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Emission reduction technologies

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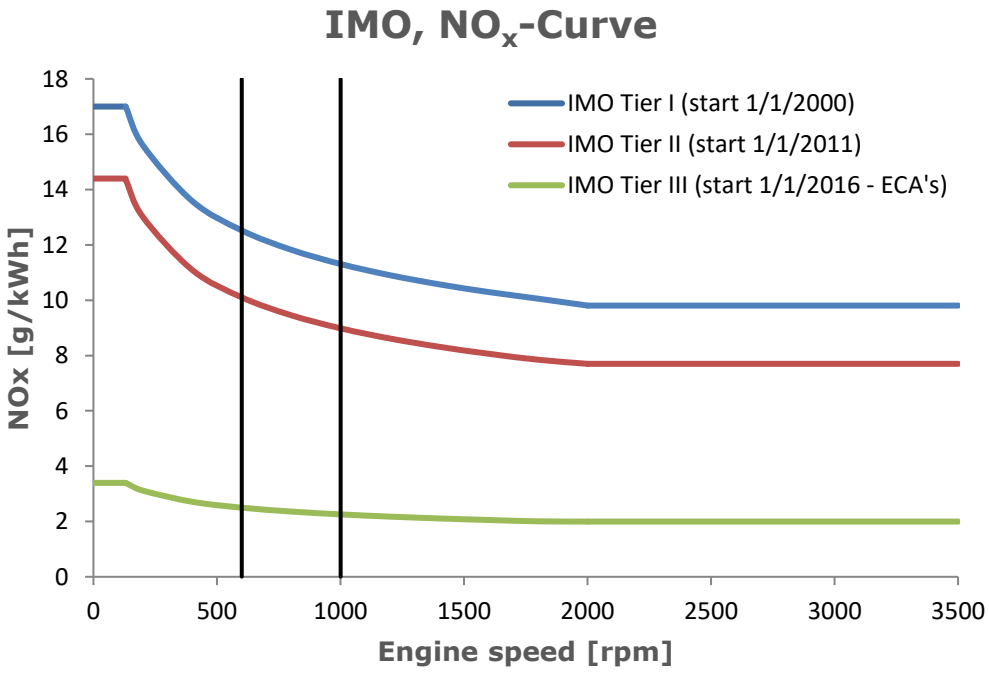
Emission requirements Sea going Vessels

International Maritime Organization – **IMO Tier 2/3**

- NOx-limits defined (see graph)
- PM-limits not defined ('no visible smoke')
- CO-limits not defined
- HC-limits not defined



Conclusion:

IMO Tier 2 is known for some time (°2011) and can be achieved engine internally without applying EGR and/or SCR-technology. Achieving IMO Tier 3 requires aditional technology

IMO

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Emission requirements Inland Waterway Vessels

EU Stage V– **EU 2016/1628**

Table II-5: Stage V emission limits for engine category IWP defined in point (5) of Article 4(1)

Emission stage	Engine sub-category	Power range	Ignition type	CO	HC	NO_x	PM mass	PN
		kW		g/kWh	g/kWh	g/kWh	g/kWh	#/kWh
Stage V	IWP-v-1 IWP-c-1	19 ≤ P < 75	all	5,00	(HC + NO_x ≤ 4,70)		0,30	—
Stage V	IWP-v-2 IWP-c-2	75 ≤ P < 130	all	5,00	(HC + NO_x ≤ 5,40)		0,14	—
Stage V	IWP-v-3 IWP-c-3	130 ≤ P < 300	all	3,50	1,00	2,10	0,10	—
Stage V	IWP-v-4 IWP-c-4	P ≥ 300	all	3,50	0,19	1,80	0,015	1×10^{12}

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Emission requirements Inland Waterway Vessels

EU Stage V

- NOx-limit: 1,80 g/kWh
- PM-limit: 0,015 g/kWh (final stage)
- CO-limit: 3,50 g/kWh
- HC-limit: 0,19 g/kWh
- PN limit: $1x10^{12}$

Conclusion:

Additional measures are necessary in order to comply with these emission limits. The technologies ABC uses specific for each pollutant:

- NOx: SCR
- PM/PN: DPF
- CO: nothing required
- HC: DPF/SCR

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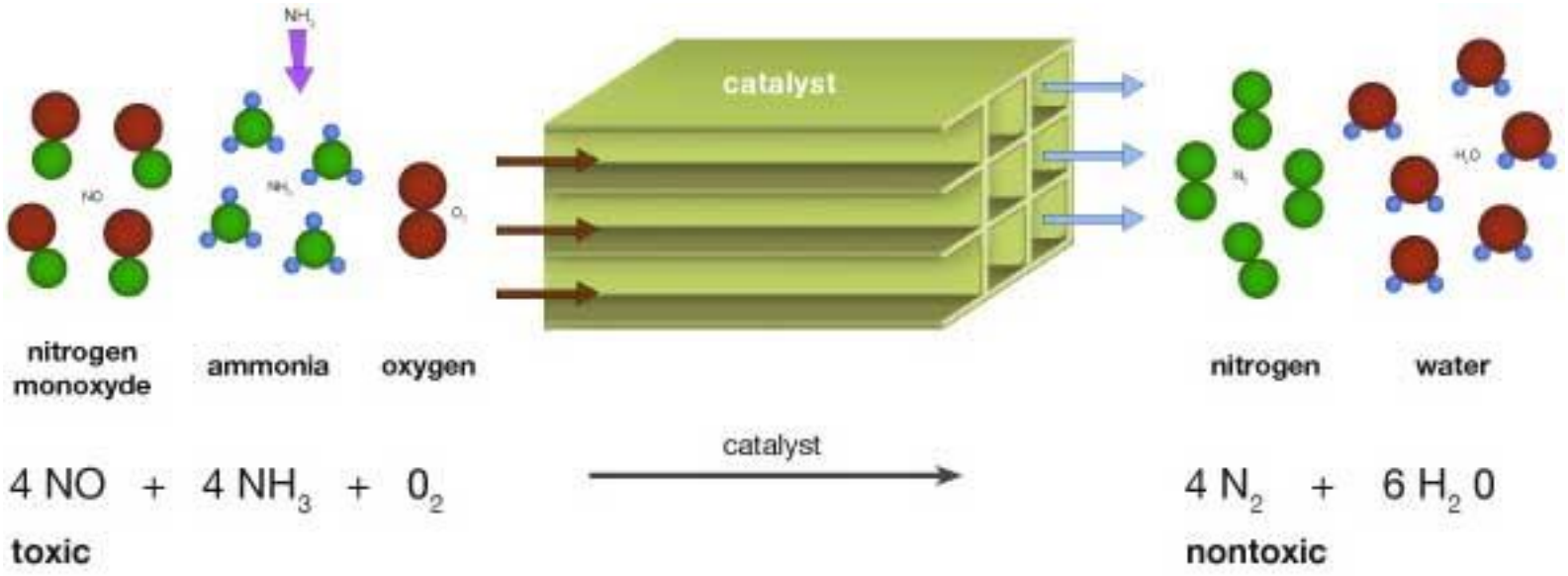
SCR Principle

Principle of Selective Catalytic Reduction (SCR):

The exhaust gas treated with a reactant passes through a honeycomb-patterned convertors with a fine cell structure. The nitrogen oxides (NOx) react with the ammonia from the reactant on the active surface of the convertor and are reduced to water and nitrogen.



High conversion rates possible

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SCR

Engine

Mixing pipe

SCR reactor

Control unit

Dosing unit

Urea supply unit

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SCR

Pro:

- Simple system – operational friendly
- Easy to perform maintenance
- Relatively long maintenance interval hours
- Customizable in execution (shape and size)
- Silencing capacity – silencer can be integrated as one system
- Relatively inexpensive

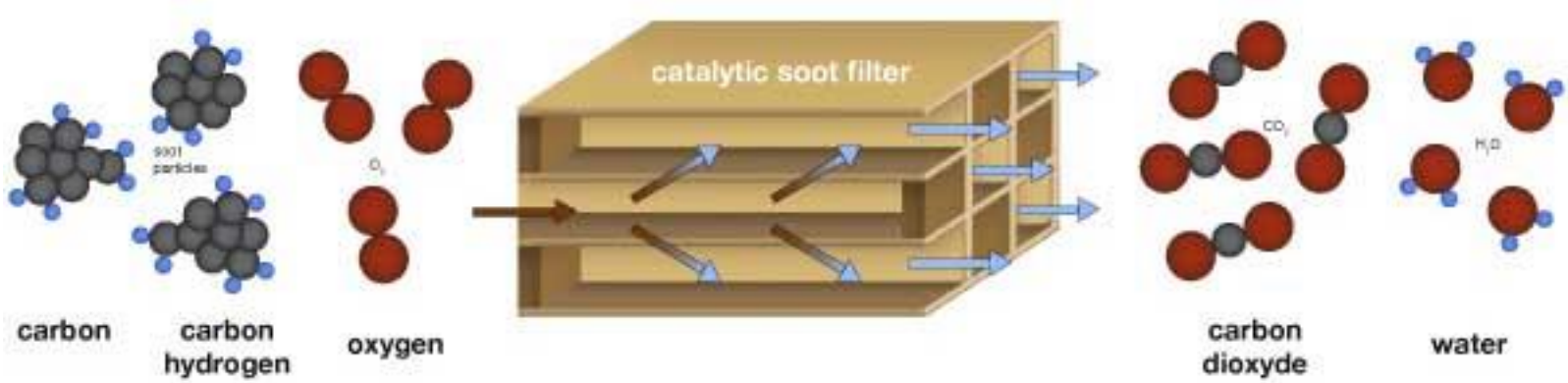
Con:

- Increased dimensions
- Usage of urea – storage on board – extra consumable - logistics
- Catalyst elements can be poisoned; maximum 1000 ppm Sulphur in fuel

DPF

Principle of Diesel Particulate Filter (DPF):

The exhaust gases flow through the porous walls between the channels that are blocked at alternate ends. During this process particles will be deposited in the walls. In order to burn off the collected soot, all filters are equipped with catalytic coating. This allows regeneration to start at lower exhaust temperatures.



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Stage V set up: DPF + SCR

Engine

DPF

SCR

Mixing pipe

CCV

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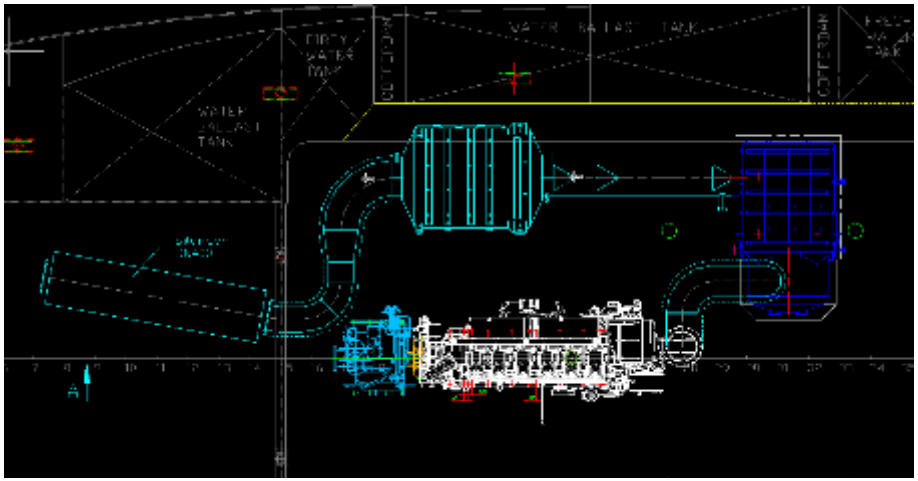
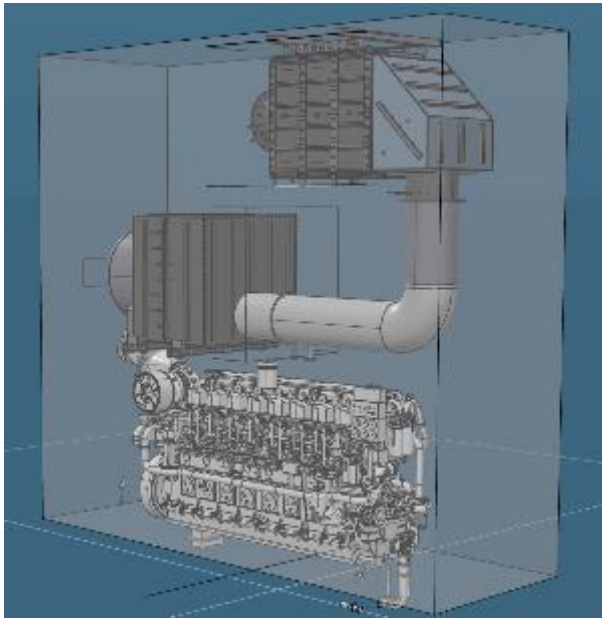
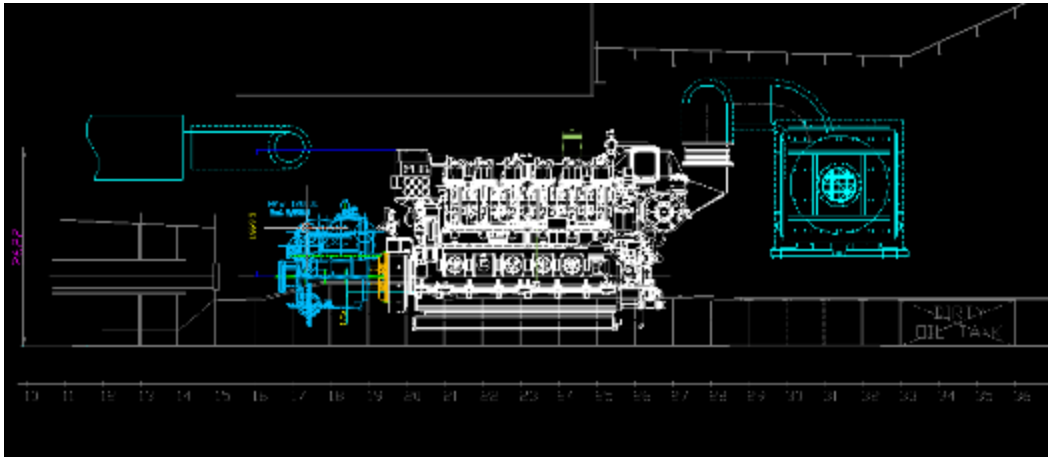
Stage V customer specific engineering







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Stage V

Pro:

- Extreme high reduction rate which allows us to achieve the latest and strict exhaust emissions
- Simple engine (PLN engine with fuel optimized tuning).
- Custom engineering
- All testing and certification done by ABC at the factory

Con:

- Expensive
- Requires additional space in vessel
- DPF and SCR require maintenance which add to the overall operational cost

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Questions?

Thank you for your attention!