SCR for Marine Applications

This is a joint presentation of

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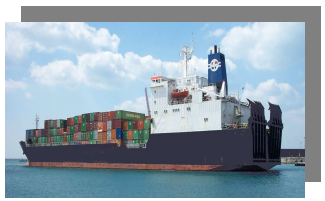
SCR for Marine Applications



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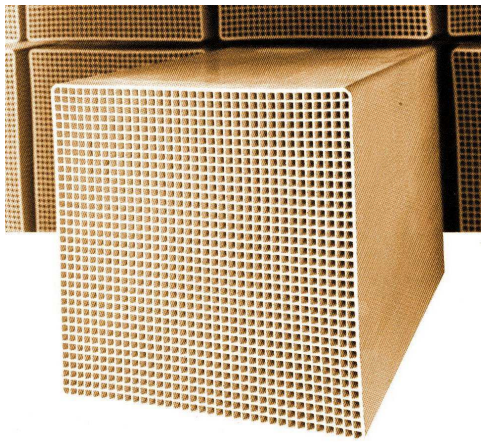

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Typical Exhaust Gas Components of a Diesel Engine

Components	Typical range (Vol.)
Nitrogen oxides	1.000 - 1.500 ppm
Sulphur oxides	30 – 900 ppm
Carbon monoxide	20 – 150 ppm
Total hydrocarbons	20 – 100 ppm
Volatile organic compounds	20 – 100 ppm
Particles (PM)	20 – 100 mg/Nm³

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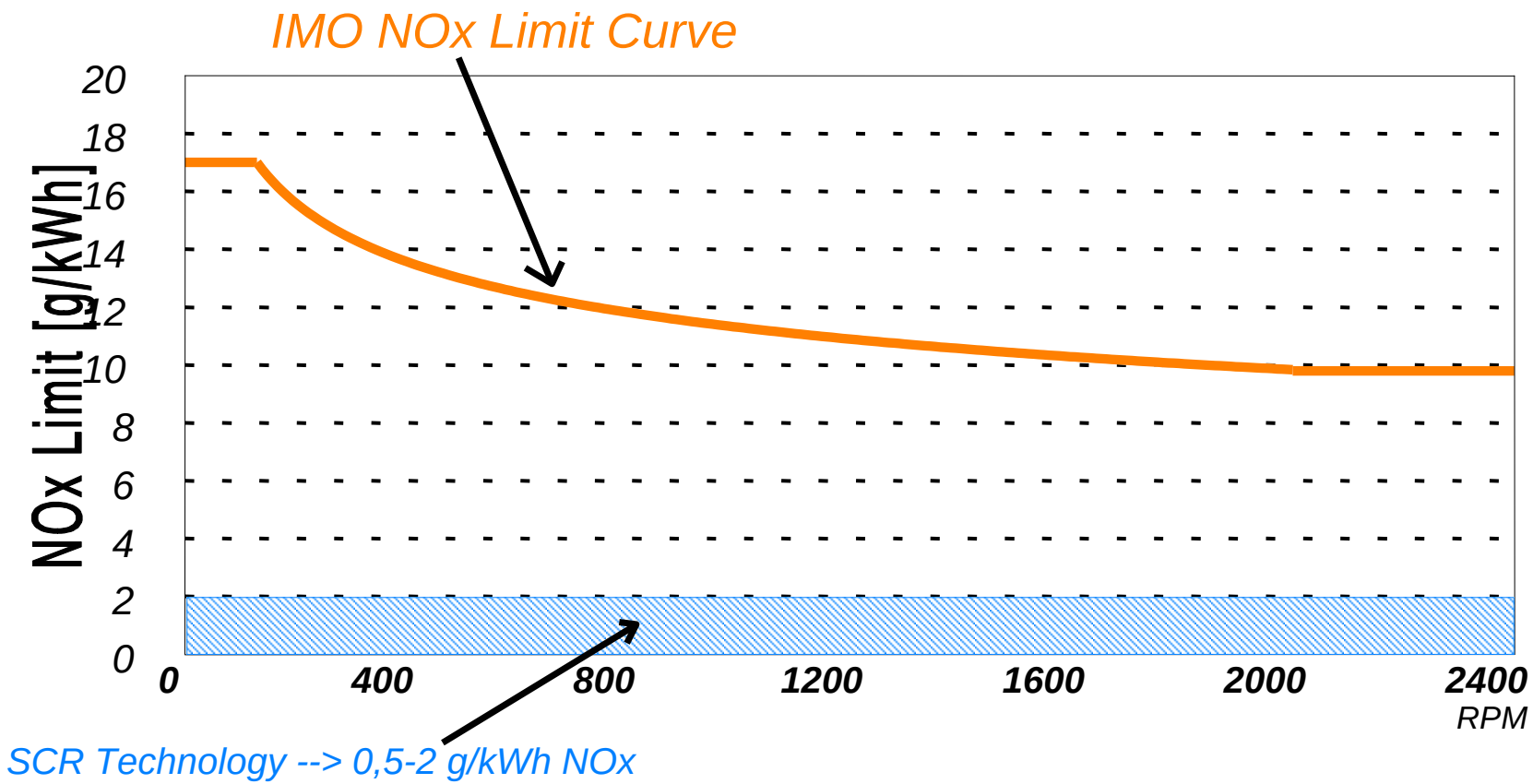
NOx Limits (IMO Regulation)



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Different Ways and Technologies for NOx Reduction

Technology	Efficiency [% below IMO]
Basic internal engine modifications	- 20 %
Exhaust gas recirculation	- 35 %
Direct water injection	- 50 %
Humid air motor (HAM)	- 70 %
SCR	- 95 %

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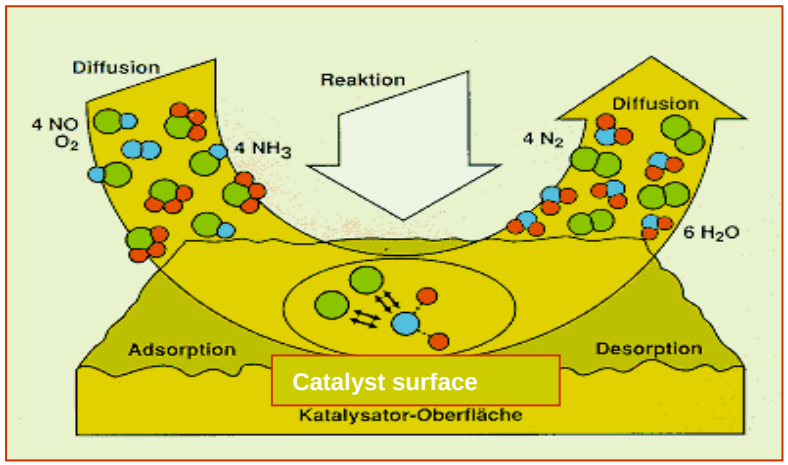
SCR Principle (1): Selective Catalytic Reduction



$$4\ NO + 4\ NH_3 + O_2 \rightarrow 4\ N_2 + 6\ H_2O$$

Nitrogen Oxides (NO and NO_2)

Ammonia; generated by aqueous urea solution

Nitrogen

Water

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SCR Principle (2): Selective Catalytic Reduction

1. Step : Injection of Urea Solution

($CO(NH_2)_2 + H_2O$)

2. Step : Conversion of Urea to Ammonia

(NH_3)

3. Step : Reduction of NOx with Ammonia

($NOx + NH_3 + O_2 \longrightarrow N_2 + H_2O$)

Result : NITROGEN and WATER

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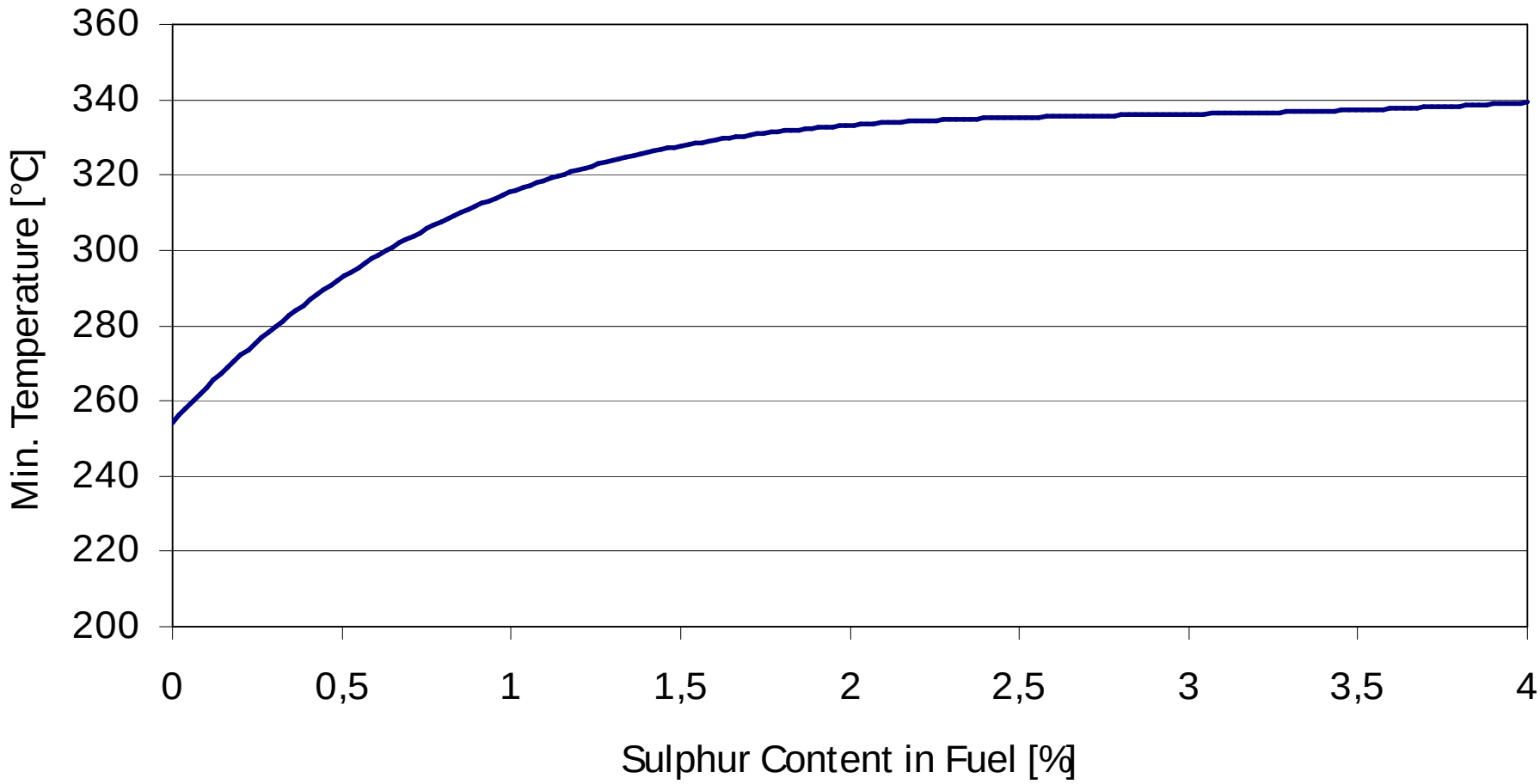
Minimum Temperature for SCR Long-term Operation



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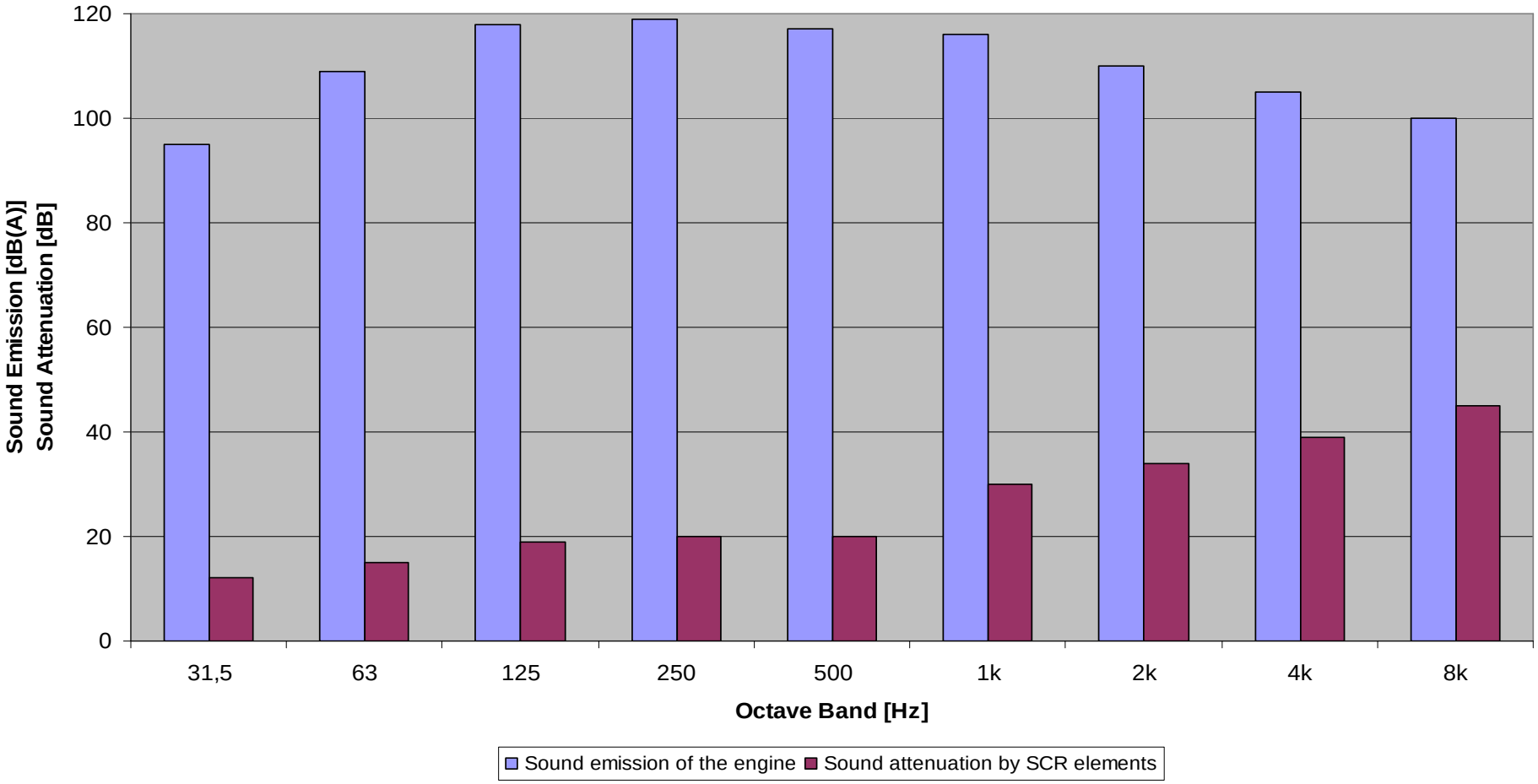
Sound Attenuation *(16 Cylinder Medium Speed Engine)*



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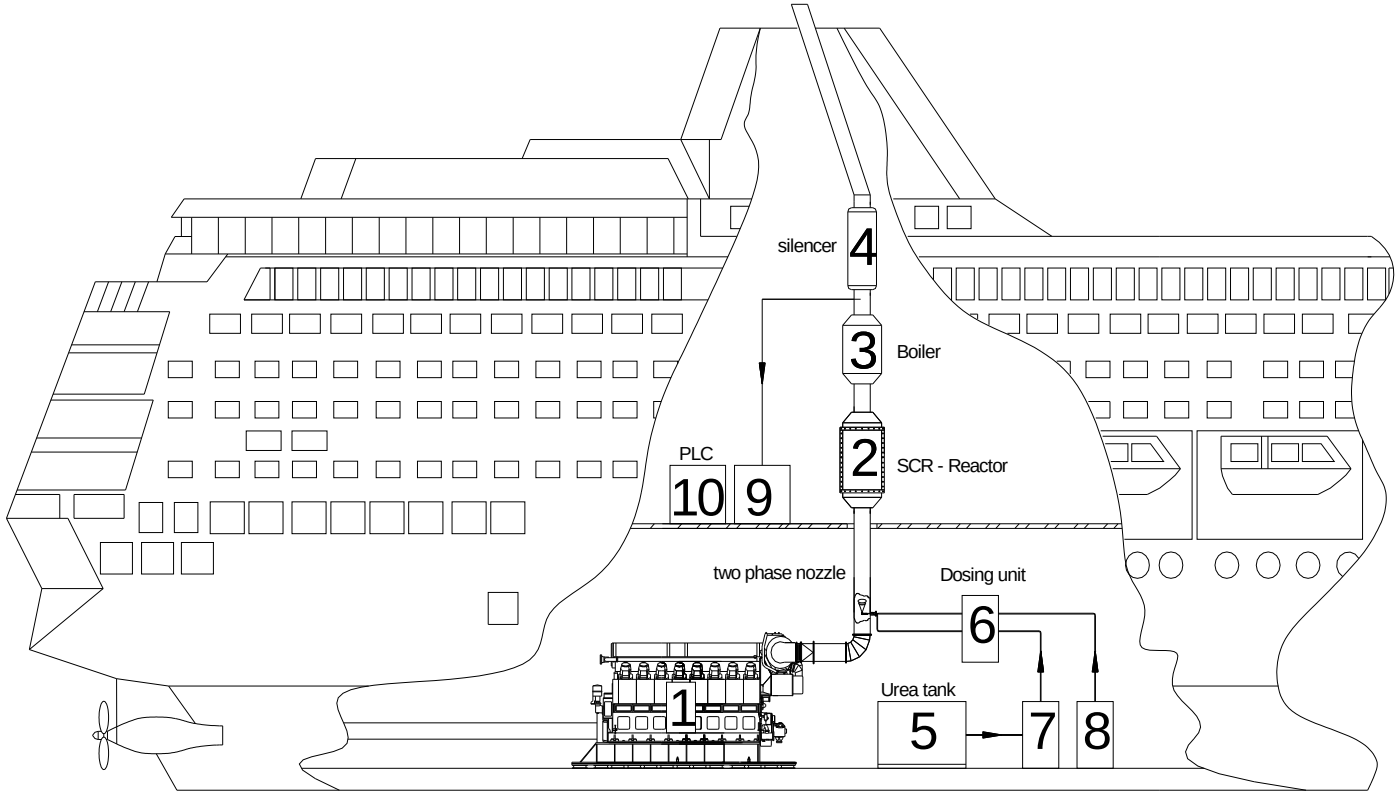
General Arrangement



1. Diesel engine
2. SCR – reactor
3. Heat Exchanger
4. Silencer
5. Urea tank
6. Dosing unit
7. Urea pump skid
8. Compressor (working air)
9. NOx analyser (*optional*)
10. PLC Control cabinet

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SCR - Main Figures

Performance :

- NOx Reduction 90 – 98 %
- HC Reduction 80 – 90 %
- Soot Reduction 20 – 30 %
- Sound Attenuation 20 – 35 dB(A)

Operation :

- Temperature Range 280 - 510 ℃
- Fuel MGO / MDO / HFO

Specific costs :

- Invest costs 30 – 50 € / kW
- Running costs 2 – 4 € / MWh

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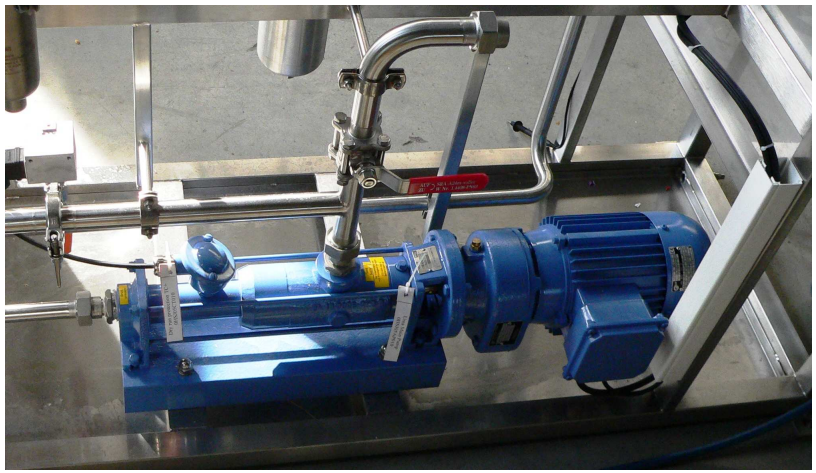

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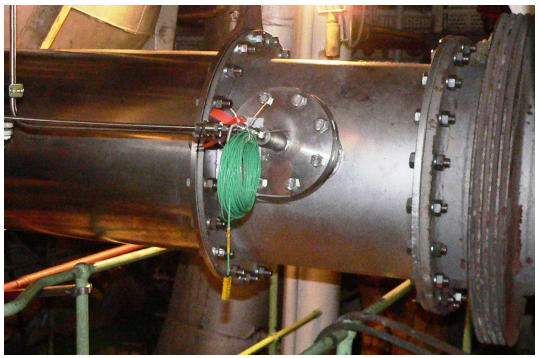

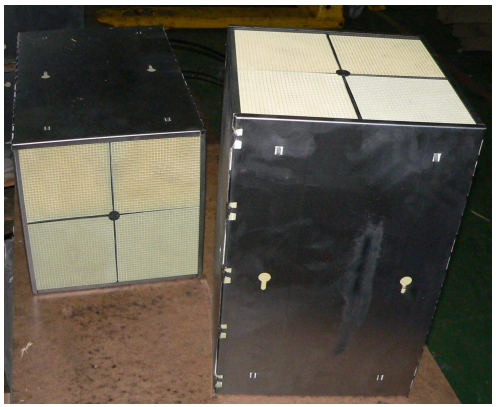

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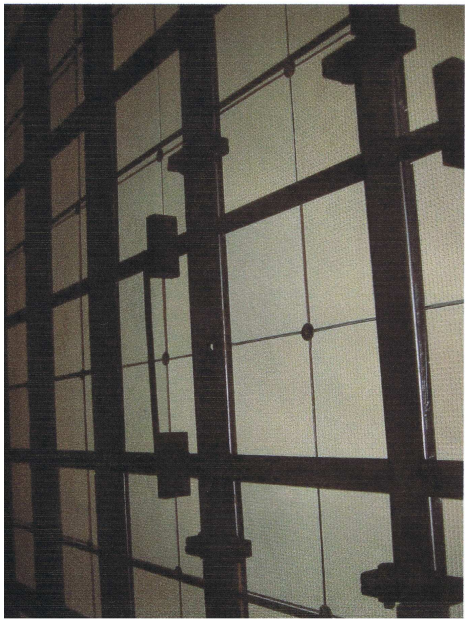

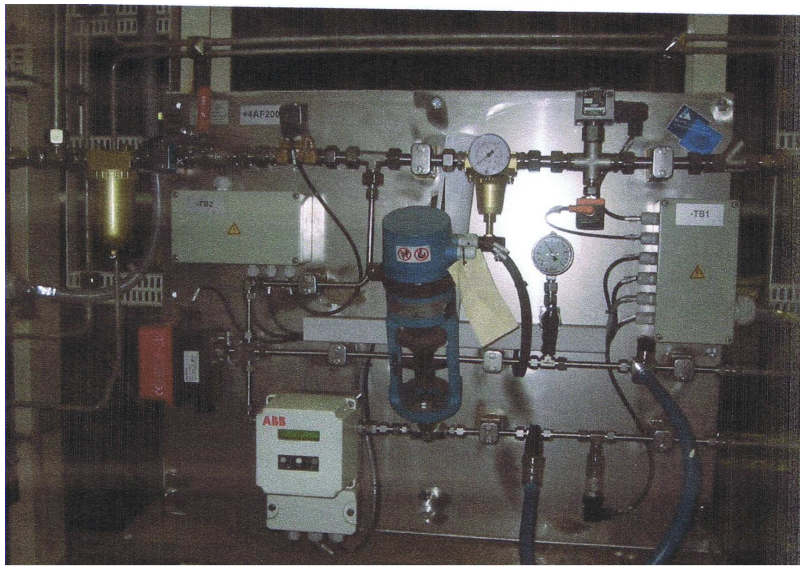

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Summary (1) :

- SCR is a reliable and proven technology for marine applications
- References: In total more than 100 vessels with about 350 engines worldwide in operation!
- SCR means: High efficient NOx reduction combined with:
  - ⇒ HC Reduction
  - ⇒ Soot Reduction
  - ⇒ Sound Attenuation

Summary (2) :

- The SCR system has no negative impact on the engine performance
- Using this system, the engines can be adjusted to a fuel optimized operation
- The SCR system can be combined and integrated with a silencer
- The SCR system plus oxidation catalysts can also reduce CO and HC
- The SCR system is modular and can be designed for any engine power

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Thank you for your attention!