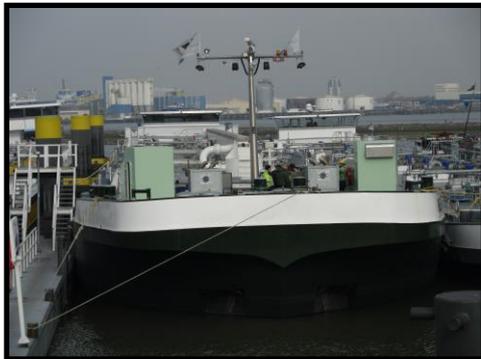


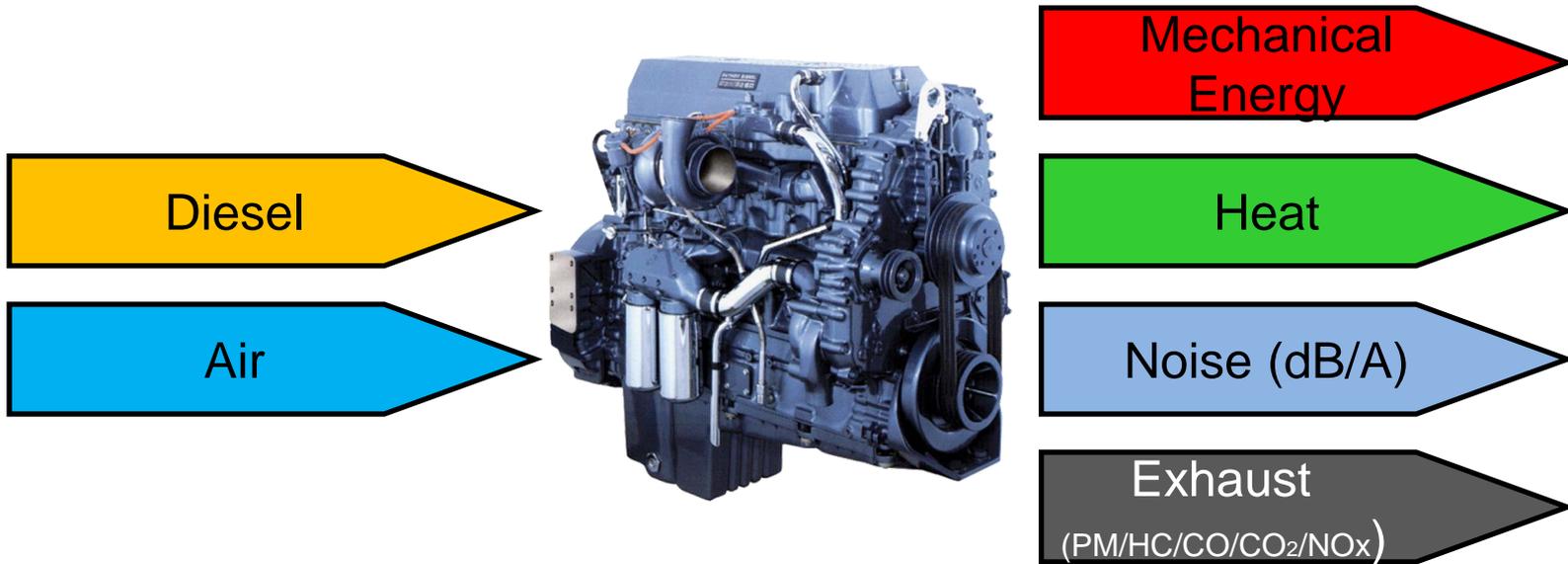
Exhaustaftertreatment for inland waterway vessels



Tehag Group

- Tehag Engineering AG founded in 1991 in Switzerland
- Since 1993 specialization on exhaust aftertreatment for fuel burning engines
- First projects SCR for stationary applications
- Tradeing DPF since 1997
- Since 2005 production of the own DPF and SCR-Systems
- Since 2010 business unit for Muffler

Why exhaust aftertreatment



Harmful Engine Emissions

Noise (dB/A)

- Muffler

Exhaust

(PM/HC/CO/CO₂/NO_x)

- PM/PN/particles

- Wall-Flow Filter

- Gaseous pollutant

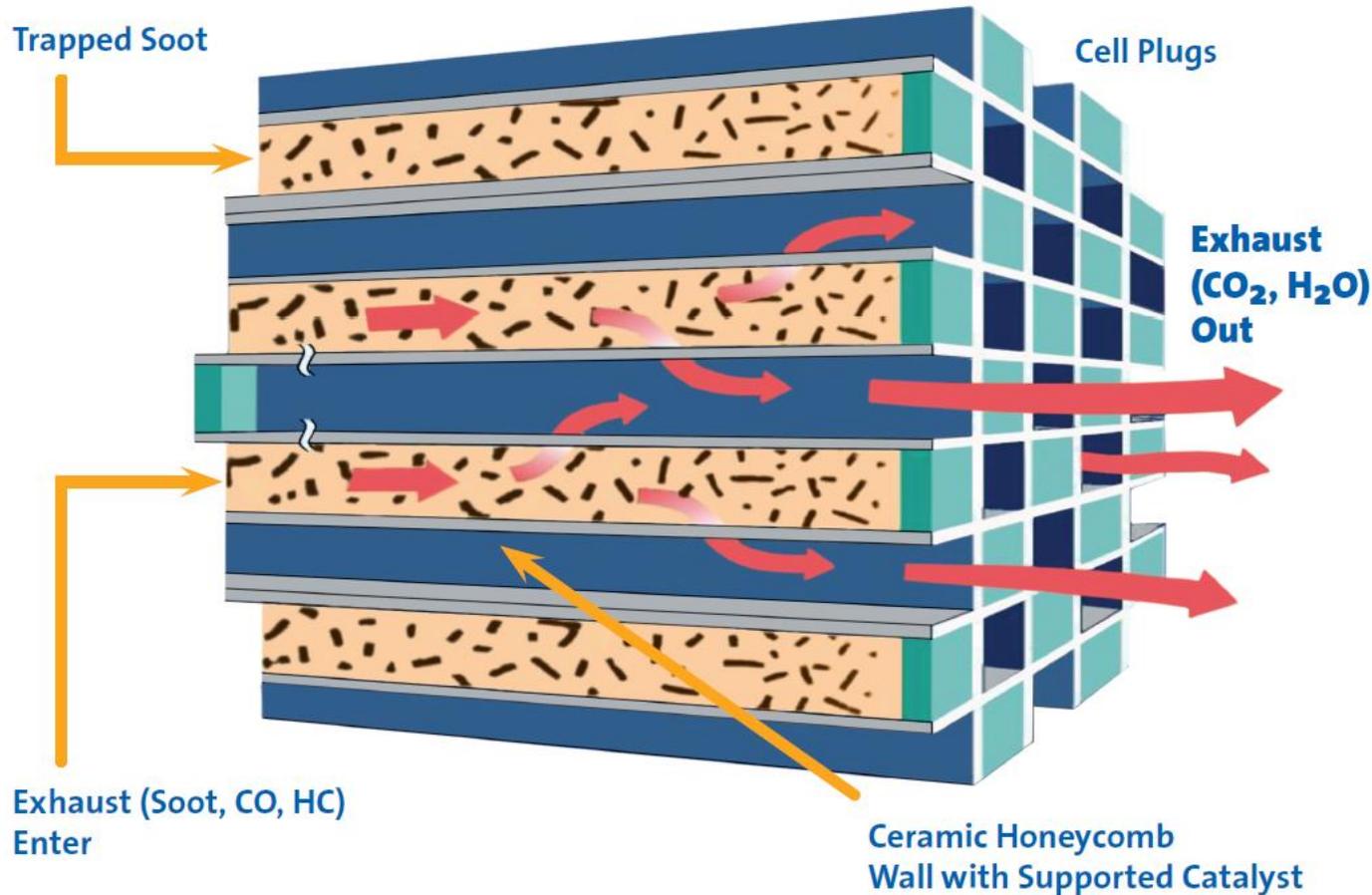
- Carbon monoxide (CO) → Oxidationcatalyst

- Hydrocarbons (HC) → Oxidationcatalyst

- Nitrogen oxide (NO/NO₂) → SCR-system

DPF-Technology

- The wall-flow concept



Regeneration methods

- DPF with passive regeneration
 - CRT System
- DPF with active regeneration
 - fuel burner
 - HC-dosing
 - electric heating
 - fuel additive
- DPF with no regeneration
 - only for short time operation

passive regeneration

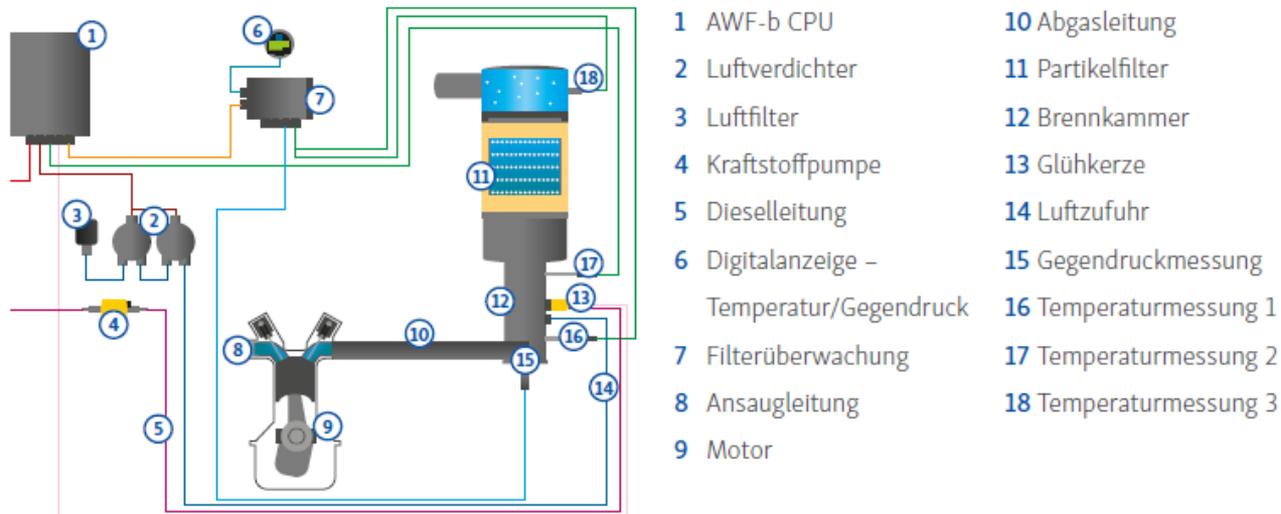
- CRT-concept
 - continuously regeneration technology
 - catalytic coating with platinum
 - oxidation of carbon to CO₂
 - side effect oxidation of HC and CO aswell to CO₂ and H₂O
 - automatic regeneration starting at 250° C
 - Tehag product CWF-particlefilter

passive regeneration

- Requirements for a proper function:
 - app. 30% of the engine duty exhaust temperatures higher than 250° C
 - Fuelquality DIN EN 590, sulfurcontent max. 350 ppm
 - Use of lubeoil with less ash
 - Maintenance of the engine
 - slight oil consumption
 - proper maintenance of the DPF
 - permanent filter function controll

active regeneration

- Fuel burner (AWF-b at Tehag)
 - Injection of Diesel in the Exhaust
 - Ignition by a glow plug
 - Increasing the exhausttemperature up to 650 ° C
 - Burning process of the soot (Carbon)



active regeneration

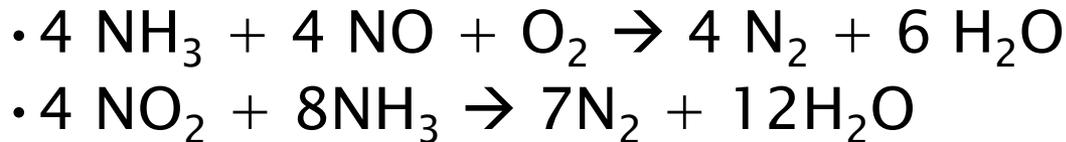
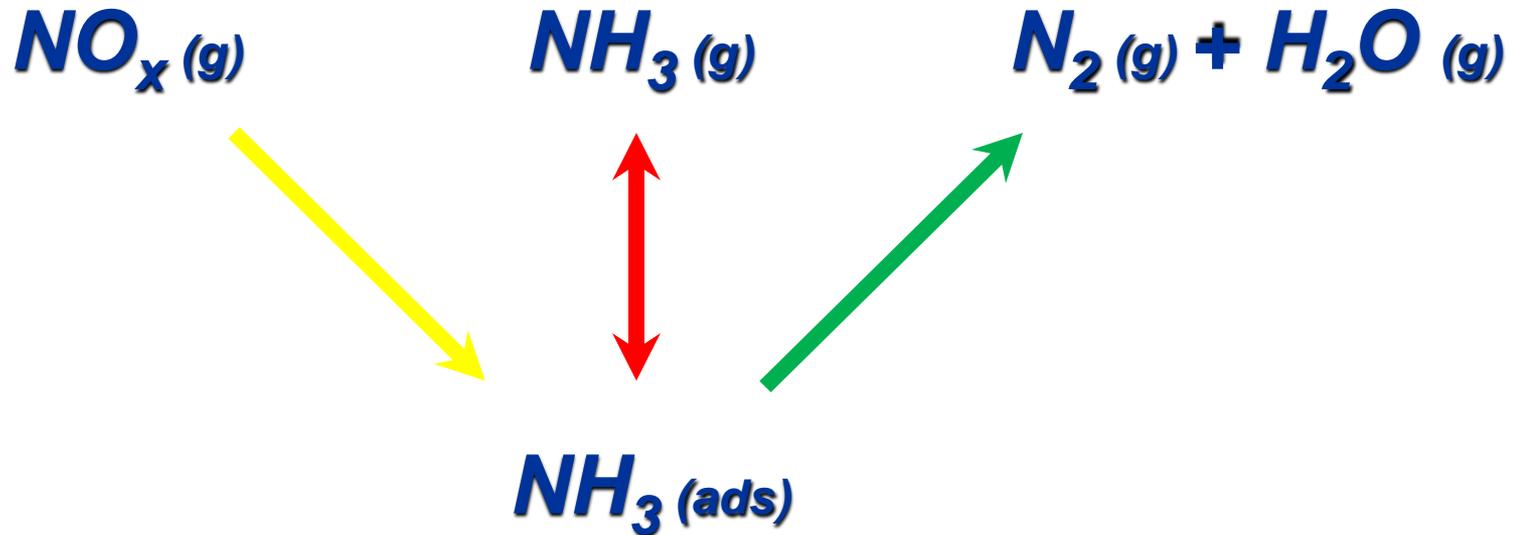
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 - Maintenance of the engine
 - slight oil consumption
 - proper maintenance of the DPF
 - permanent filter function control
 - heat insulation

NOx-reduction

- SCR-technology
 - Selective catalytic reduction
 - longterm proven solution to reduce NO & NO₂
 - Urea (Ad-blue) as reactant
 - Catalyst with special coating
 - Automatic control for the injection of Urea
 - Retrofit solution without connection to the engine management
 - Working temperature app. 200° C

NOx-reduction

- Principal of operation:



Examples

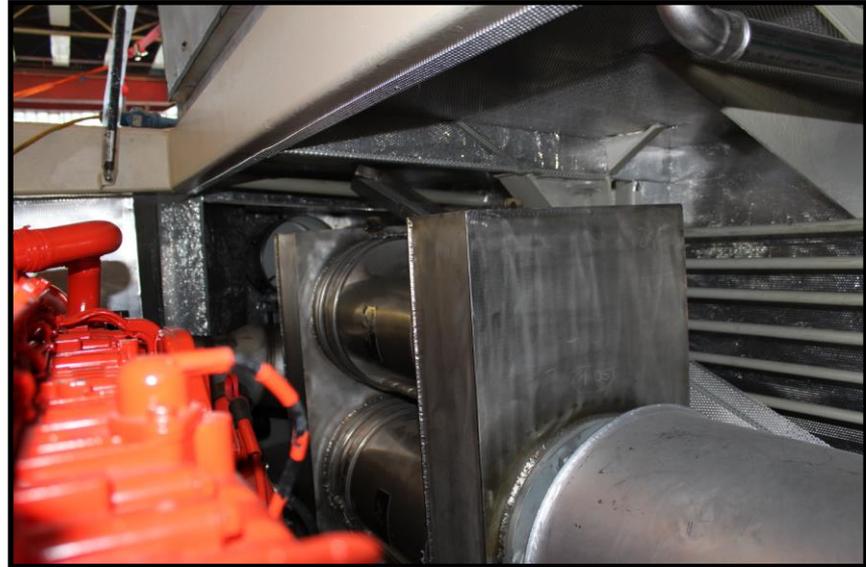
- MS Max Prüss



- Engines 2x MAN D2876 / 250 kW each
- Combi-Systems DPF and SCR installed 2015

Examples

- MS Linz



- Engines 2x Scania DI 13 / 331 kW each
- DPF-Systems installed in 2012
- In total 6 boats were made

Examples



conclusion

- Every engine produces harmful emissions
- There is long term proven exhaust aftertreatment technology available today to reduce soot, NOx, HC & CO very effective
- Selection of the technology depending of the Operating conditions
- Proper function also depending of the maintenance
- **Fuel and lubeoil quality very important**

Thanks a lot for your attention!

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