

SCR Technology for NOx Reduction: Series Experience and State of Development

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SCR Technology for NOx Reduction

Outline

- Necessity of NOx Exhaust Gas Aftertreatment
- Air-assisted Dosing Systems (HD applications)
- Field experience with DENOXTRONIC for MD/HD
- SCR Market Overviews
- Airless Dosing Systems (including PC/LD applications)
- Measures to optimize NOx conversion performance
- Summary

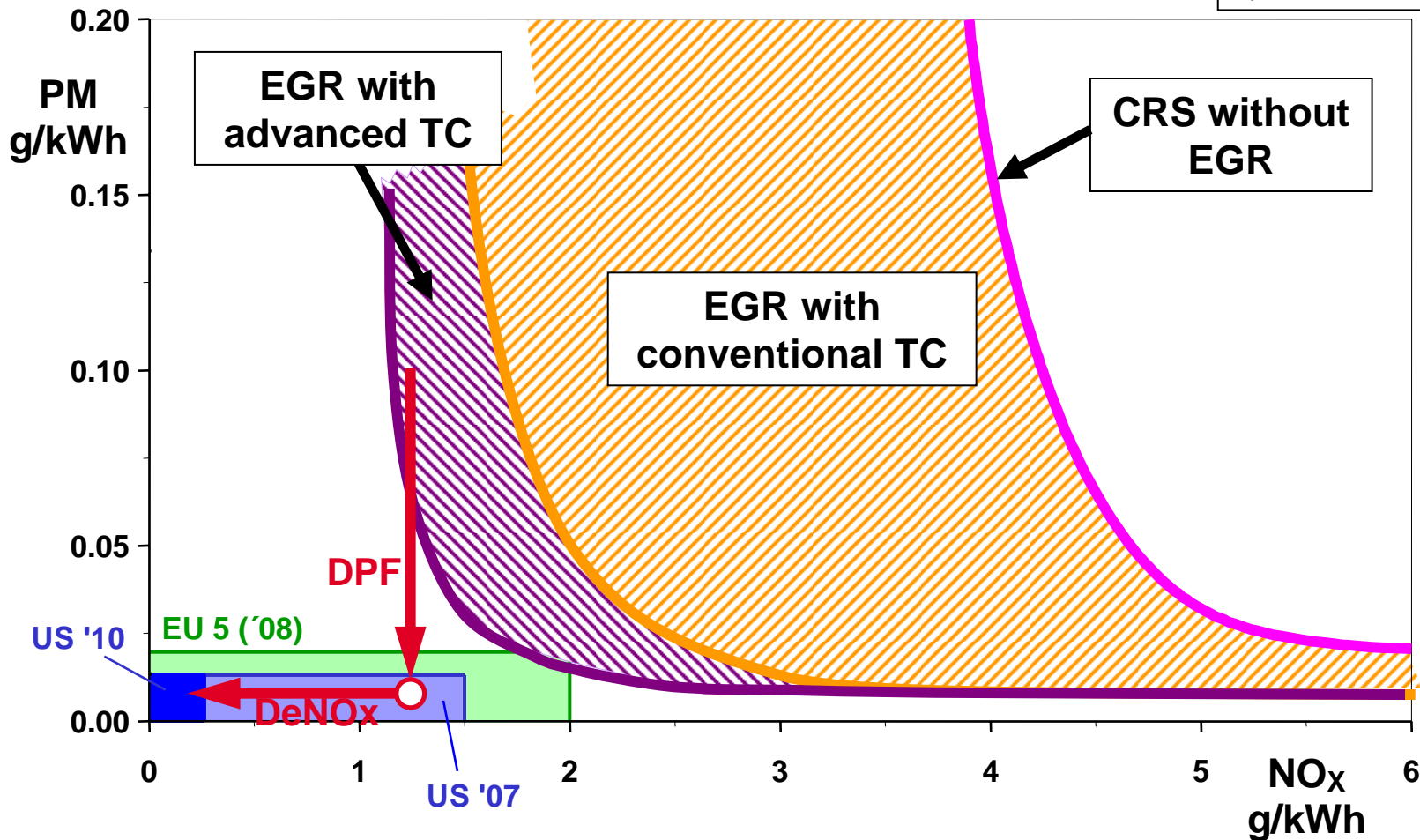


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MD/HD: Strategies for US10

EGR Rates: 15% / 25% max at FL
 Boost Pressure: 3 / 4 bar abs.
 Inj. Pressure: ≤ 2400 bar



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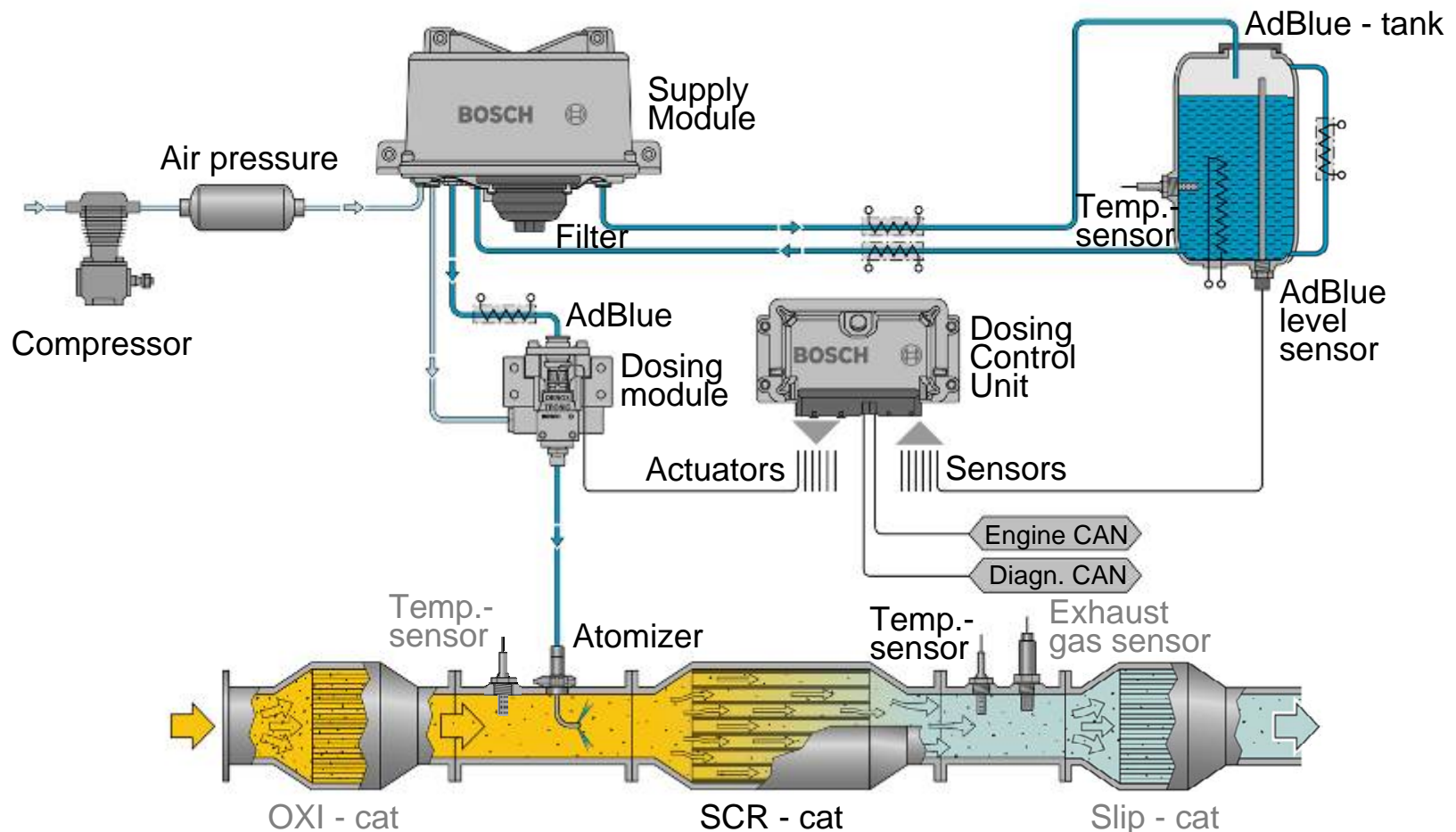
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System layout DENOXTRONIC 1 (w/ air support)





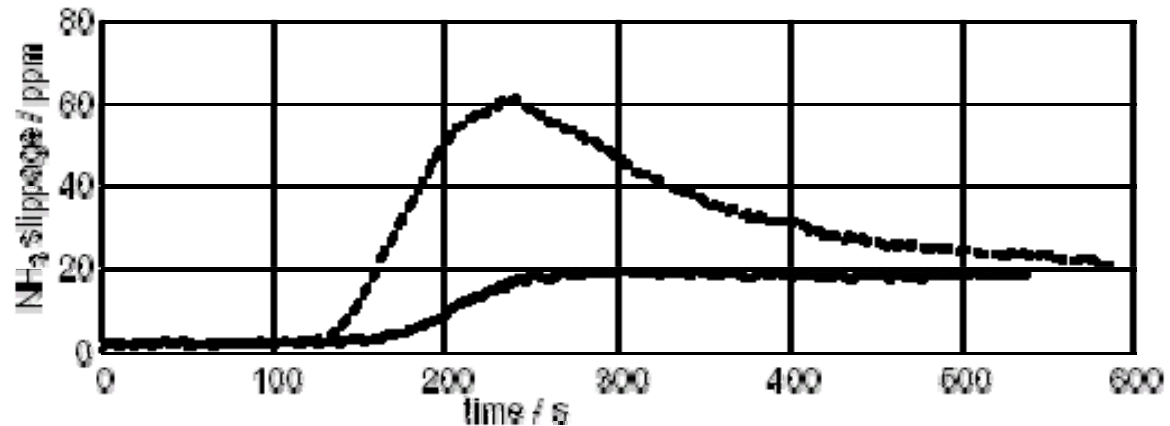
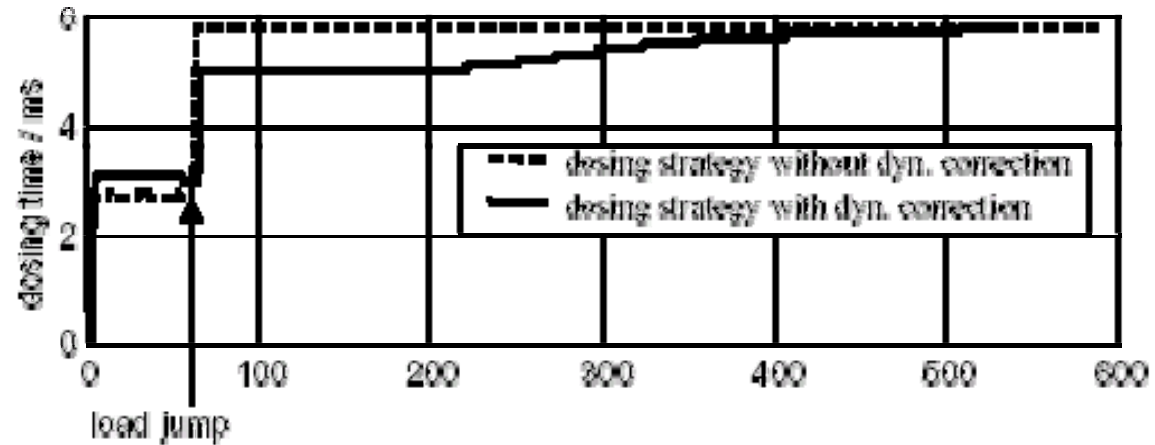
DENOXTRONIC 1- Dynamic Correction

speed:

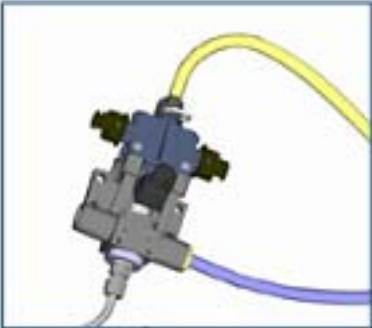
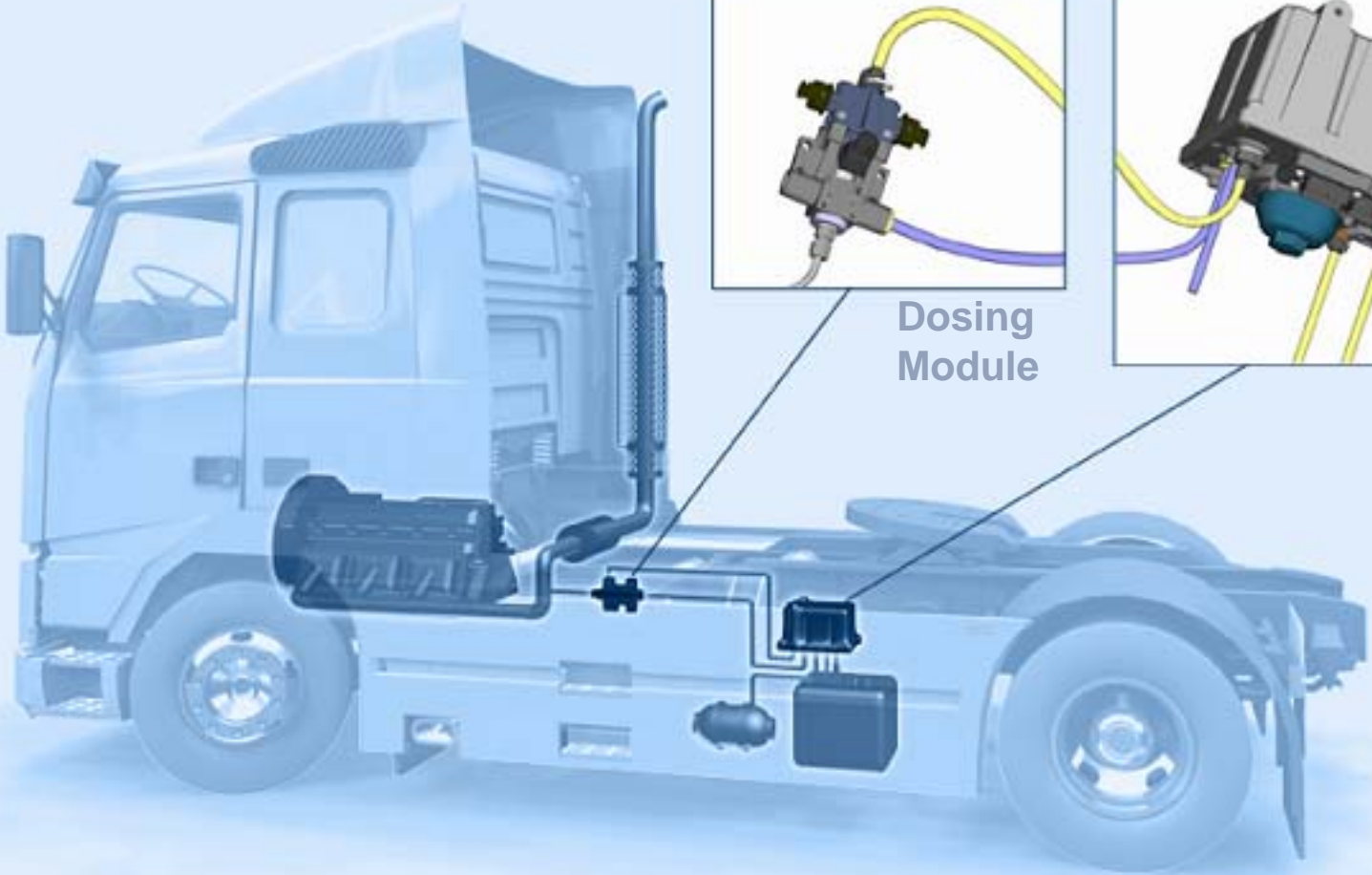
1000 rpm const.

torque:

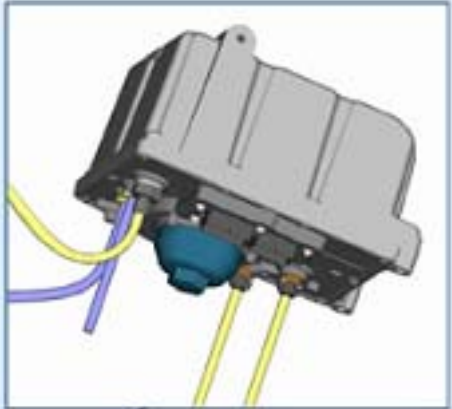
250 Nm to 530 Nm



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Dosing Module



Delivery Module



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Field experience with DENOXTRONIC for HD/MD

- First SCR market introduction with Nissan Diesel in Nov. 2004 in Japan
- First SCR market introduction by Volvo-Bus at the end of 2004 in Europe
- Other OEM's will launch first SCR vehicles in 2005 and 2006
- 1200 vehicles have been sold so far (Europe and Japan combined)
- Field test mileage with 6 OEM's (Europe and Japan combined):
 - 14 Mio km with 200 vehicles
- Field test experience:
 - SCR is a reliable technology for automotive exhaust gas treatment
 - Solutions to technical challenges, e.g. avoiding of crystallization and heat protection at exhaust gas interface, are available.



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SCR in Europe

→ HD/MD

Drivers:

- Benefits in specific fuel consumption and reliability
- Early compliance with Euro 5 emission standards
 - Highway tax incentives, e.g. Germany 0.02 €/km until 2009



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Urea / AdBlue Infrastructure in Europe

→ 3 Companies provide AdBlue through their filling station networks



→ At present:

- 20 filling stations with pumps
- 650 filling stations offer canisters (>1500 stations by the end of 2005)

→ Various companies offer the distribution of:

- On-site tanks and pumps
- Bulk loads
- Intermediate bulk containers and cans



SCR in Japan

→ HD/MD

- Reducing agent infrastructure is being prepared with cans, on-site tanks and public filling stations (~700).
- Driver: Compliance with 'New Long Term Regulations' (2g/kWh NOx)

→ PC/LD

- Market potential is expected to increase as the AdBlue infrastructure expands.



SCR in North America

→ HD/MD

- For 2007 industry is focused on EGR and DPF
- SCR is seen as potential technology for US10 combined with EGR/DPF
- No definitive technology path determined yet (LNT ↔ SCR)

→ PC/LD

- SCR seems to be the preferred solution with regard to lifetime performance, effective temperature range, fuel consumption and costs
- OEM's are in discussion with EPA for a potential SCR introduction in 2008/09.



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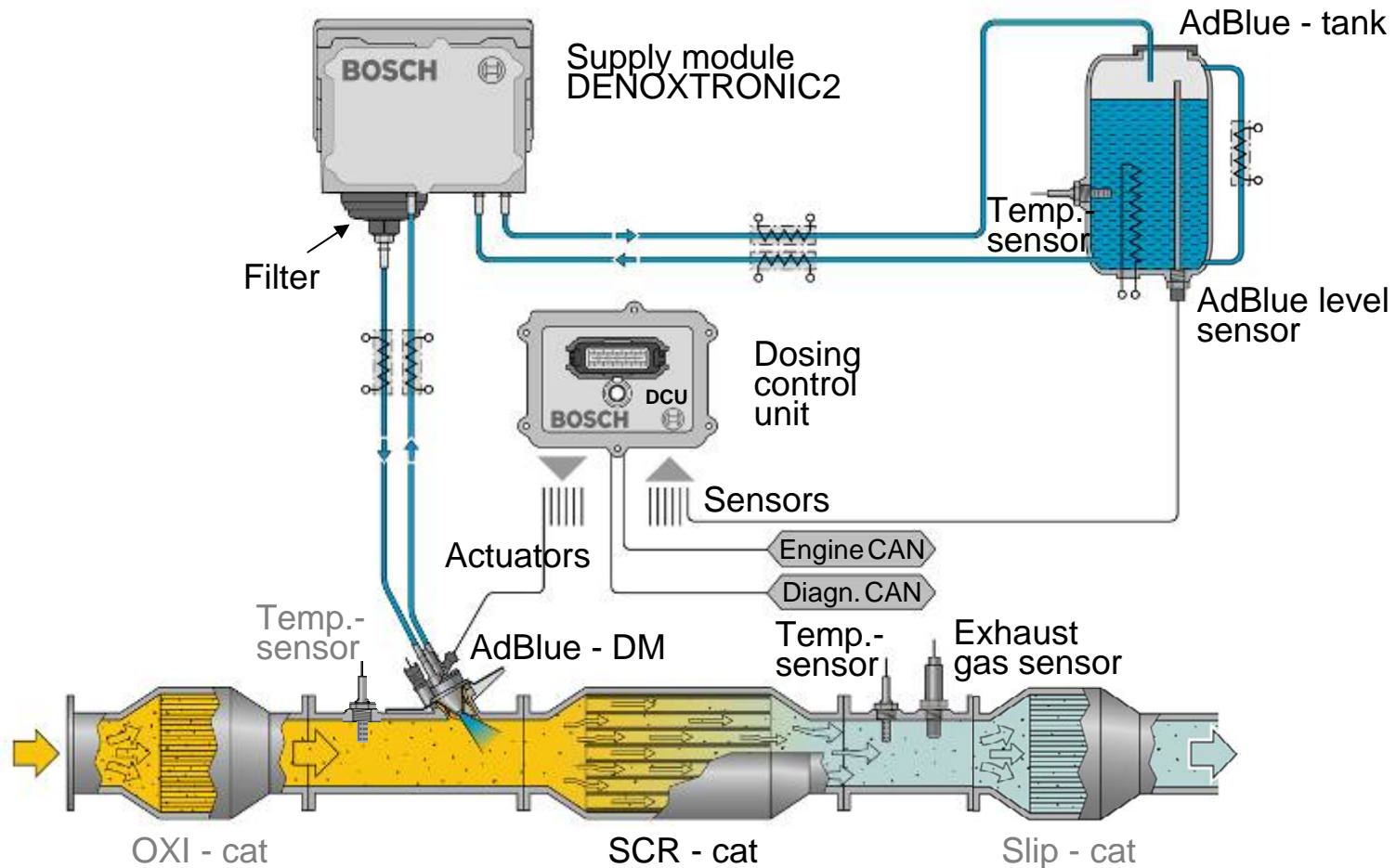
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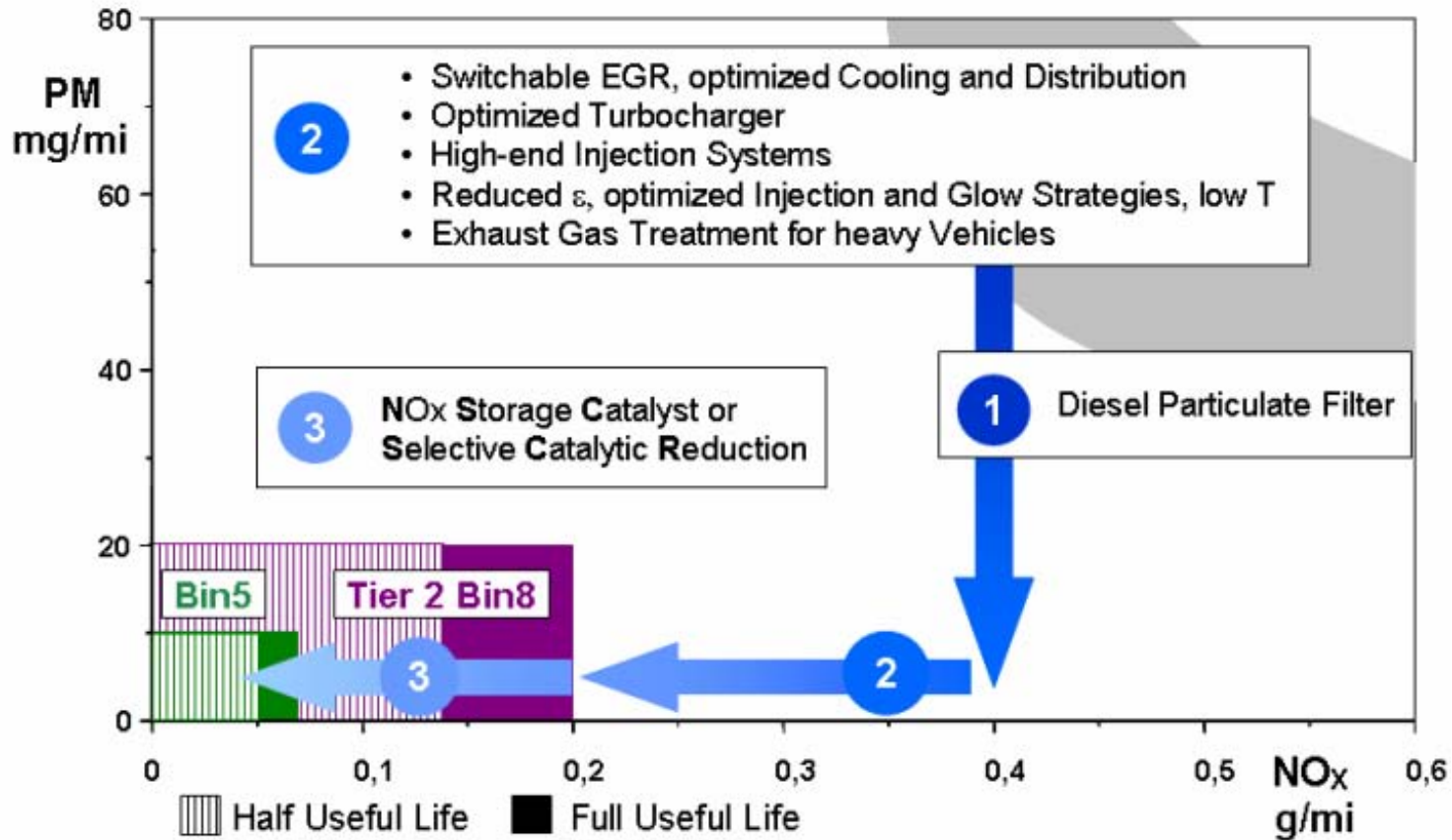


System layout for HD/MD, non-air assisted



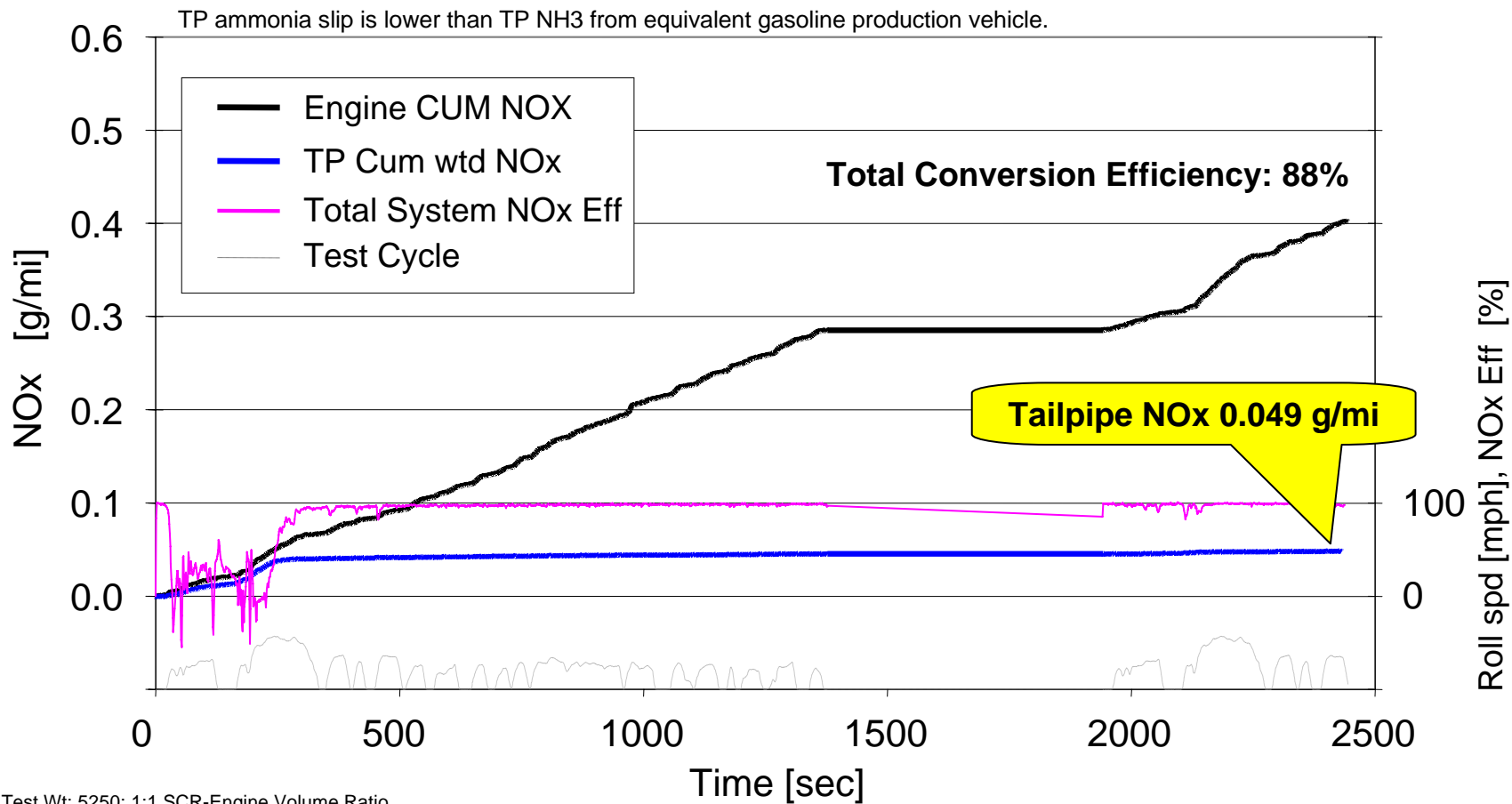
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PC/LD: Strategies for Tier 2 Bin 5 (FTP)



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FTP75 Test Cycle – 120k aged / Non-air assisted

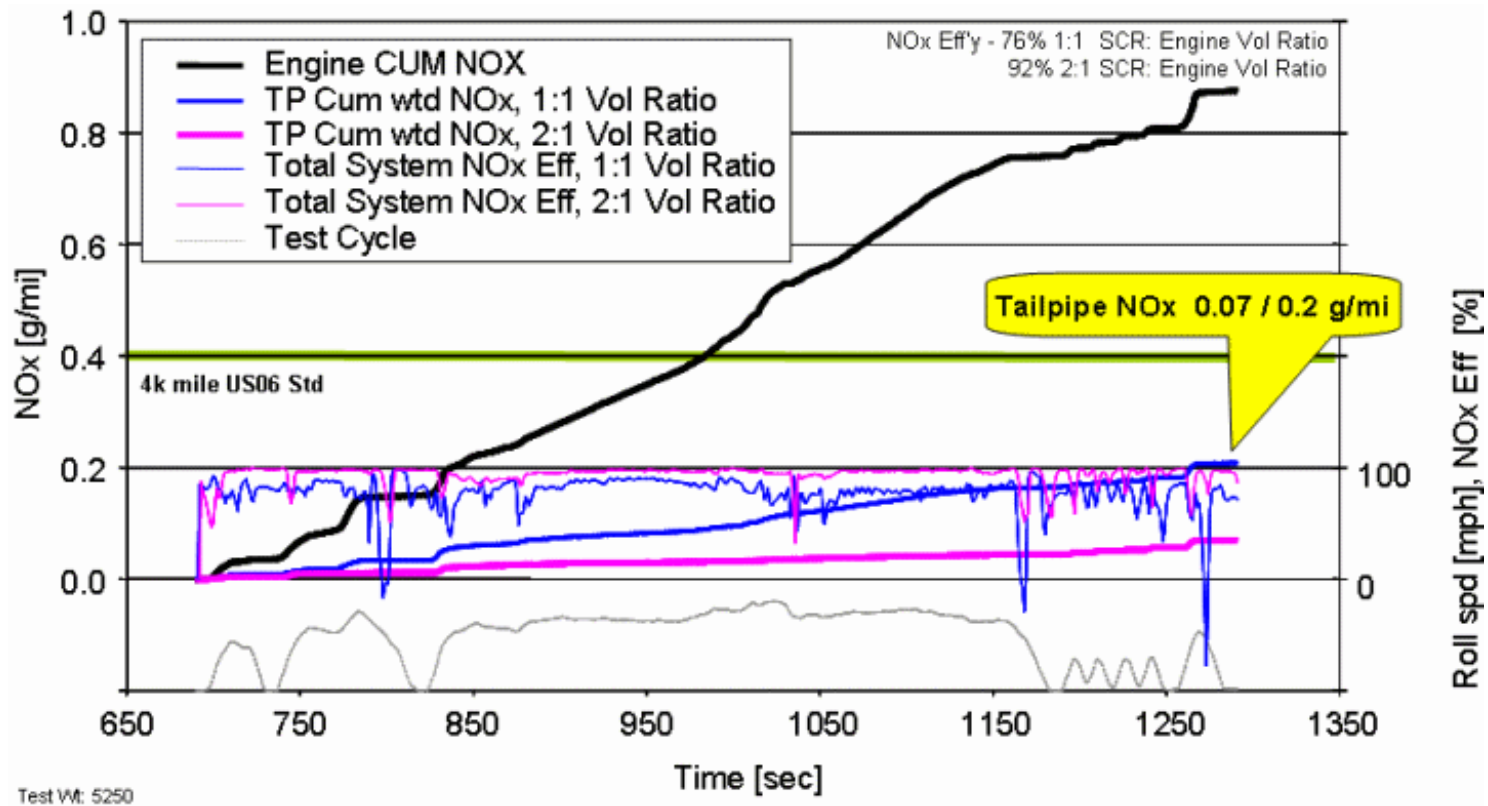


Test Wt: 5250; 1:1 SCR-Engine Volume Ratio



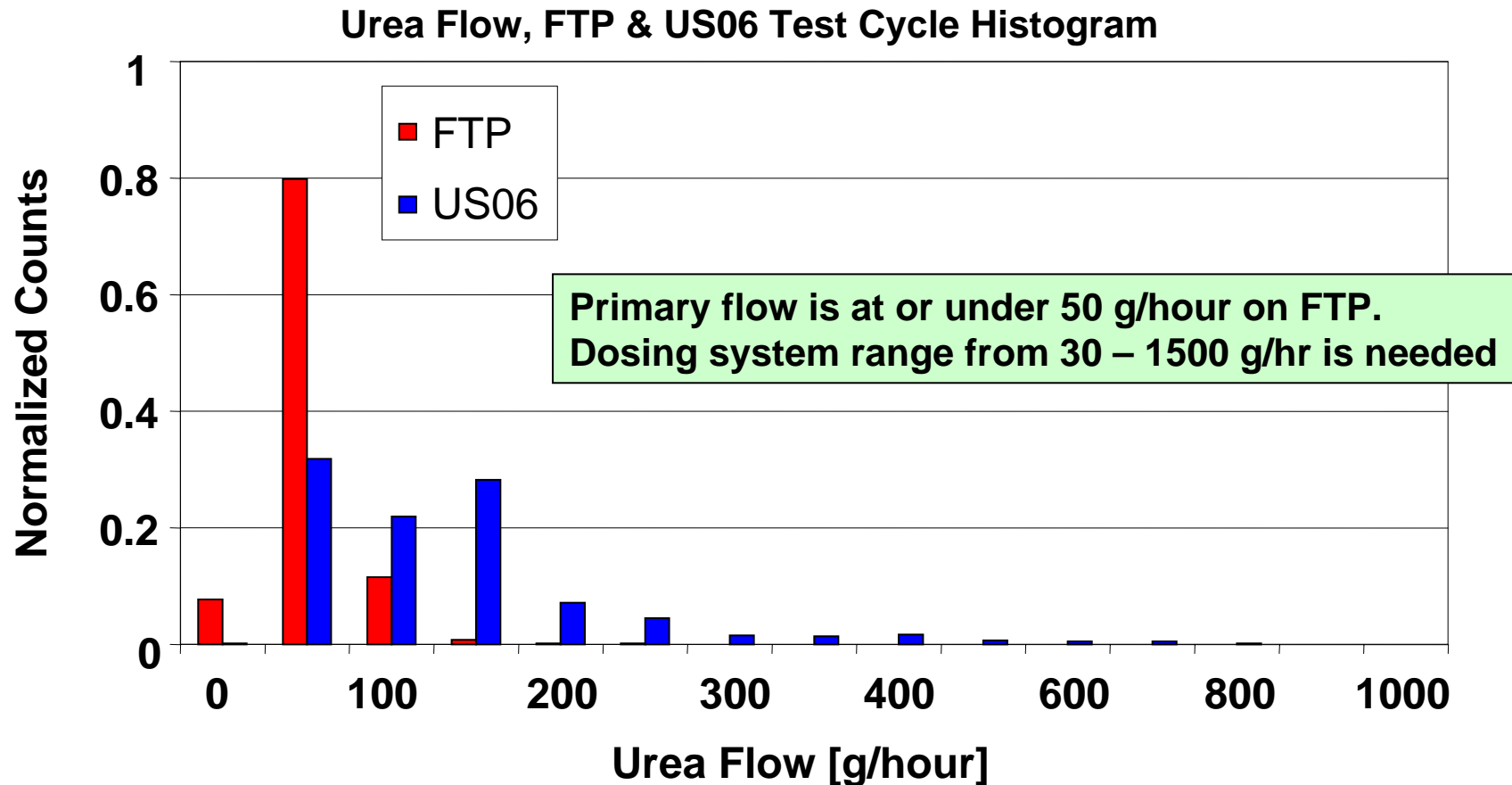
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US06 Test Cycle – 120k aged / Non-air assisted



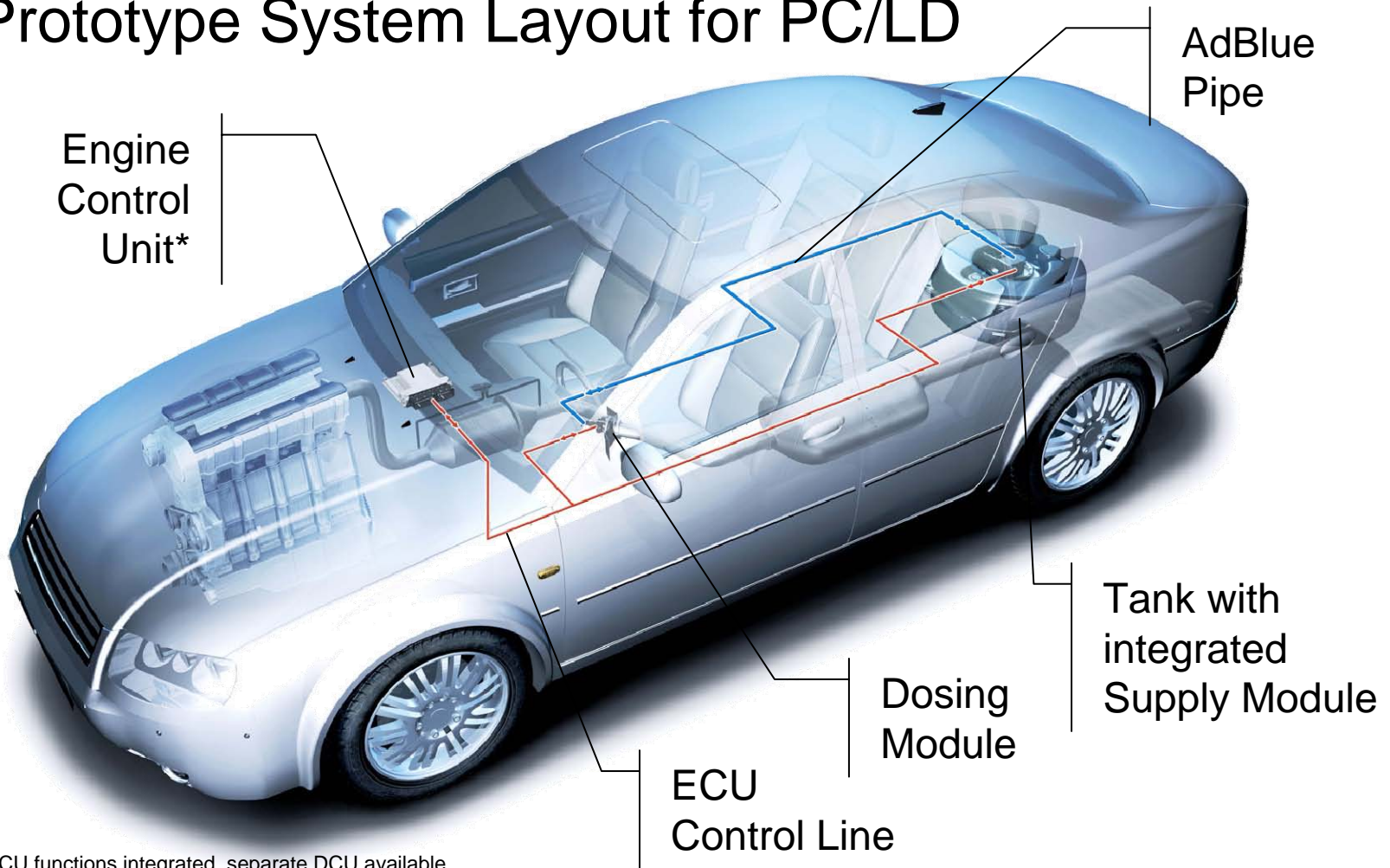
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Urea Flow Requirements



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Prototype System Layout for PC/LD



*DCU functions integrated, separate DCU available



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Challenges and potential Solutions for PC/LD

Challenges:

- Minimize refilling and reducing agent consumption

Minimize reducing agent tank volume (mass)

- Cold climate operation (below - 11 °C)
- Low temperature performance (Catalyst Light-off)

Solutions:

- Minimize NOx raw emissions

- System heating or freeze resistant reducing agent
- “Rapid-heat up“ (engine measures) and advanced catalyst technologies



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Refilling options currently under consideration

A.) During regular service

- Driver is not involved with refilling
- Independent of infrastructure status
- Tank volume \geq 20 liters (oil change interval)

☺ preferred initial solution

B.) Do it yourself

- Driver is involved with refilling
- Reduced tank volume possible

☹ not customer friendly

C.) Co-fueling

- Involvement of driver is minimized
- Co-fueling equipment at filling stations necessary

☺ preferred future solution



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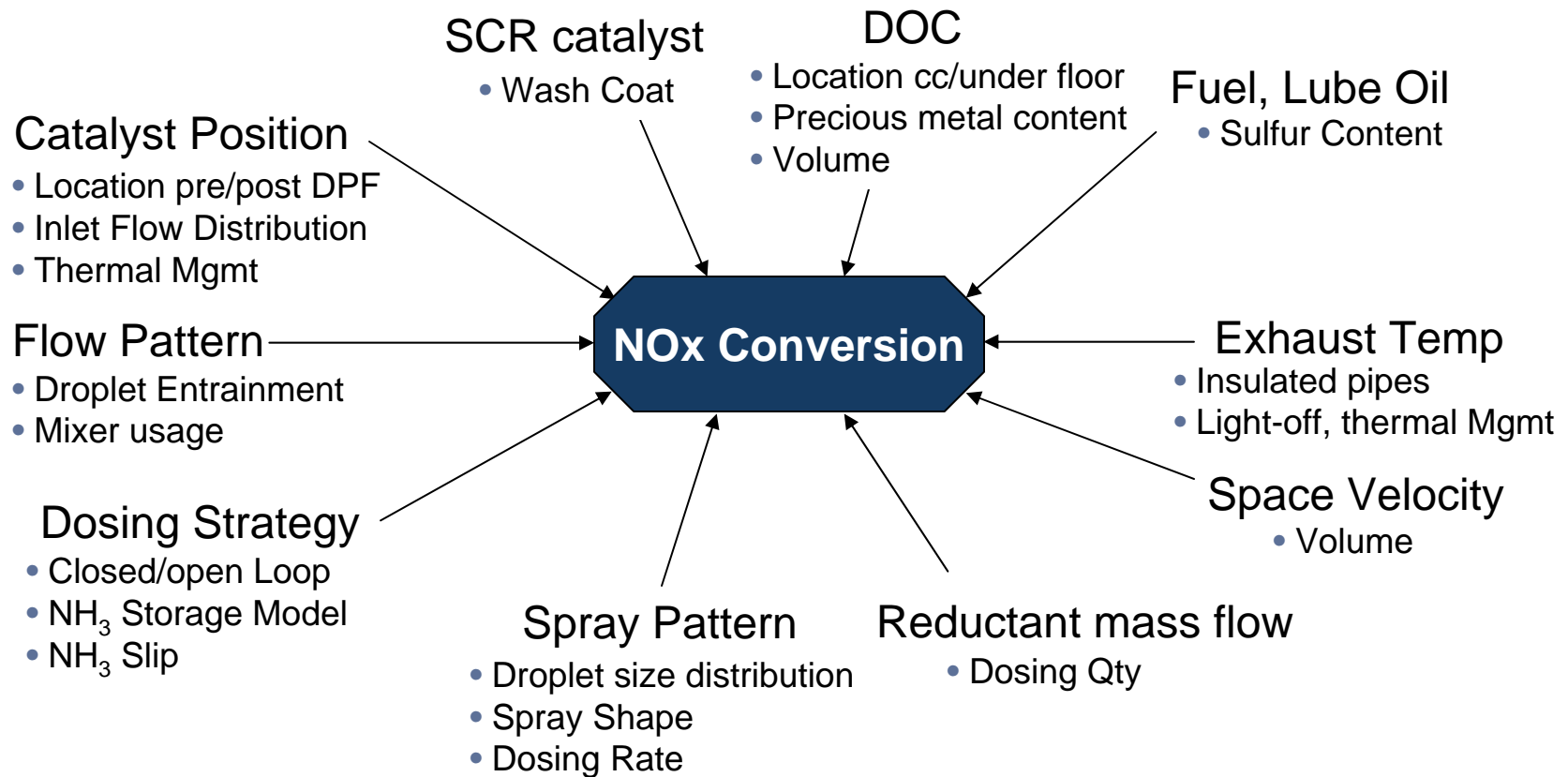
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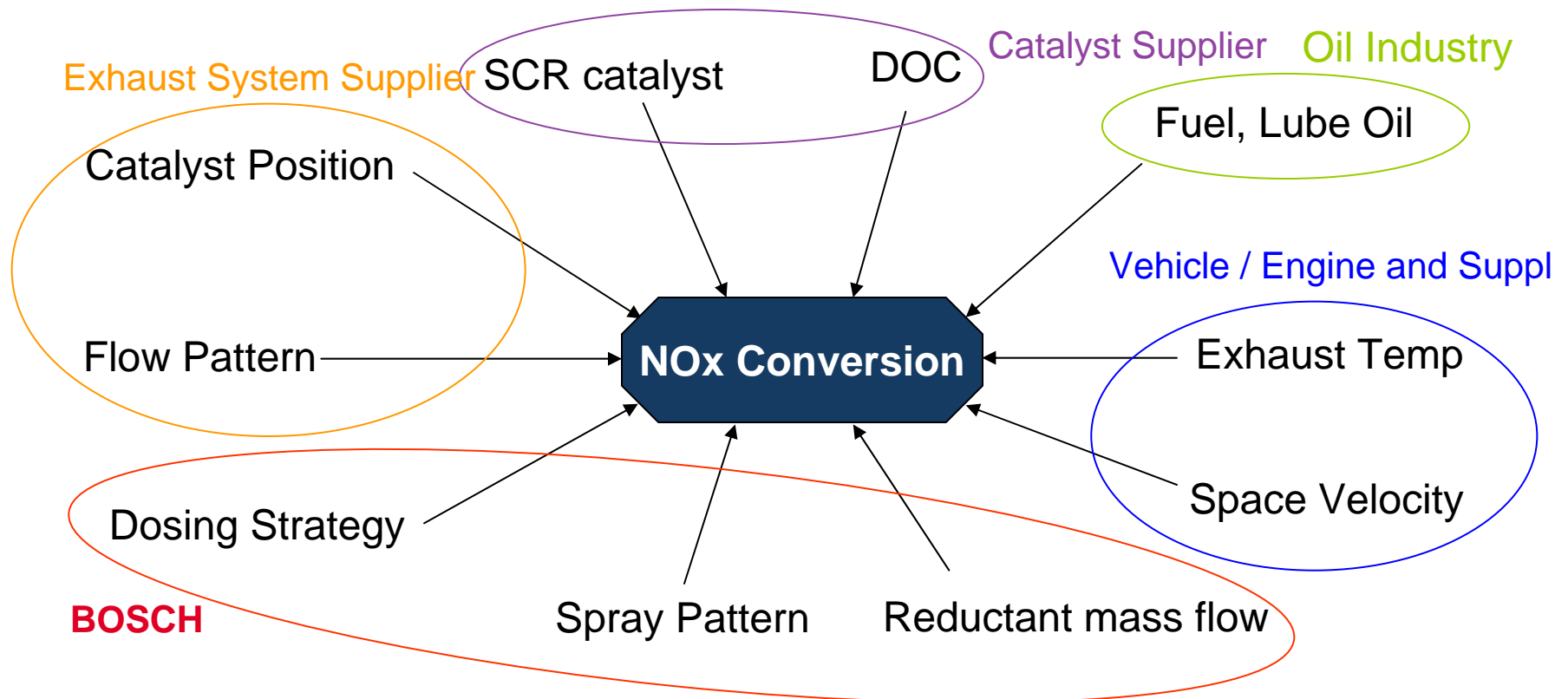
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The NOx Conversion Maximization Process



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The NOx Conversion Maximization Process



NOx conversion maximization requires close cooperation of all partners!



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Summary

- NOx Aftertreatment required to meet future emission legislation (EU, J, US)
- SCR is currently the most robust and long-term stable NOx reduction technology.
- Challenges (e.g. Infrastructure, in-use compliance, urea freezing) are identified and addressed
- SCR is expected to become the prime NOx reduction technology for HD/MD in Europe and Japan. High potential for US.
- SCR is very promising for PC/LD applications requiring highest NOx conversion rates over lifetime.
- Bosch offers SCR Technology which enables compliance with stringent future emission regulations for PC/LD, MD and HD applications.



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Thank you!

