ?

- Design, validation, manufacturing of complete EATS from A to Z
- Projects driven by principles :
  - ✓ Meeting the most demanding specifications
  - ✓ Cost-effective proposals
  - ✓ IP protected mixing technology integration
  - ✓ Robust & reliable designs
- Strong experience in off-road market
- Best in class quality supplier
- Full validation in-house capability:
  - ✓ Emissions – engine lab
  - ✓ Durability – shaker lab



Bedankt Terima kasih धन्यवाद
Děkuji Danke Thank you Grazie
감사합니다 Merci Gracias ขอบคุณ
شكرا ありがとう Dziękuję
Obrigado Teşekkürler 谢谢

Donaldson
FILTRATION SOLUTIONS

Thanks and best regards,

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