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Contribution of ATS on CO_2 Reduction for CAFÉ Phase 2

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ECMA's 12th International Conference, 14th – 15th Nov., 2019

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  - Stop/Start strategy
    - ✓ Gasoline
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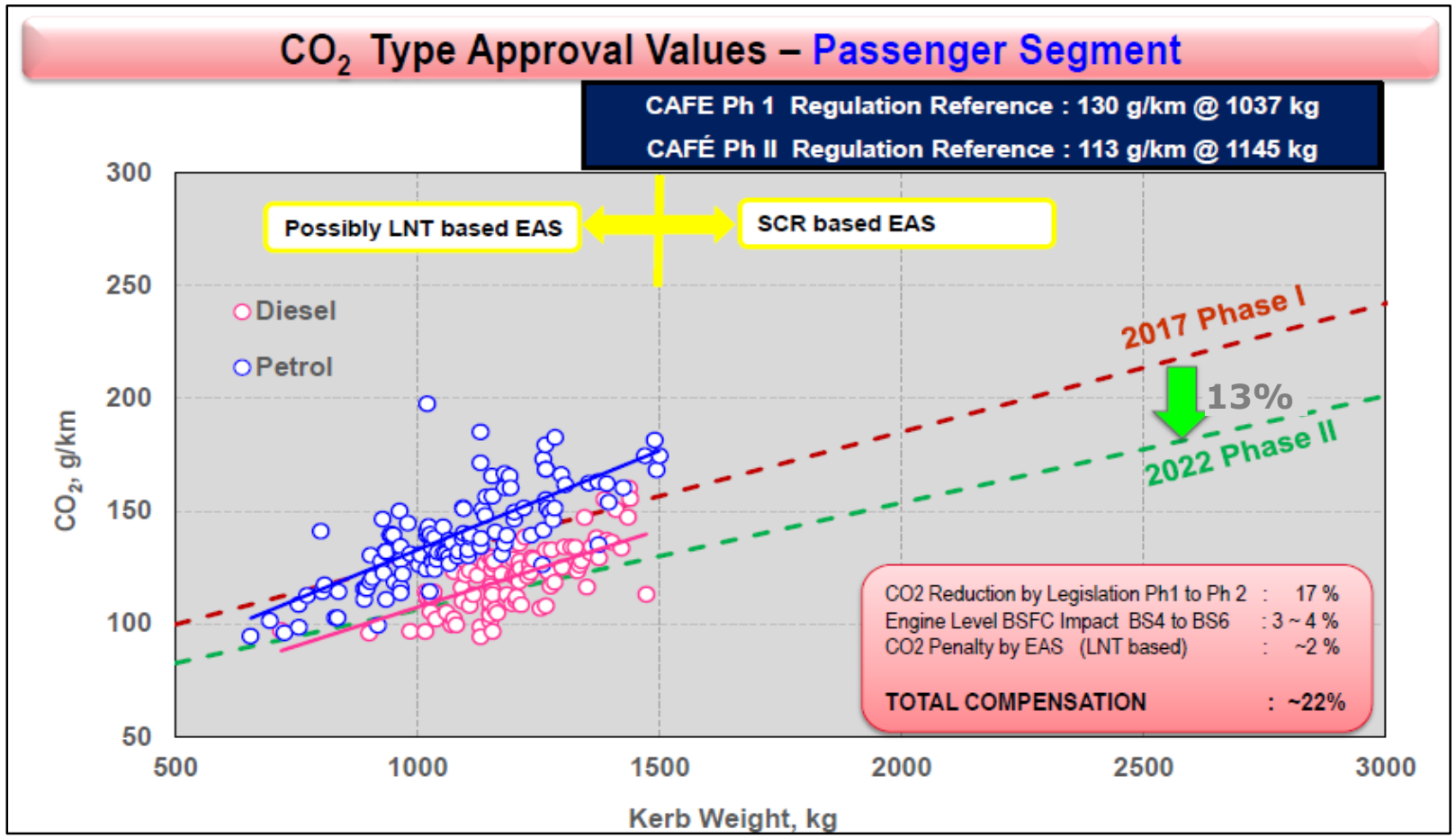
  - Catalytic performance improvement

- Summary

Cafe Phase 2 Over View



Both Diesel and Gasoline need CO_2 reduction strategy to meet the café 2 target in 2022

Source : K Senthur Pandian, ECMA International Conference 25th Oct., 2018

- BS VI introduction with RDE (2023~) need to be managed simultaneously!

Fuel Economy Improvement
- ATS related Countermeasures

- **Electric Vehicle:** After treatment system (ATS) is not required however will take time for successful industrialization
- **Hybridization:** Successful in other part of world however technology add significant cost increase for buyers
- **Engine / Vehicle improvement:** Engine efficiency has increased over the past several decade and simultaneous below mention idea contribute to fuel economy improvement significantly
  - ✓ ATS applicability to Start-Stop system
  - ✓ Catalyst performance improvement can contribute significantly

    Formulation improvement

    Substrate specifications (Cell density, porosity……)

    System configuration

    Formulation improvement

    Calibration (Urea dosing for SCR, Lean-Rich strategy for NSC)

Fuel Economy Improvement
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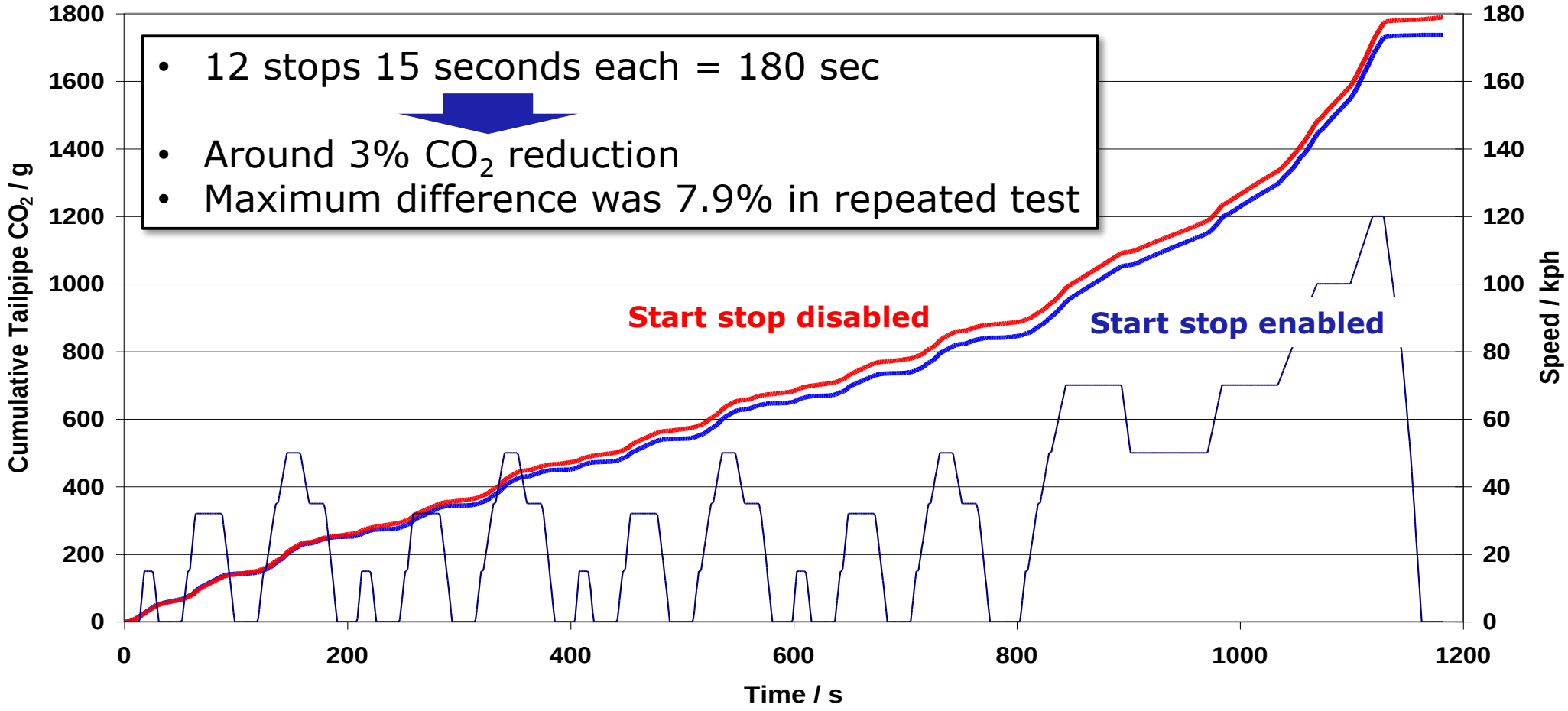
Start Stop System - Gasoline

- CO_2 Advantage

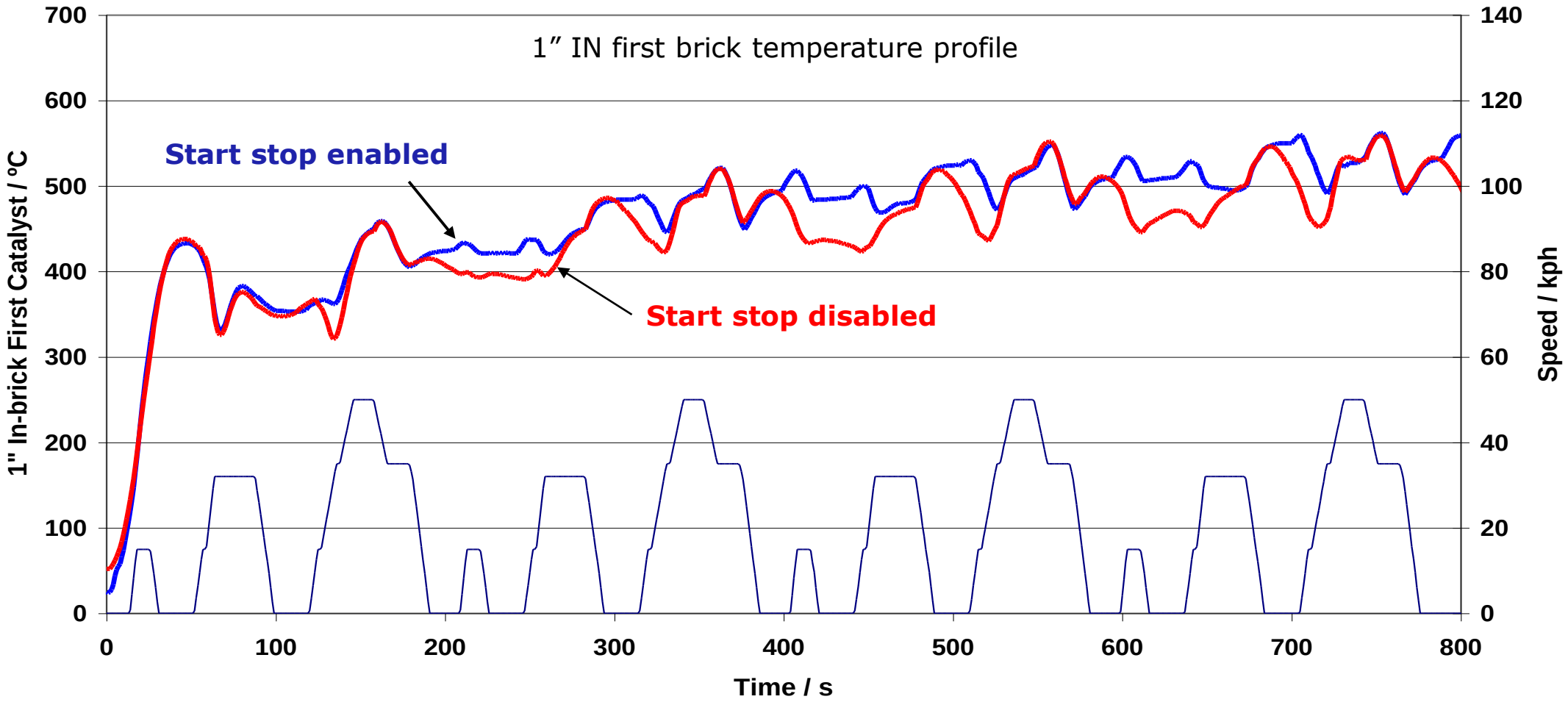
Vehicle : 1.6 L (DI Turbo)



Start Stop System - Gasoline

- Brick temperature profile over NEDC

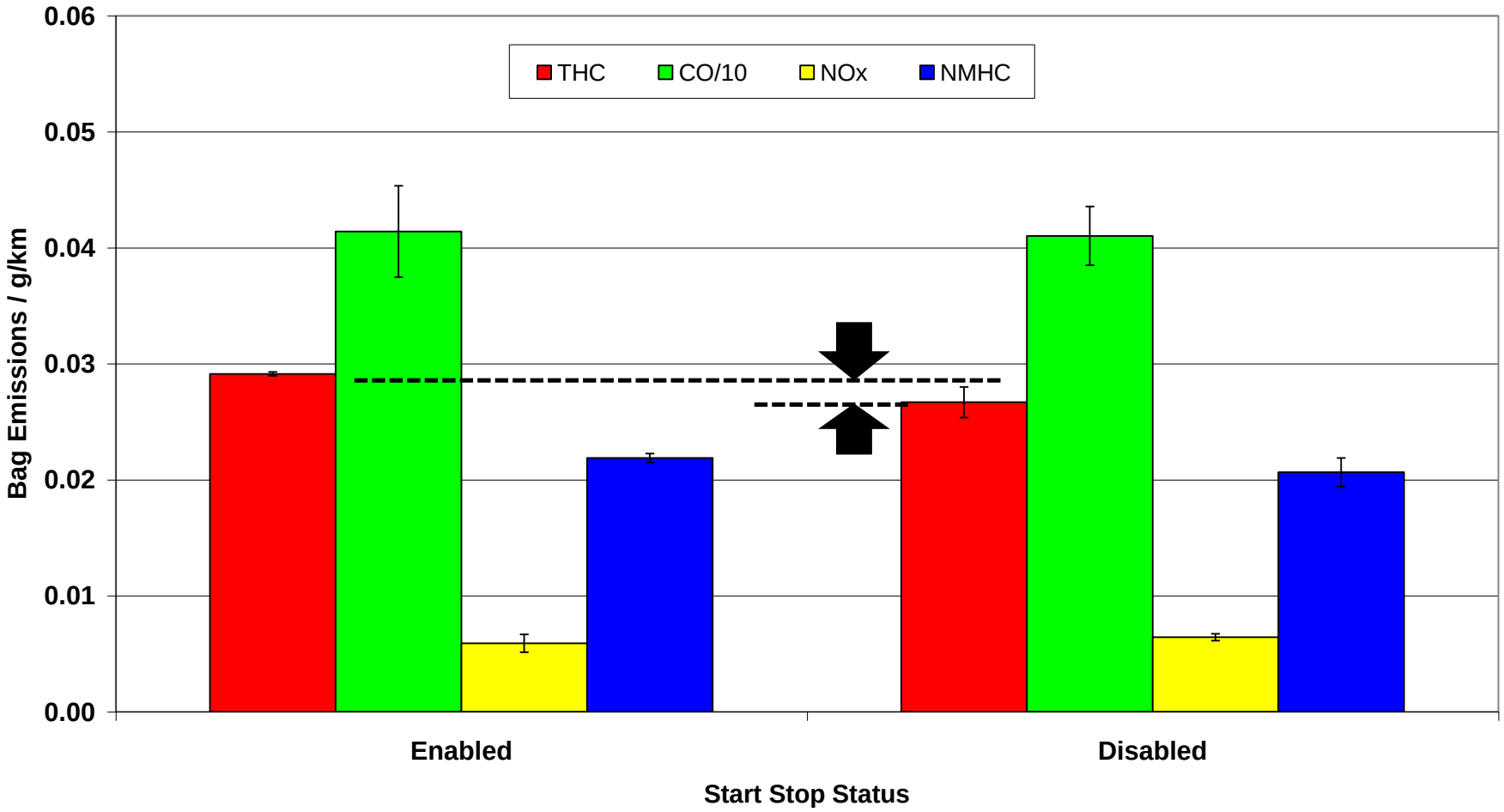
- No Negative impact on temperature profile was observed with Start stop system



Start Stop System - Gasoline

- Bag emissions

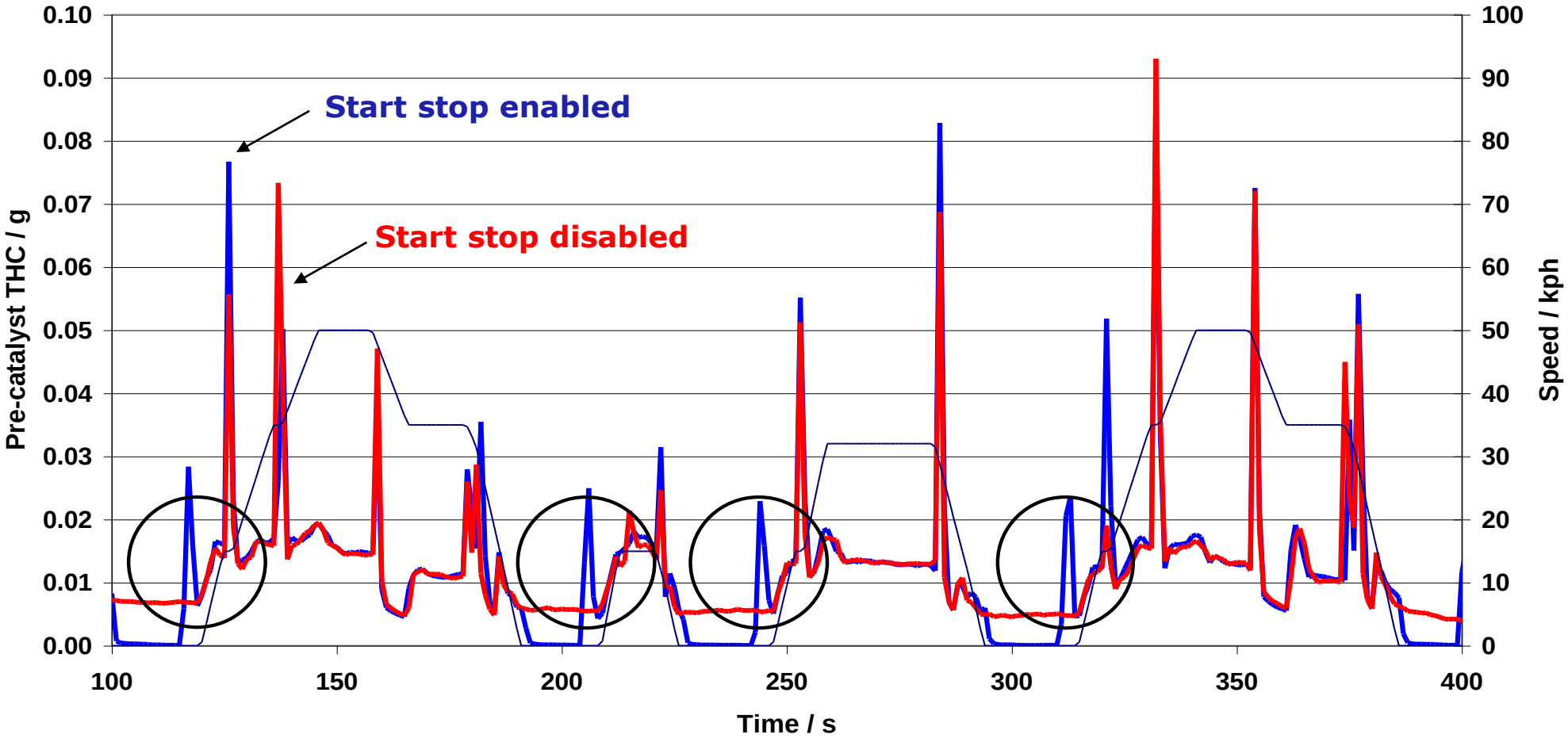
- CO / NOx were equivalent
- Small increase in THC was observed with start stop system



Start Stop System - Gasoline

- HC emission analysis at post pre-catalyst

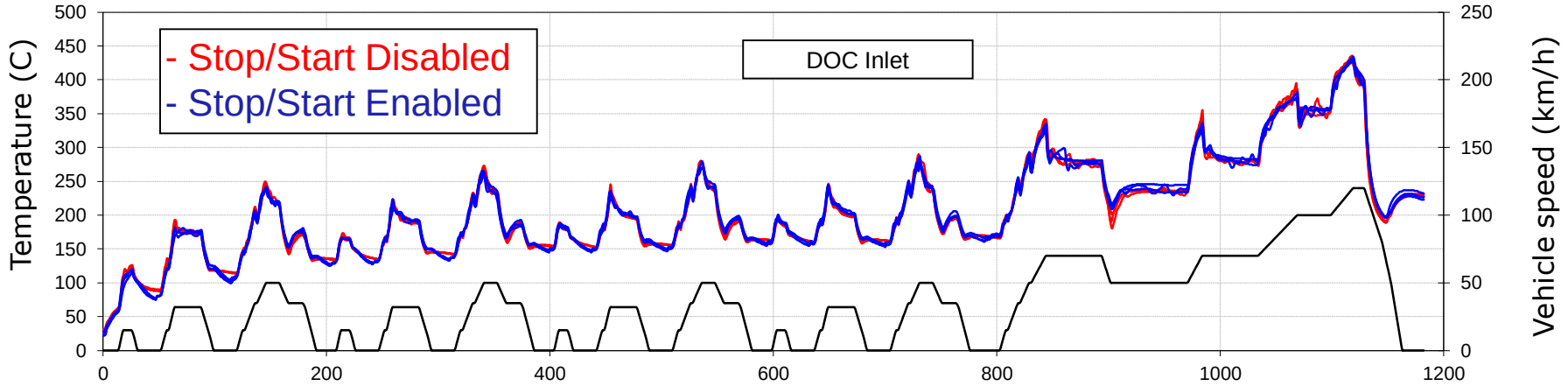
- HC spikes were observed at "start" points

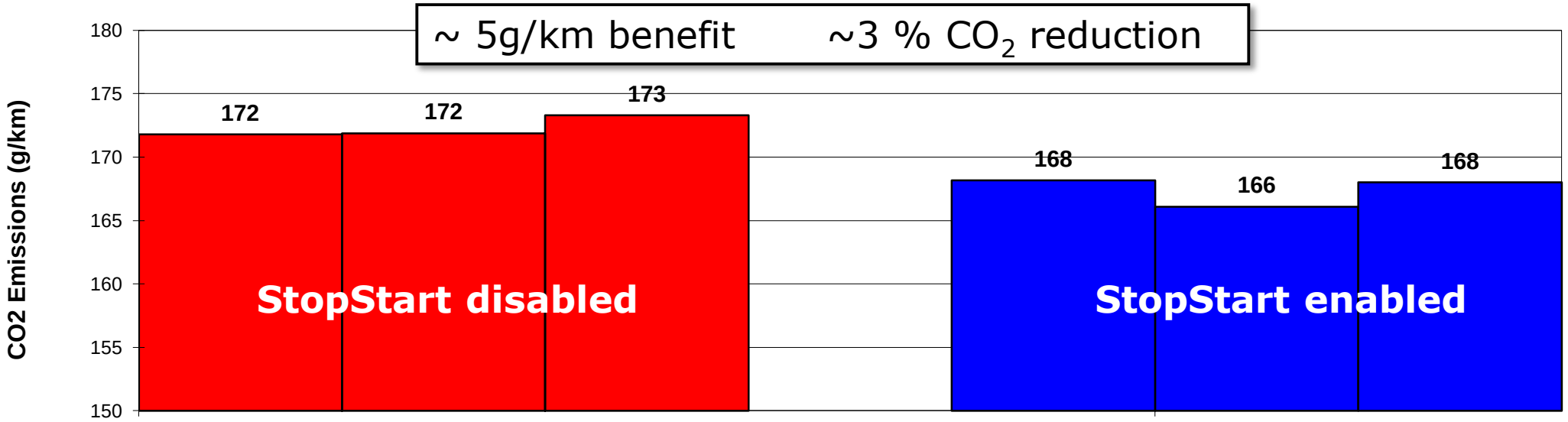


Start Stop System – LDD (Light Duty Diesel)

- Vehicle : Engine size 2 L, CR

- Temperature profile was comparable with/without start stop system

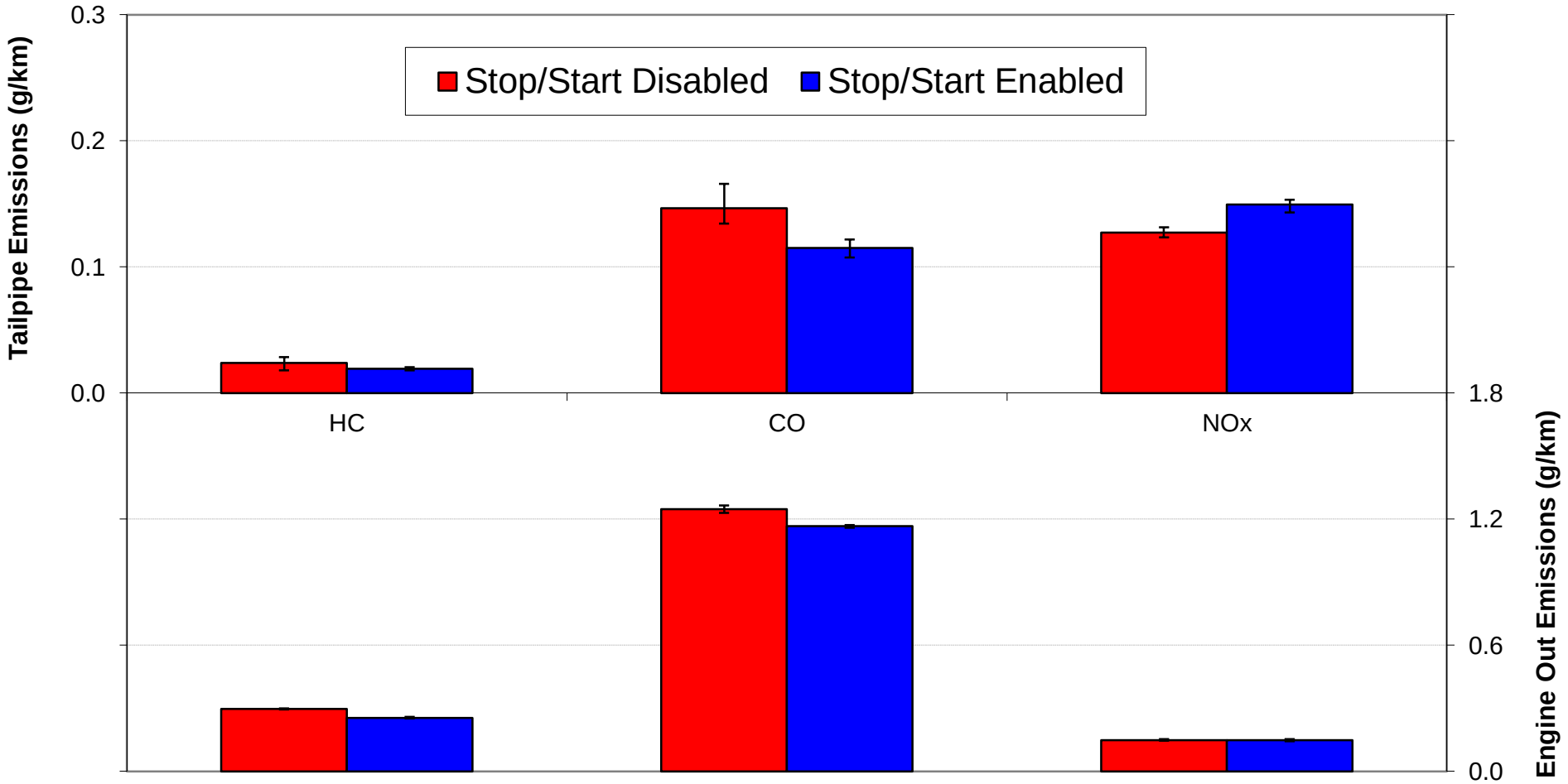




Start Stop System – LDD (Light Duty Diesel)

- Engine out and tailpipe emissions

- Engine out CO / HC were reduced with start stop system
- CO / HC tailpipe emissions were also reduced with start stop system



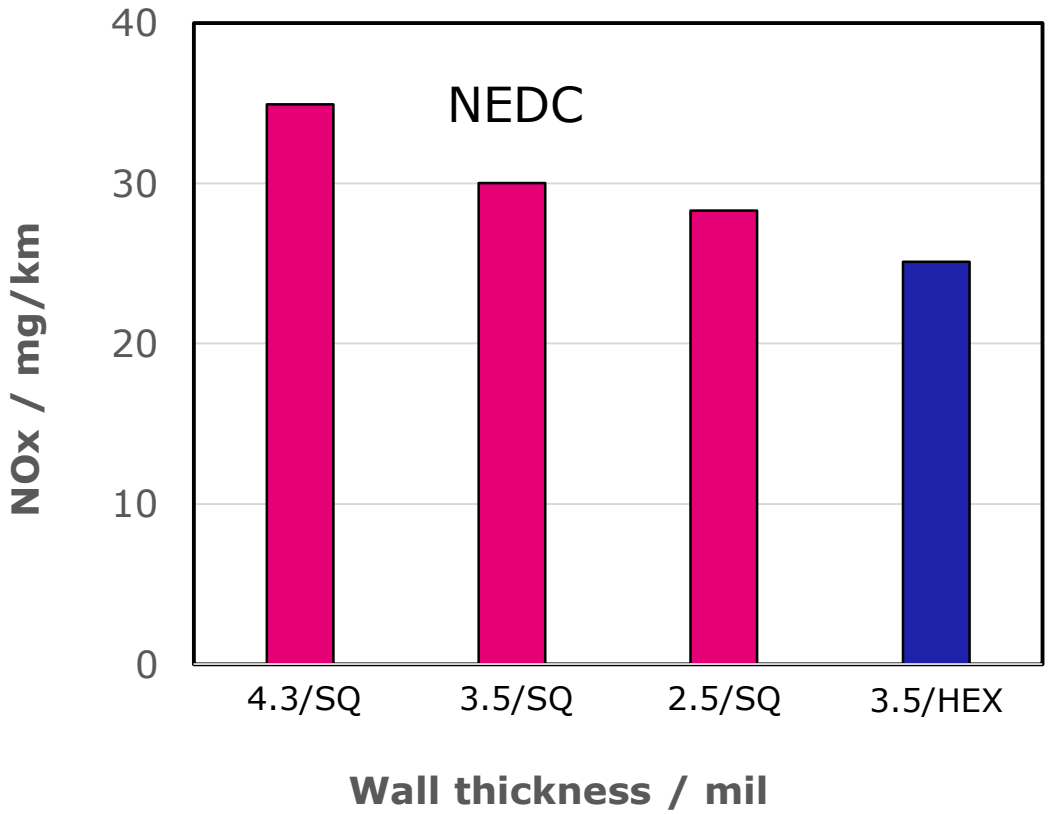
Start Stop System – LDD (Light Duty Diesel)

- Summary

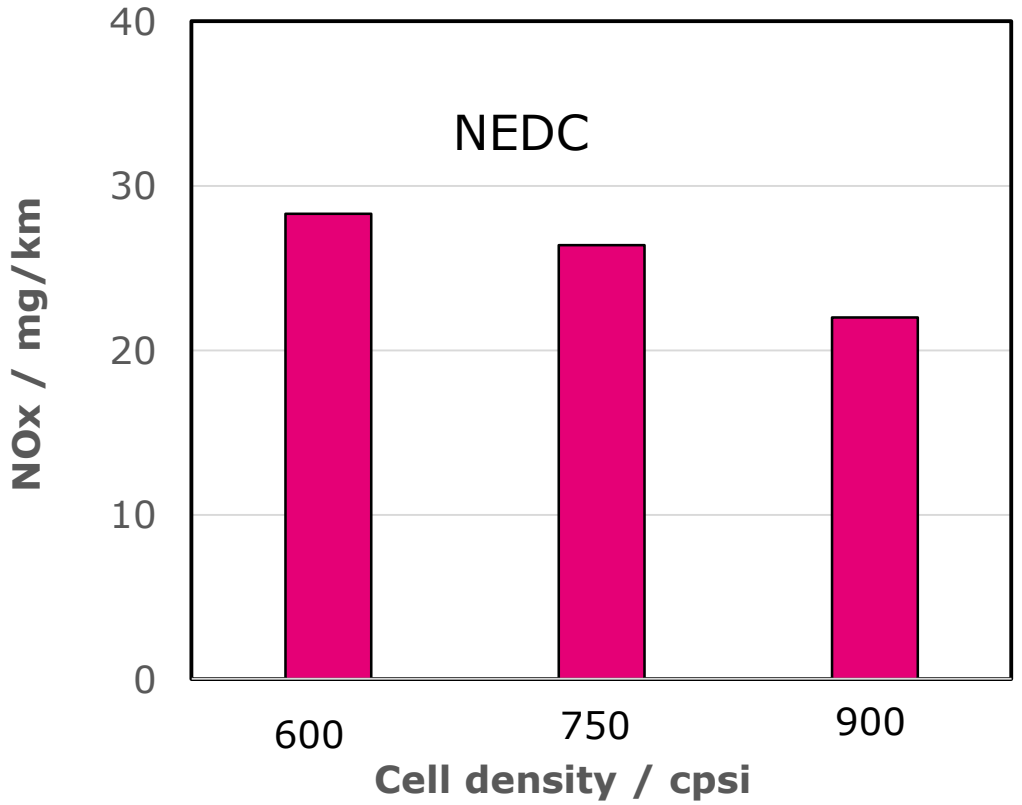
- Around 3 % of CO_2 reduction was observed with Start Stop system
- Stop/Start system showed an emission benefit for HC & CO emissions

Effect of Substrate Specifications [Gasoline]

- Reduced wall thickness delivered advantage

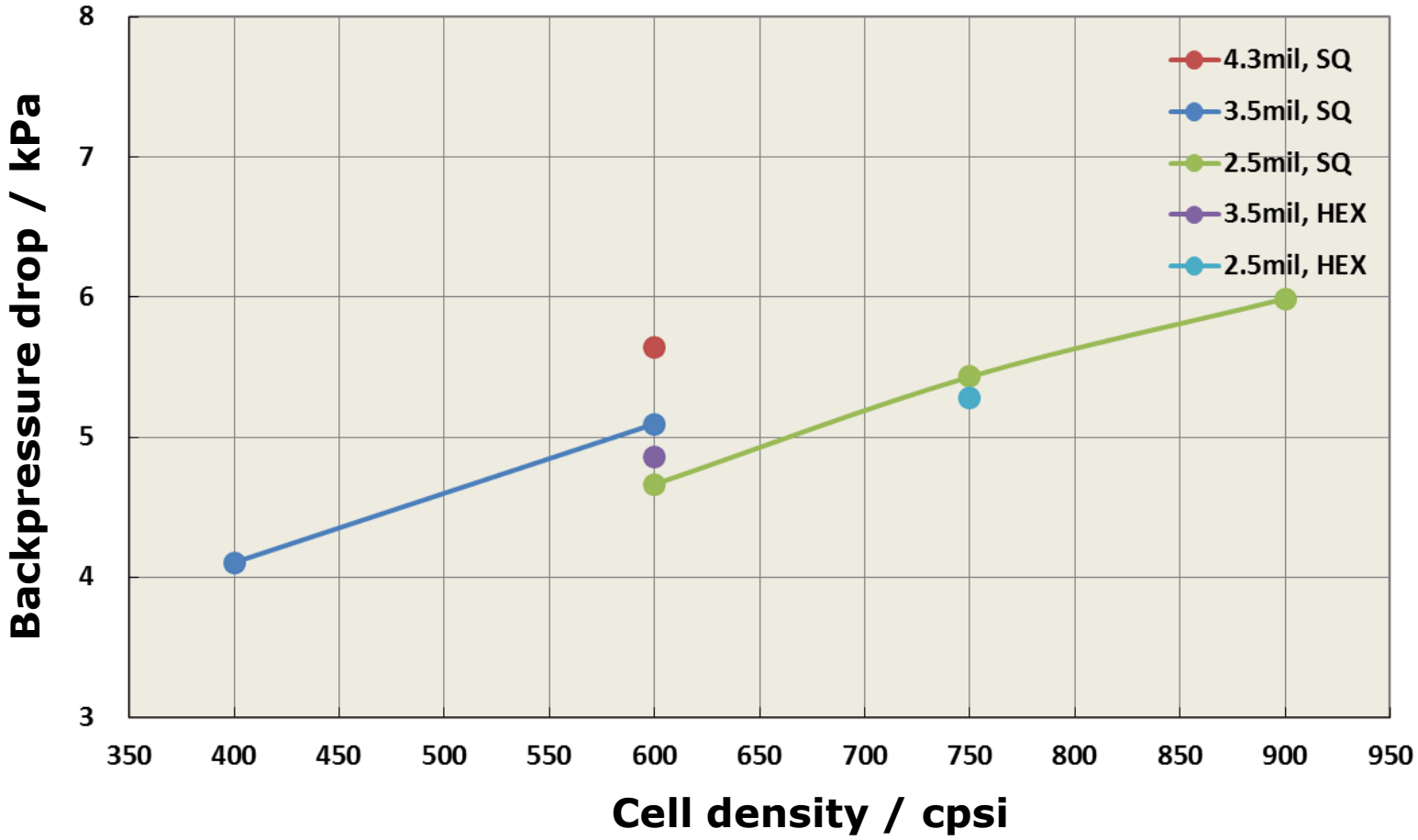


- Higher cpsi improves NOx emission



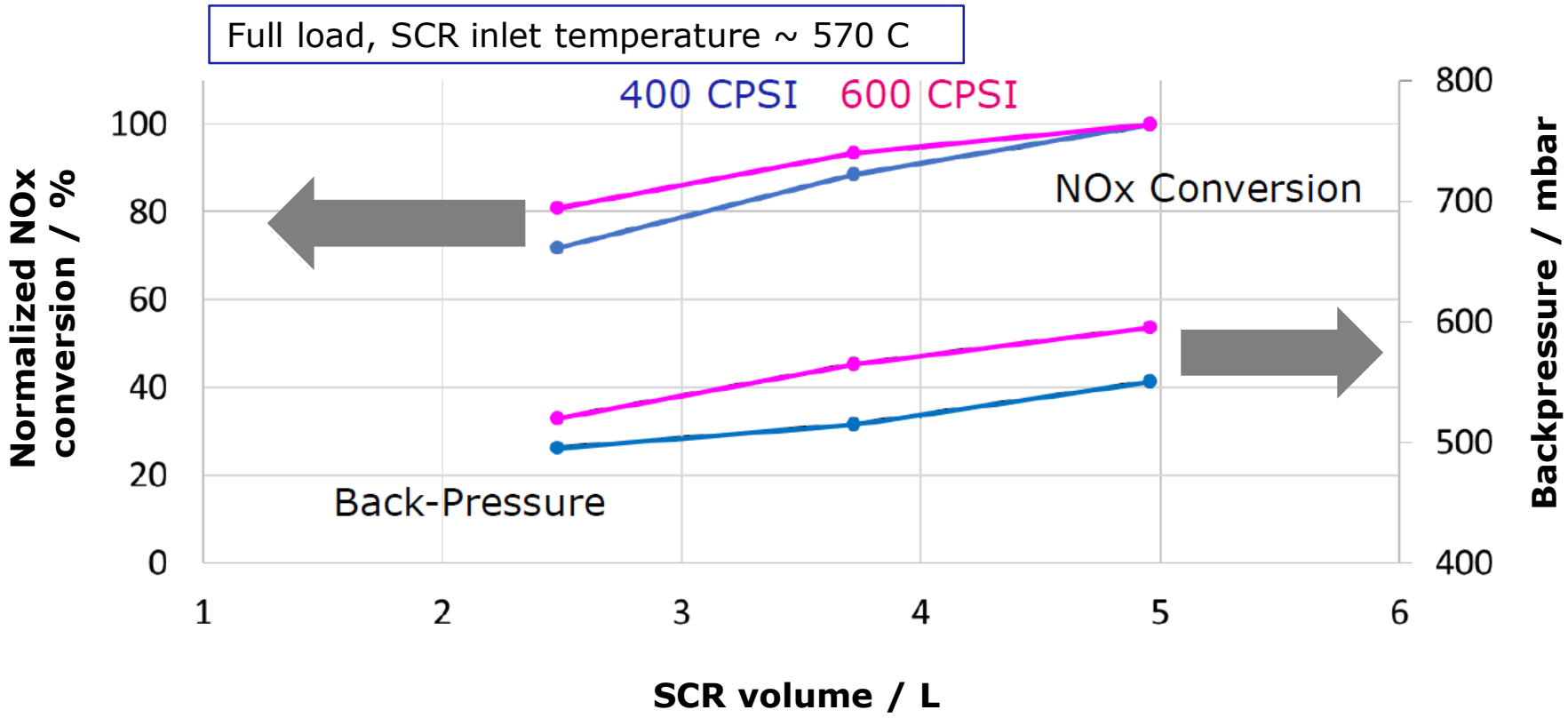
Effect of Substrate Specifications [Gasoline]

- Thicker wall and Higher cell density showed higher backpressure.



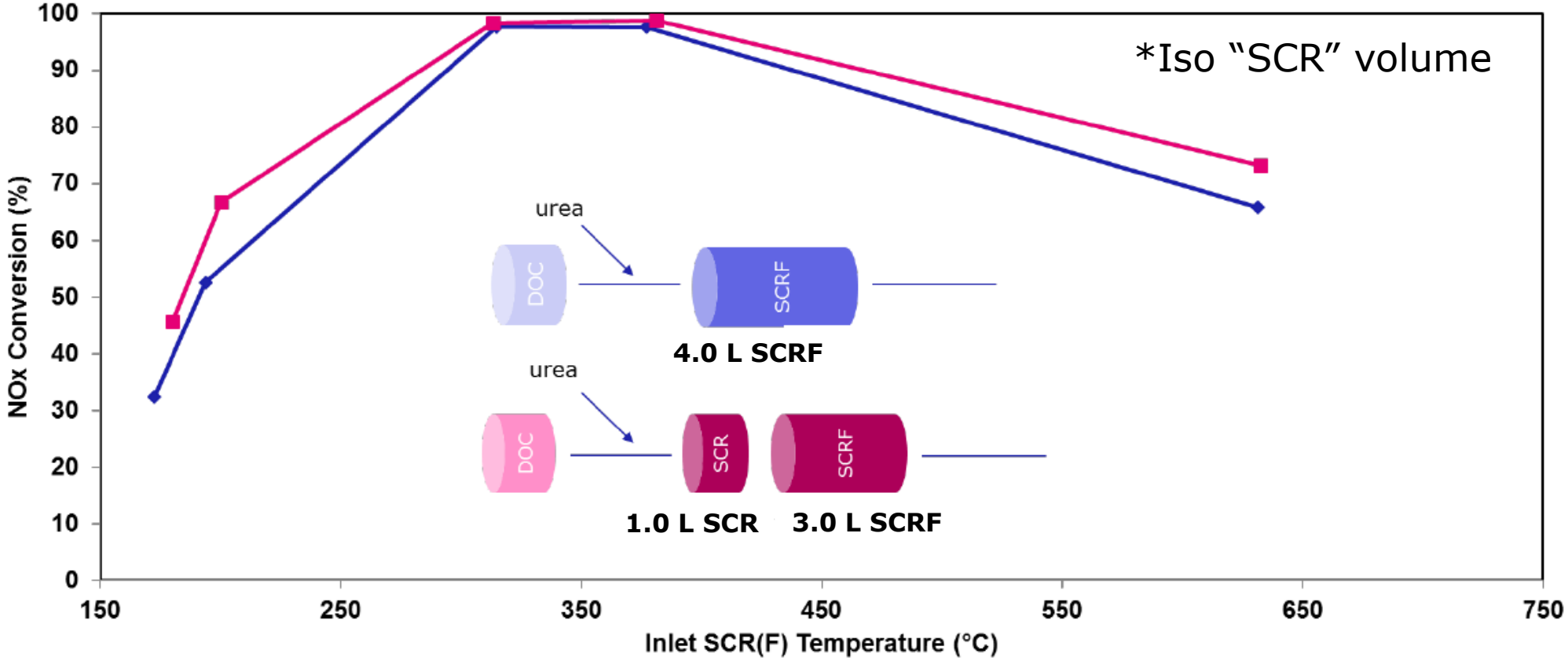
Effect of Substrate Specifications [Diesel]

- High cell density showed performance advantage, but delivered higher backpressure



Effect of System Layout [LDD]

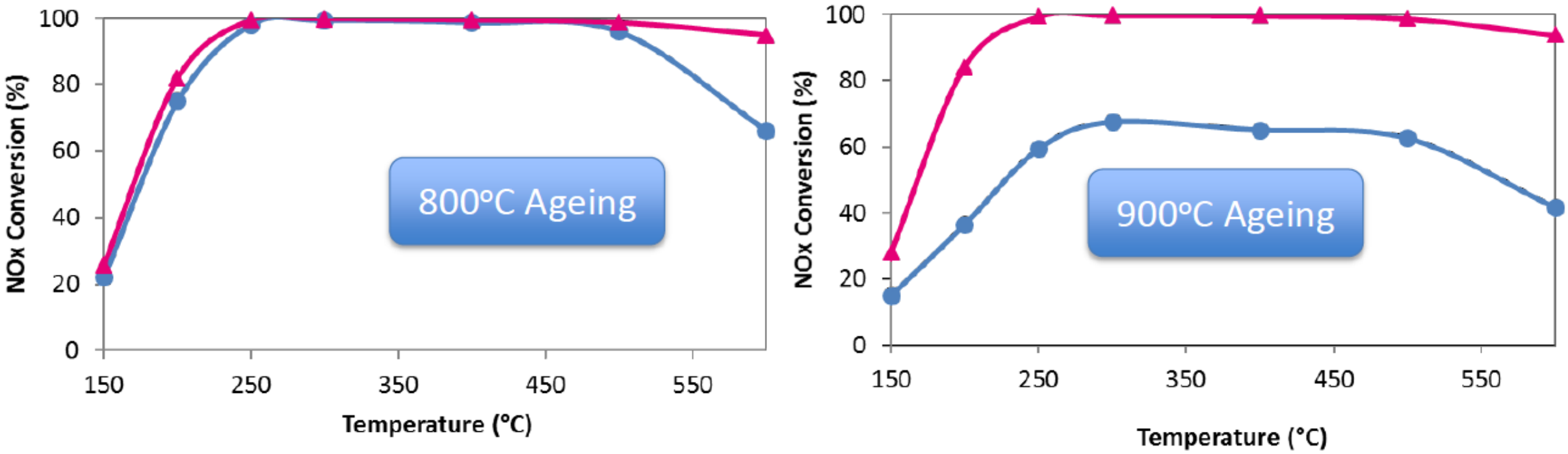
- Pre-SCR (flow-through) gives higher conversion than SCRF only
- Advantage on transient cycle can be expected



Formulation Improvement - SCR

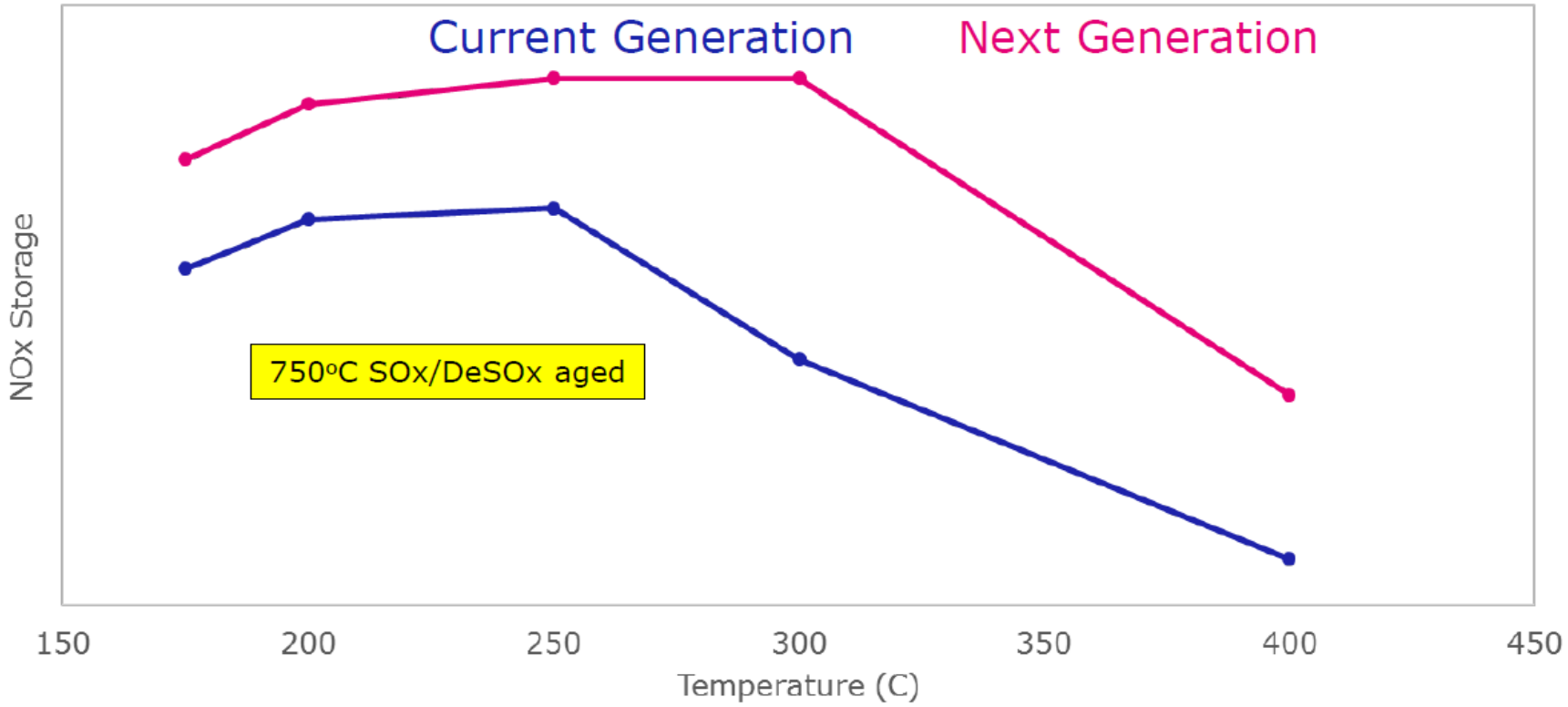
- BS VI SCR improved thermal stability from previous technology.
- This allow to apply to SCRF application

- Previous SCR **- BS VI SCR**



Formulation Improvement - NSC

- New NSC achieved significant performance gain across the temperature window



Summary

Start Stop System

- Both Gasoline and Diesel application demonstrated around 3 % of CO_2 reduction
  - Start stop with 1.6 L Gasoline ;
    - ✓ Increase in HC emission was observed (potential risk?)
  - Start stop with 2.0 L LDD ;
    - ✓ CO/HC tailpipe emission was improved with the system

Substrate Specifications

- Higher cell density and thinner wall thickness showed advantage in emission (Though BP was negative)

System Layout

- Pre-flowthrough SCR improved NOx conversion across the temperature window

Catalytic performance improvement

- Advanced formulations are used for BS VI

To achieve CAFÉ Phase 2, combination with multiple countermeasures will be needed

JM

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