

Overview of Emissions Treatment Technologies for Heavy-duty Engines

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AECC Technical Steering Committee

AECC Technical Seminar
on Heavy-duty Engine Emissions
Brussels, 25 October 2007

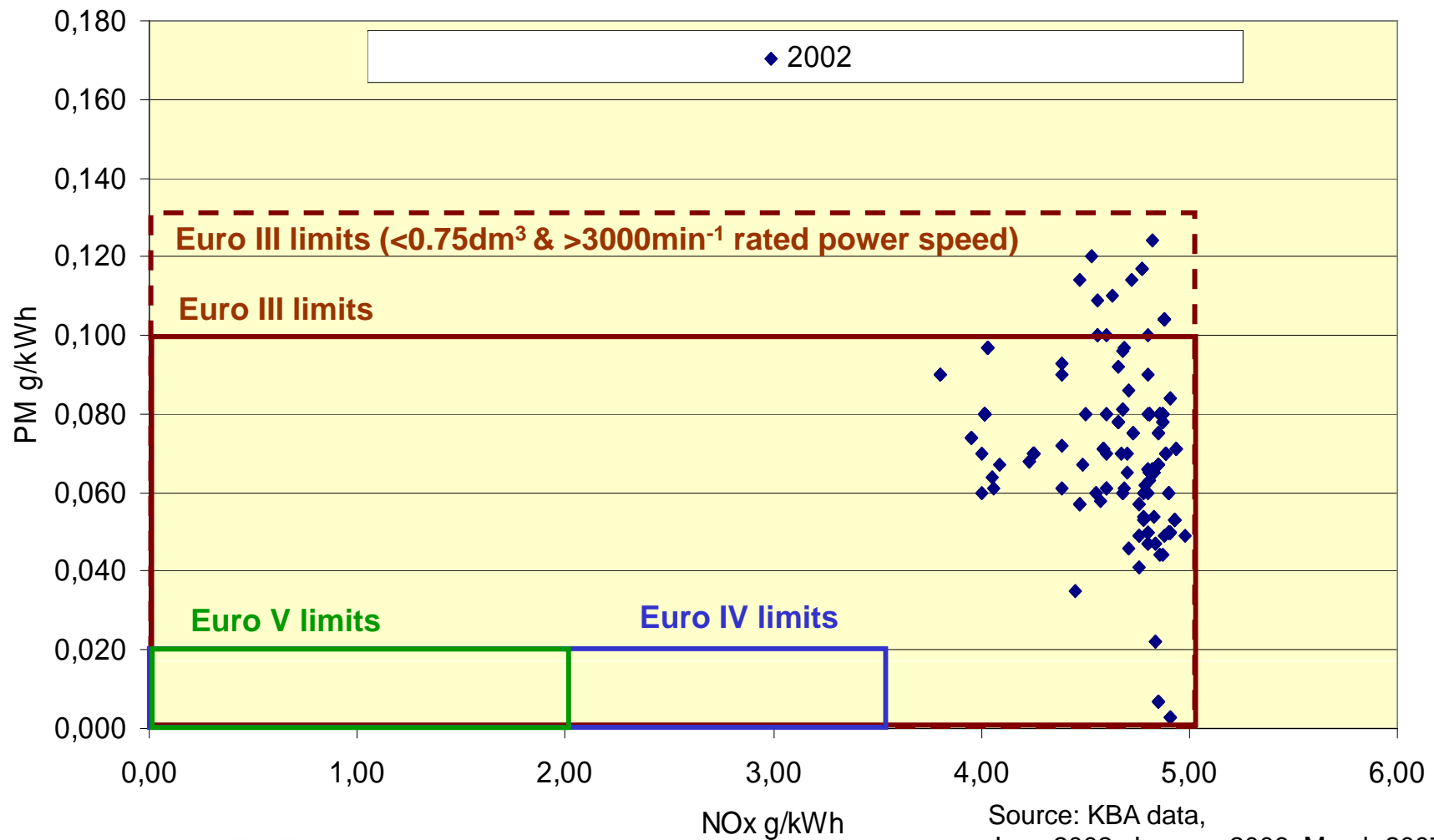


Association for Emissions Control by Catalyst AISBL

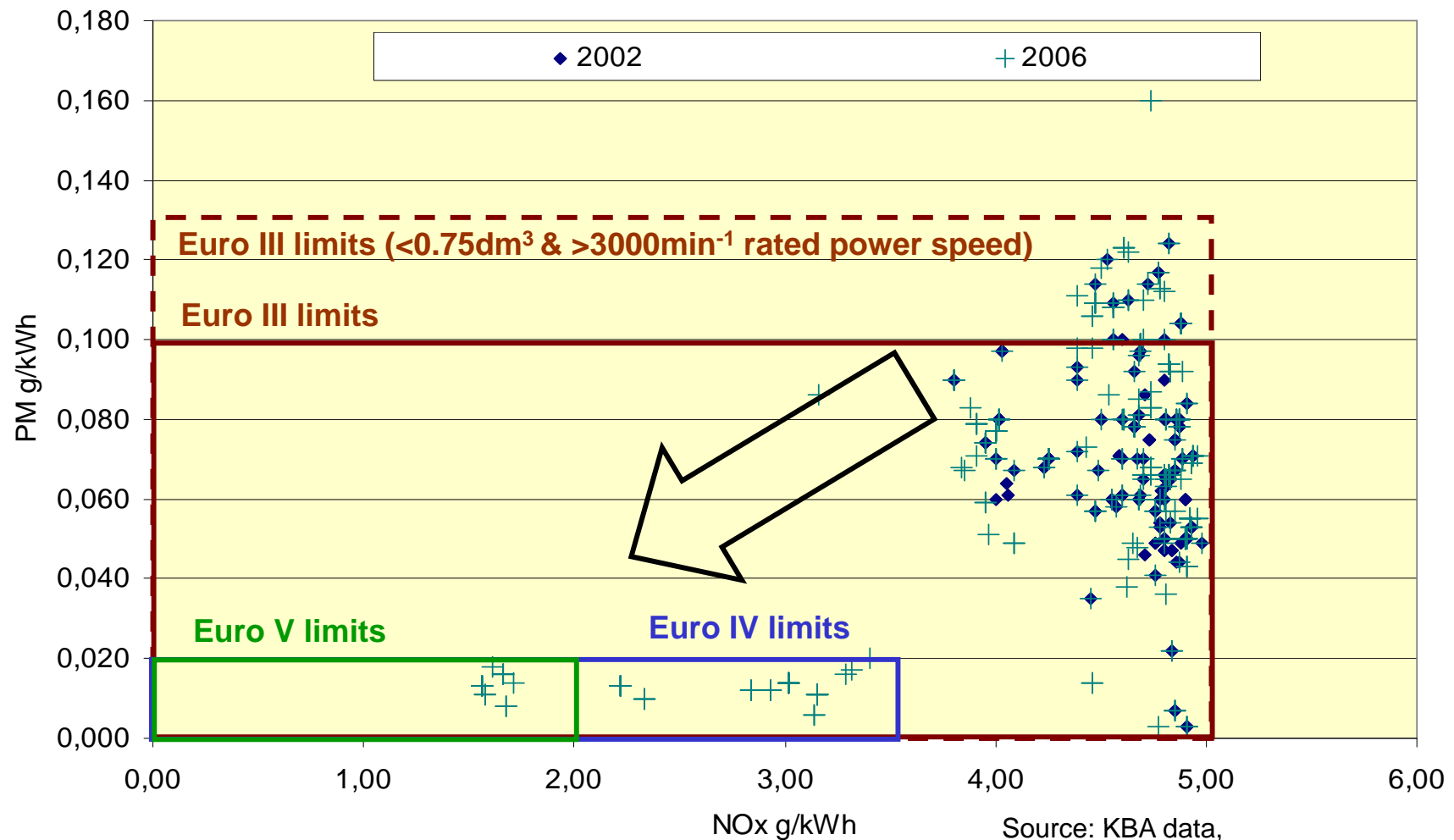
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- Diesel Oxidation Catalysts
- Particulate Filters
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- Selective Catalytic reduction
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PM vs NOx (ESC test): 2002-2006

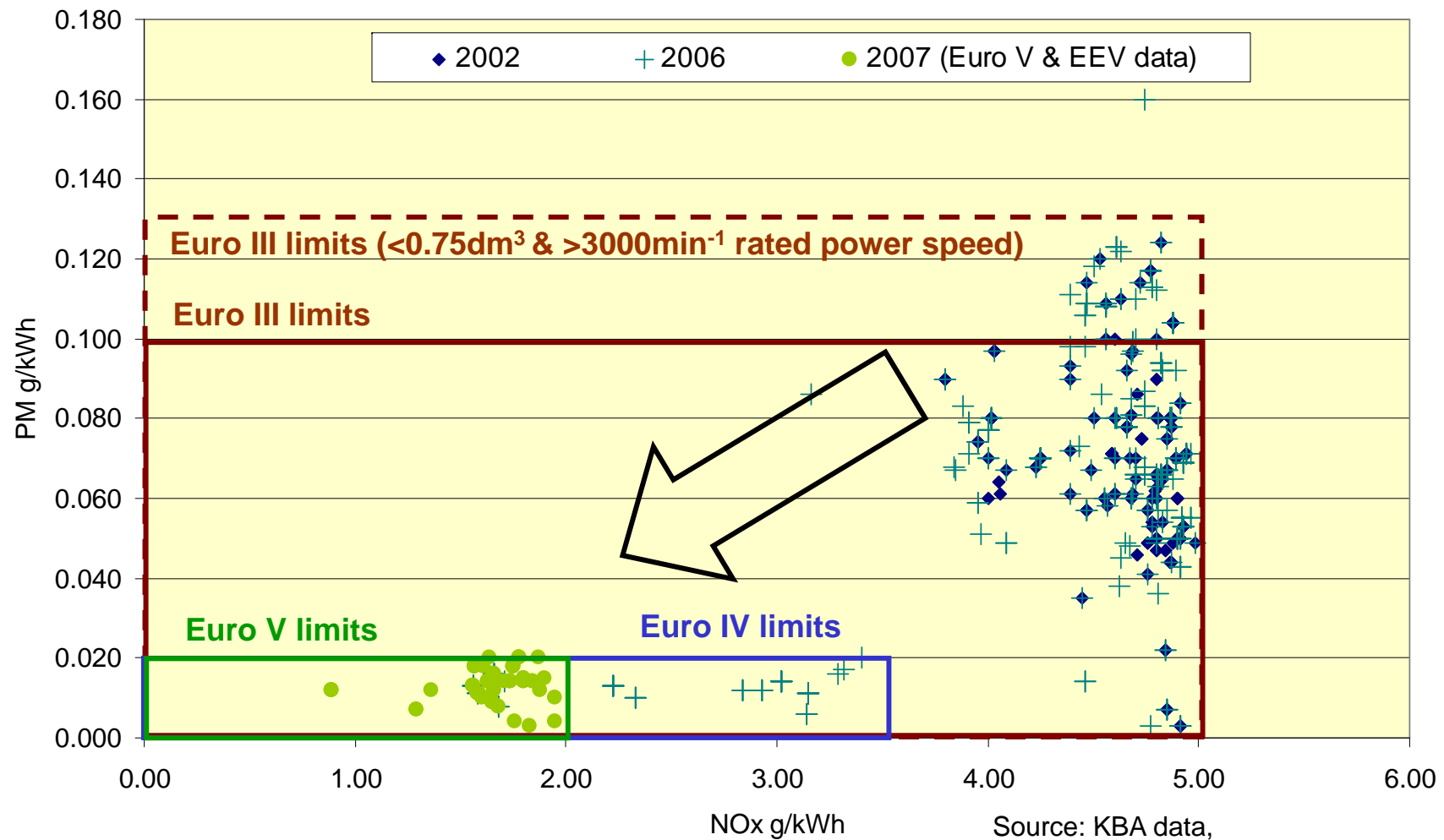


PM vs NOx (ESC test): 2002-2006



Source: KBA data,
June 2002, January 2006, March 2007

PM vs NOx (ESC test): 2002-2006



Source: KBA data,
June 2002, January 2006, March 2007

Euro V & EEV diesels at Hanover IAA Show September 2006

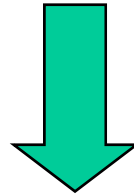


PACCAR EEV Technologie DA					
Emissionswerte					
	Diesel Emissionsklassen			Gas norm	EEV
	Euro 3	Euro 4	Euro 5		
CO	5,45	4,0	4,0	0,01	3,0
HC	0,78	0,55	0,55	0,06	0,40
NOx	5,0	3,5	2,0	1,27	2,0
PM	0,16	0,03	0,03	0,018	0,02
Rauch	0,8	0,5	0,5	0,10	0,15

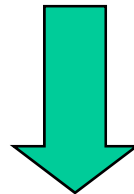


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**Engine Technology
(engine out emissions)**



**Emissions Control
Technologies**



Tailpipe Emissions

One view of a future engine

ETC cycle demands on the engine raw emissions and on PM conversion to meet emissions limits (MAN)

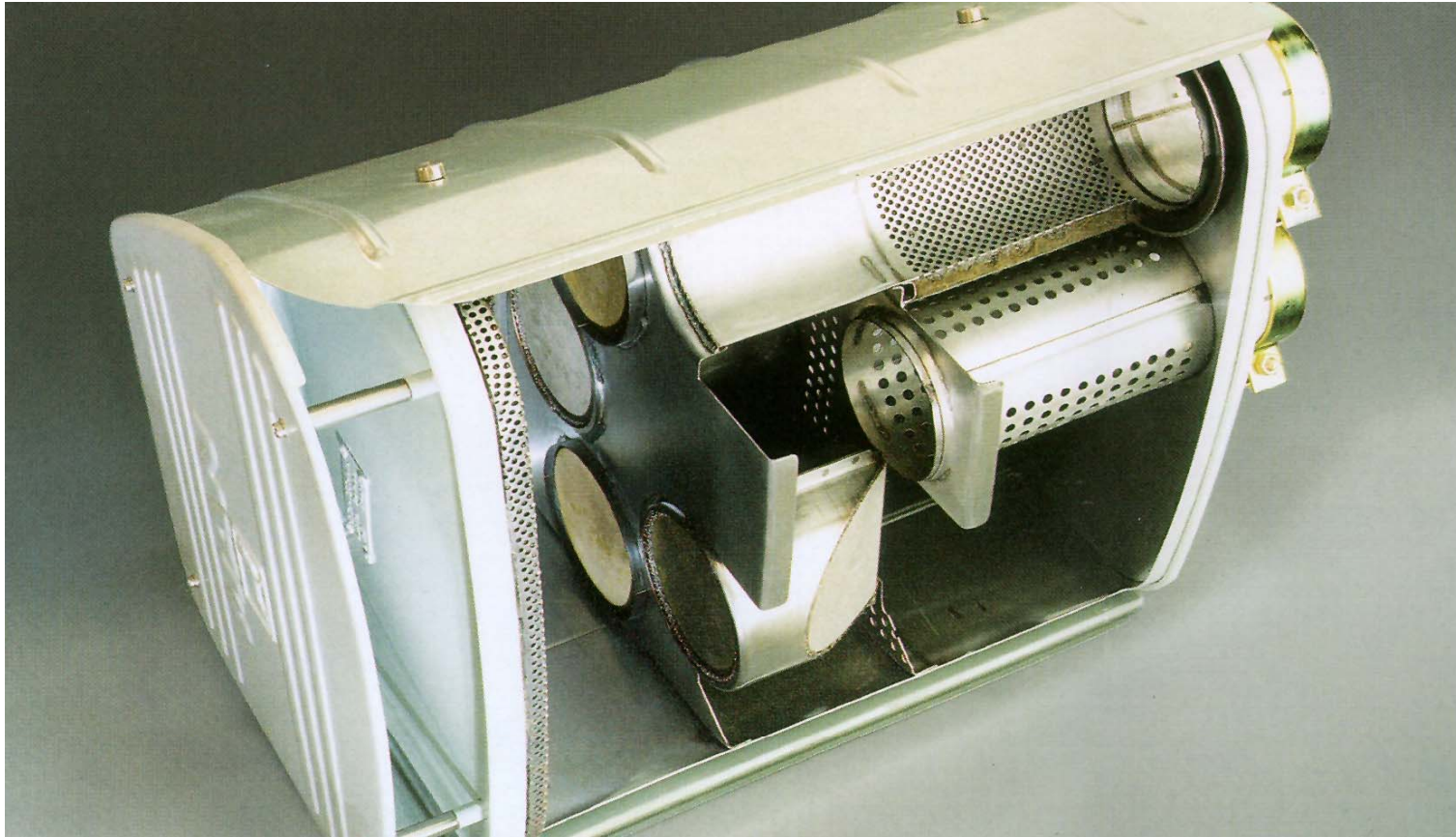
Euro Stage	Limit Value NOx g/kWh / PM mg/kWh	Raw emissions NOx g/kWh / PM mg/kWh	~max. EGR rate (%)	CR Injection pressure (bar)	Turbo	PM Conversion (%)
IV	3.5 / 30	3.3 / 50	18 – 20	1600	1 stage	60
V	2.0 / 30	1.8 / 60	25 - 30	1800 - 2000	2 stage inter- cooled	65
“VI”	1.0 / 20	0.9 / 60	30 - 35	2400 - 2500	2 stage inter- cooled	75

Source: MAN; 26. Internationales Wiener Motorensymposium 2005

Emissions Control Technologies

- Diesel Oxidation Catalyst (DOC)
=> *Conversion of HC and CO*
- Diesel Particulate Filters
=> *Particulate Reduction (Mass / Number)*
- Selective Catalytic Reaction (SCR)
=> *NOx Reduction*

Diesel Oxidation Catalysts (DOC)

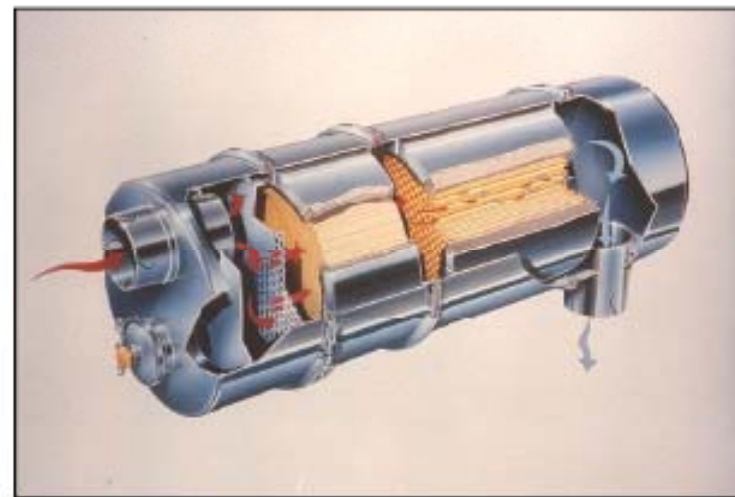
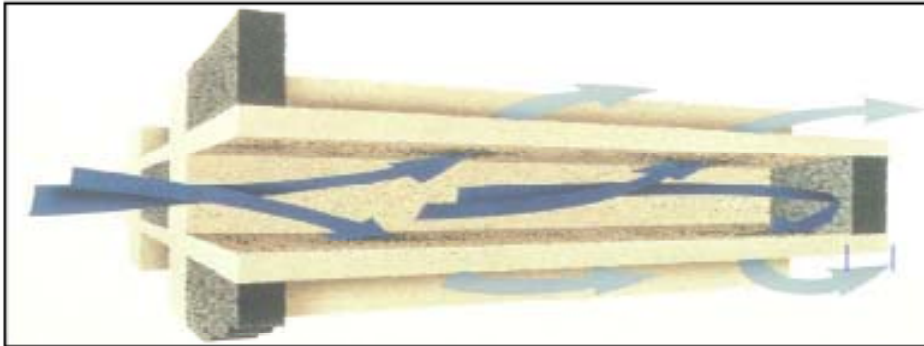


Source: MAN

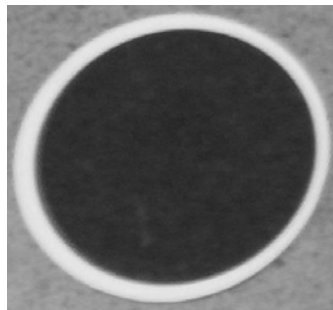
Emissions Control Technologies

- Diesel Oxidation Catalyst (DOC)
=> Conversion of HC and CO
- **Diesel Particulate Filters**
=> Particulate Reduction (Mass / Number)
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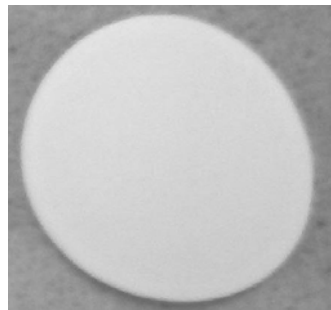
Wall-flow particulate filters for light-duty and heavy-duty applications



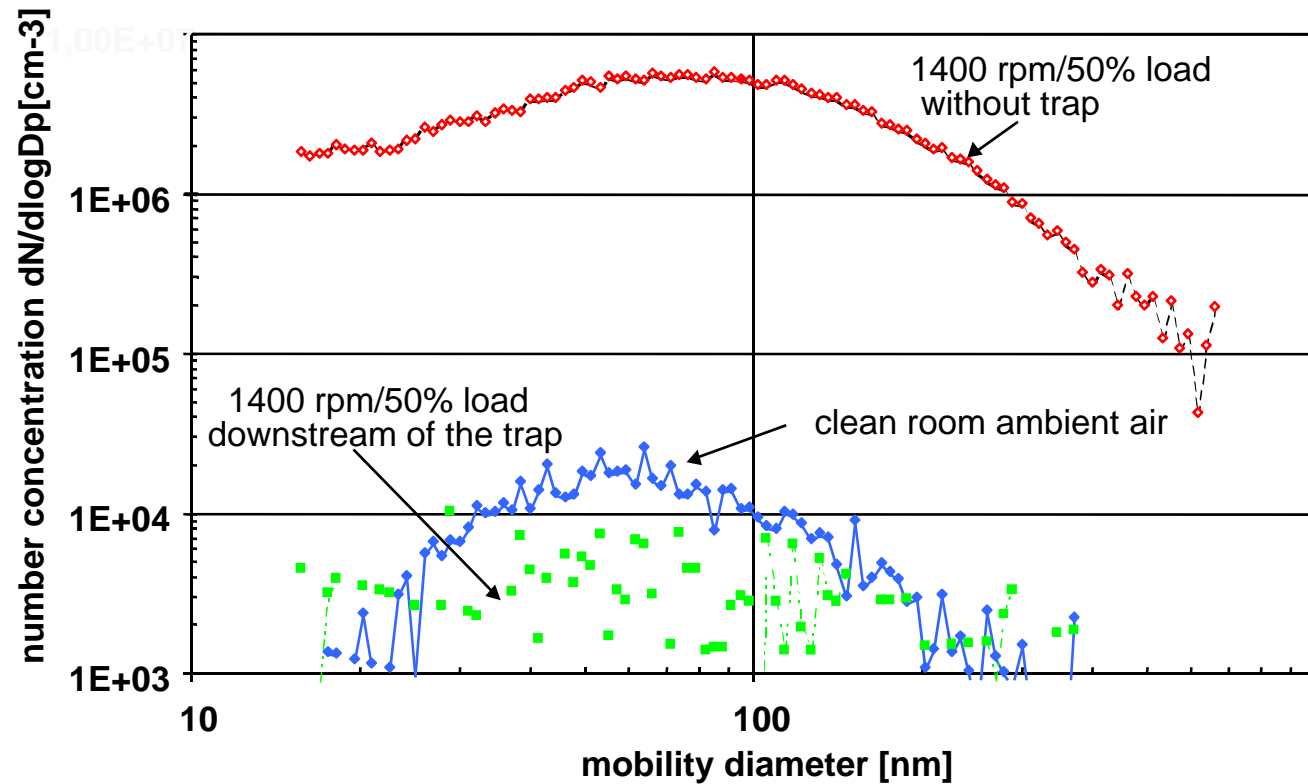
Wall-flow particulate filters



Engine-out

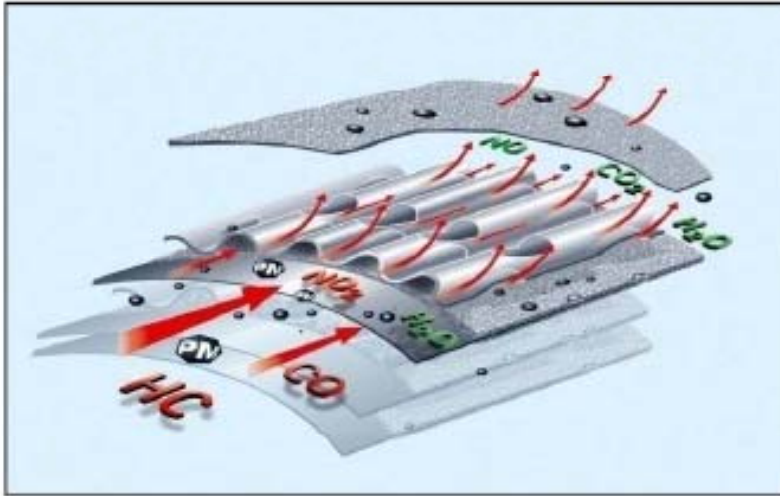


Post-DPF

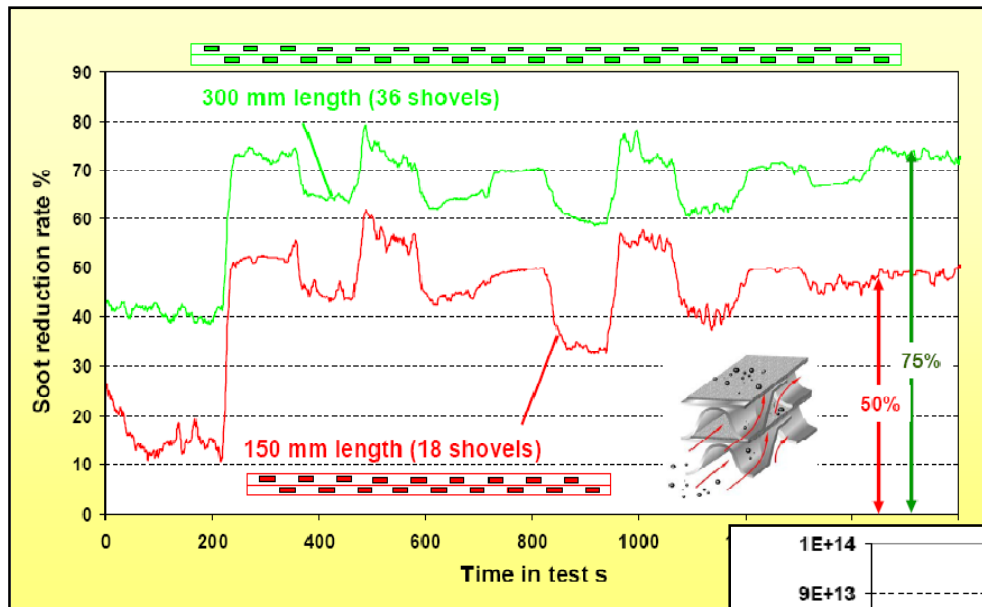


Measurement by Matter Engineering Ingenieurschule Biel

Partial-flow particulate filters for light-duty and heavy-duty applications

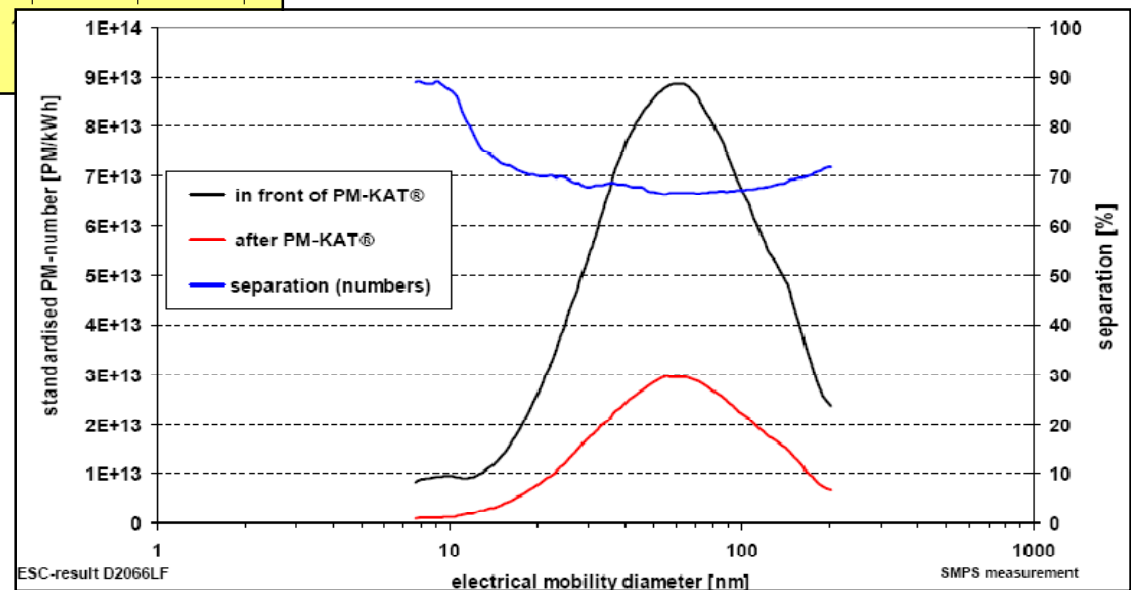


Partial-flow particulate filter



Source: AECC Member Company,
CTI Forum Abgastechnik, 2007

Source: MAN,
CTI Forum Abgastechnik, 2007



Worldwide DPF retrofit experiences

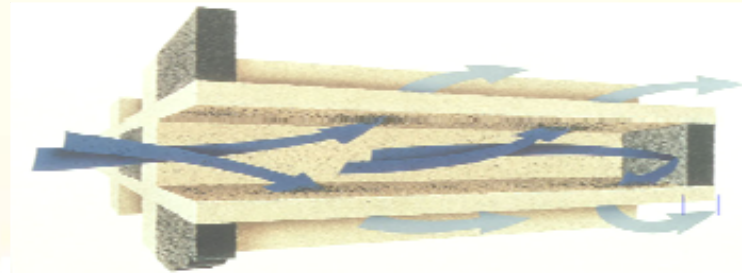
- Construction equipment
- Mining equipment
- Materials Handling
- Refuse trucks
- City and School buses
- Stationary Diesel Engines
- Marine Vessels
- Locomotives



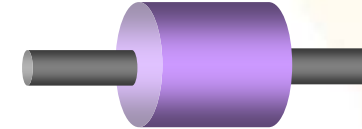
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Diesel Particulate Filter (DPF) regeneration technologies

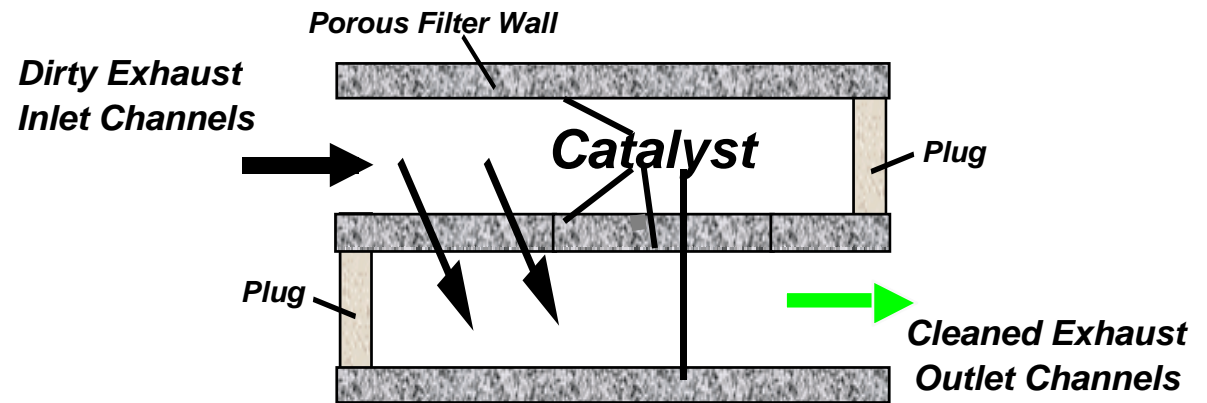
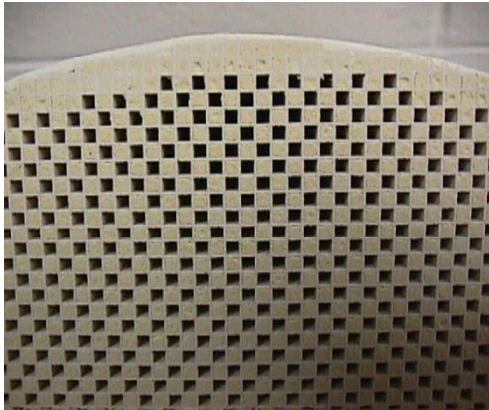
- Engine control to increase exhaust gas temperature
- Catalysed C-DPF



Catalysed DPF

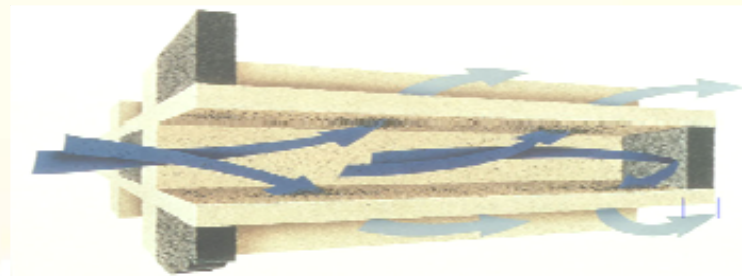


Catalysed Particulate Filter (C-DPF)

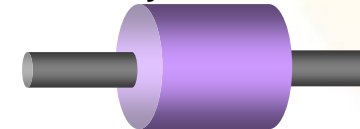


Diesel Particulate Filter (DPF) regeneration technologies

- Engine control to increase exhaust gas temperature
- Catalysed C-DPF
- Continuously Regenerating CR-DPF

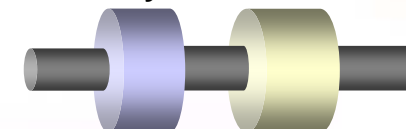


Catalysed DPF

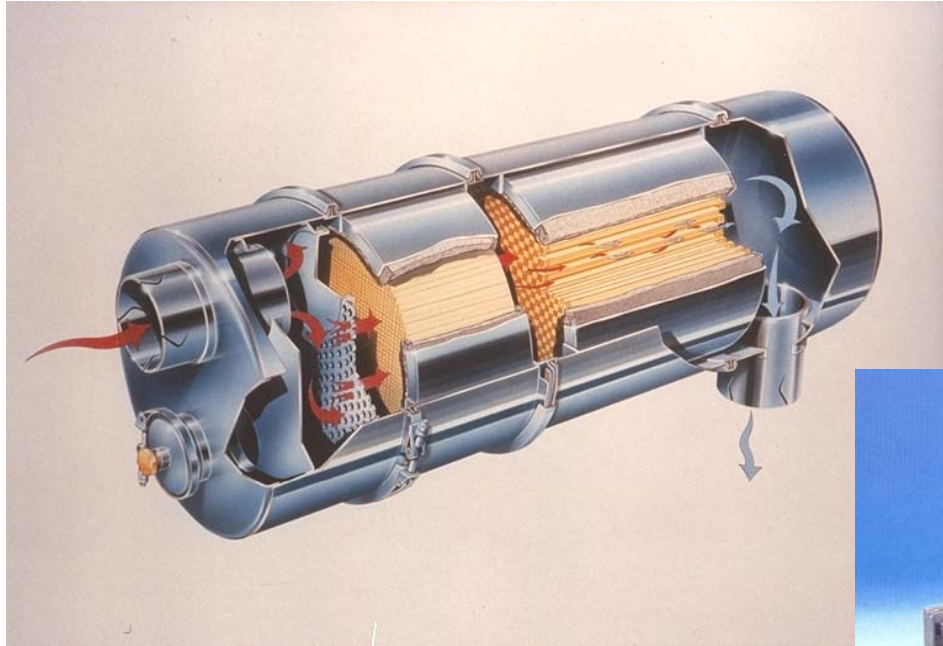


Oxidation Catalyst

DPF

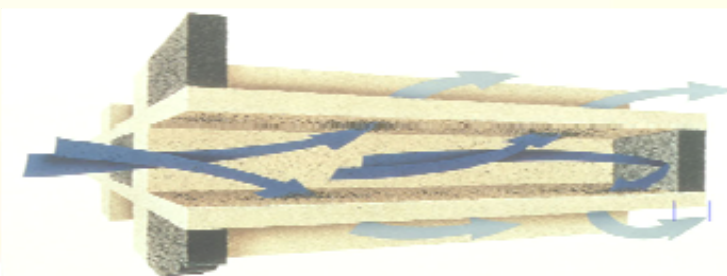


Continuously Regenerating Particulate Filter (CR-DPF)

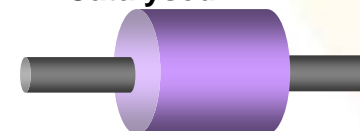


Diesel Particulate Filter (DPF) regeneration technologies

- Engine control to increase exhaust gas temperature
- Catalysed C-DPF
- Continuously Regenerating CR-DPF
- DPF + Fuel Borne Additive

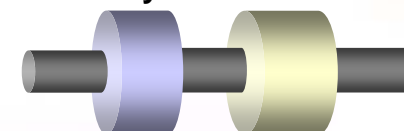


Catalysed DPF



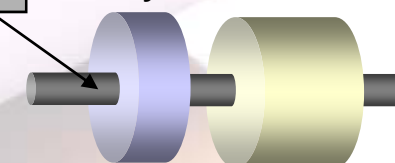
Oxidation Catalyst

DPF

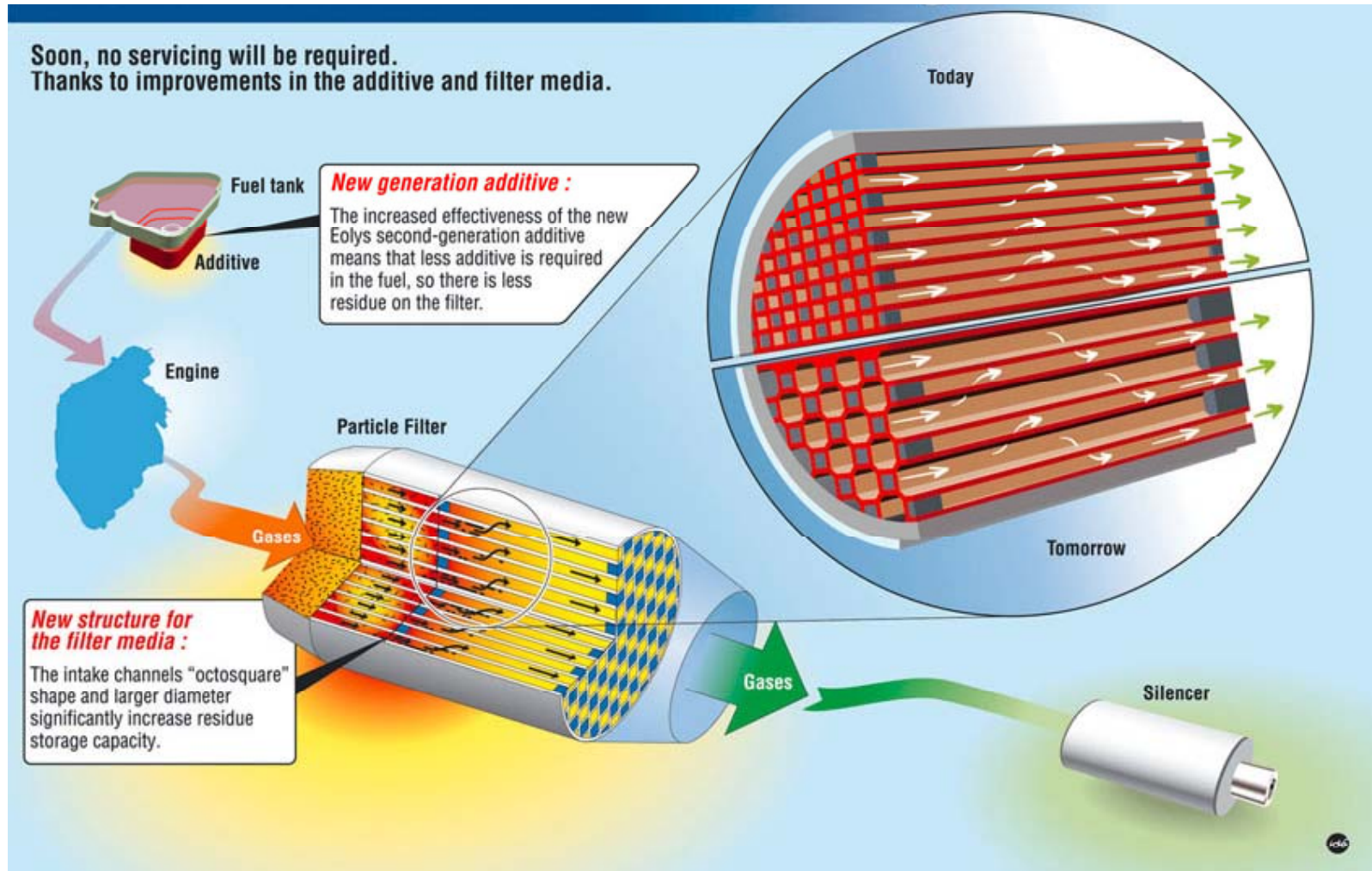


Oxidation Catalyst

DPF

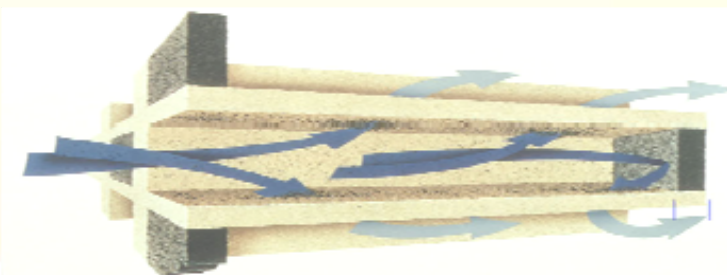


Particle Filters using fuel-borne additive

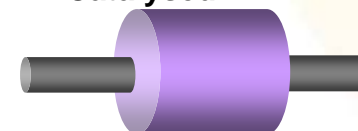


Diesel Particulate Filter (DPF) regeneration technologies

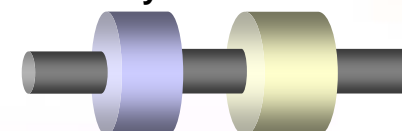
- Engine control to increase exhaust gas temperature
- Catalysed C-DPF
- Continuously Regenerating CR-DPF
- DPF + Fuel Borne Additive
- (Off-line electrical / thermal regeneration)



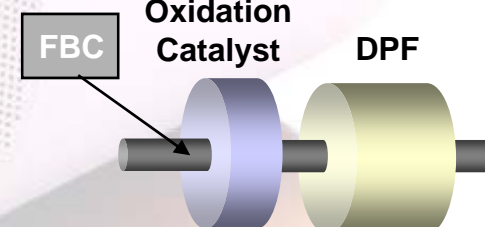
Catalysed DPF



Oxidation Catalyst



Oxidation Catalyst



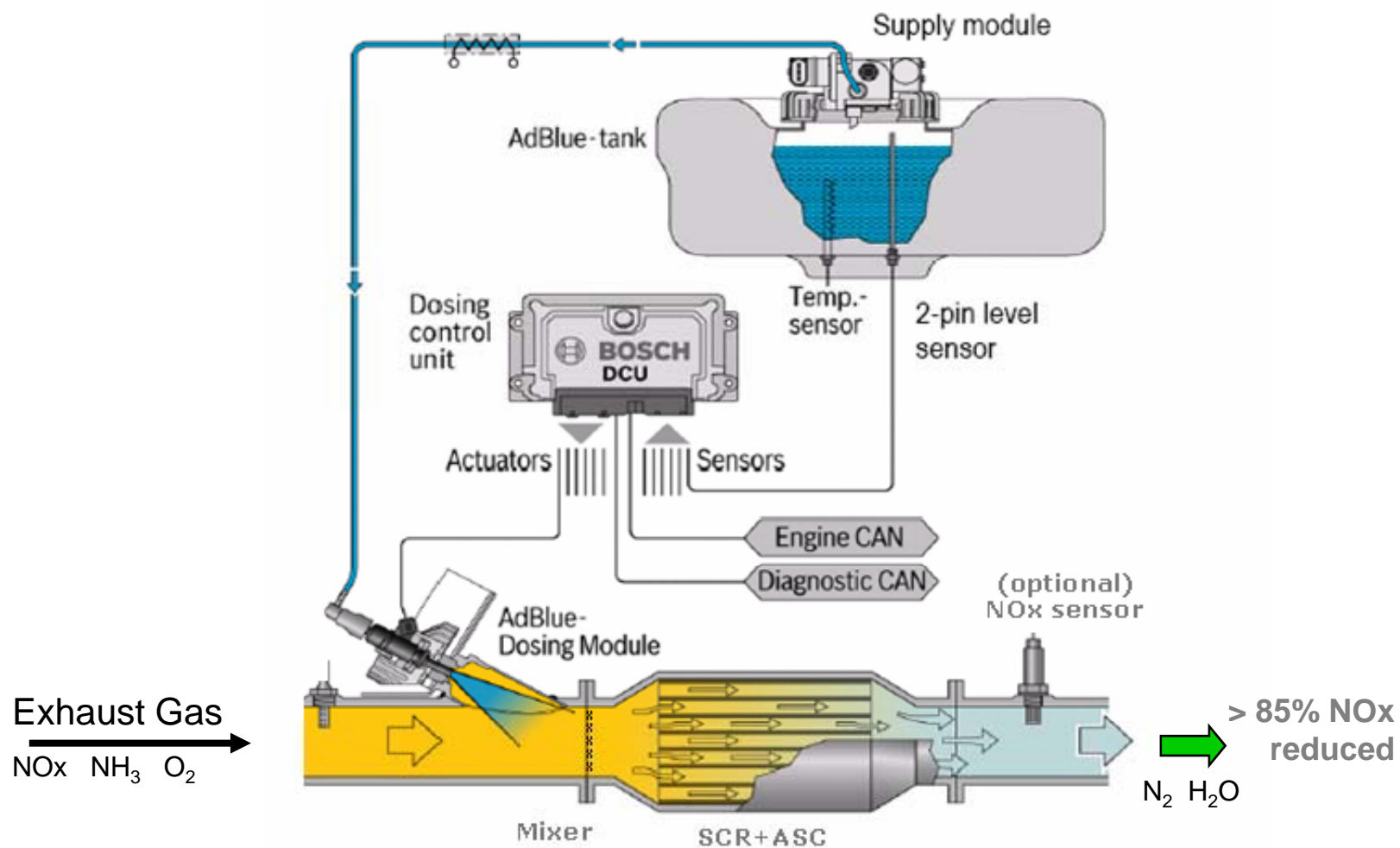
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Selective-Catalytic reduction (SCR)

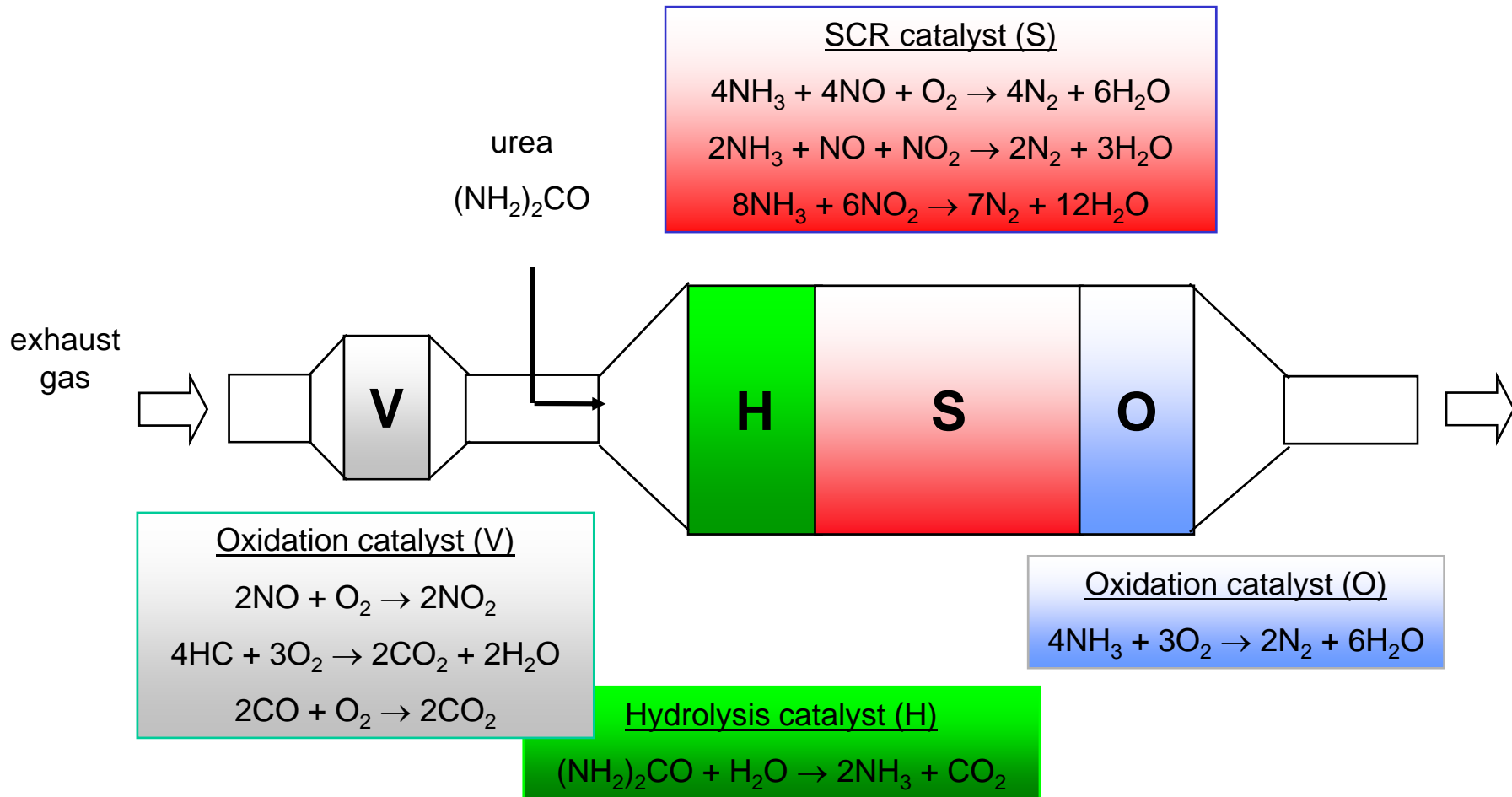


Urea SCR-system



Source: Bosch, drawing adapted

Chemistry of the SCR catalyst system



NOx and NH₃ sensors



Heavy-duty applications



Marine vessels SCR system



Emission reduction in Baltic Sea maritime transport:

Reducing the weighted overall NO_x emission to levels below 2 g/kWh.

Main propulsion engines:
0.6 resp. 0.85 g/kWh NO_x.

Auxiliary engines:
0.2 g/kWh NO_x.

(according to SJÖFS 1997:28 at 75% load)





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Who are AECC and what do we do ?

AECC is an international non-profit scientific association of European companies making technologies for automobile exhaust emissions control.

The members of AECC are companies operating worldwide in the research, development, testing and manufacture of key technologies for emissions control.

Their products are the [ceramic and metallic substrates](#) for catalysts and filters; [autocatalysts](#) (substrates with catalytic materials incorporated or coated); [adsorbers](#); [filter-based](#) technologies to control particulate emissions from diesel and other lean burn engines; and speciality materials incorporated into the [catalytic converter](#) or filter.

Catalyst-equipped cars were first introduced in the USA in 1974 but only appeared on European roads in 1985 and in 1993 [legislation](#) forced their use on cars. Now more than 275 million of the world's 500 million cars and over 85% of all new cars produced worldwide are equipped with autocatalysts. Catalytic converters and filters are also fitted to heavy-duty vehicles, motorcycles and non-road engines and

What are the emission control technologies?

Exhaust gas contains [carbon monoxide](#) (CO), [hydrocarbons](#) (HC), [nitrogen oxides](#) (NOx) and [particulate matter](#) (PM). The main technologies used to treat exhaust to remove harmful gases and particles are:

- [autocatalysts](#)
- [adsorbers](#) (traps)
- [filters](#)

There are more details on the [technology](#) pages.



Thank you for your attention

