BREEZE
MARINE GROUP

Attention to detail, quality in everything!

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Breezemarine group links Science to the Market

FOR THE SAKE OF OUR ENVIRONMENT

Breezemarine is a pioneer in the field of Exhaust Gas After Treatment

Exhaust Emissions requiring attention

Soot	causing fouling of the immediate environment
NOx	regulated; harmful to the environment
Hydrocarbons	responsible for odour
Noise	affects comfort

Those emissions can be reduced individually or in combinations

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Field of expertise

- Chemical composition of exhaust gasses
- Fuel- and Luboil composition affecting exhaust gas compositions
- Chemical reactions of substances
- Combustion process of engines
- Thermodynamics
- Noise and vibration

Main products

- Delta Passive Diesel Particulate Filter systems (DPF)
- Alfa Alfa Active Diesel Particulate Filter systems (DPF)
- MINOx Selective Catalytic Reduction systems (SCR)
- In-house developed sophisticated control

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Process:

- Assessment of all techncial aspects
- Design
- Specification
- Production
- Installation instruction
- Training
- Aftersales
- Maintenance
- Maintenance prediction
- Performance monitoring

Markets:

- Luxury Yachts
- Marine
- Inland waterway
- Ocean going and short-sea vessels
- Off-shore
- Energy
- Industry

Exhaust Emissions of Concern; Regulations

EPA : Environmental Protection Agency (U.S.)

Emission limits are referred to as EPA Tier 1, Tier 2, etc. with latest being Tier 4

EU : European Union

Emission limits for Non-Road Mobile Machinery (NRMM) are referred to as EU Stage I, Stage II, etc. with latest being Stage V

IMO : International Maritime Organisation

Emission limits are referred to as IMO MARPOL Annex IV Tier I, Tier II with latest being Tier III

Exhaust Emissions of Concern; Limits

EU Stage V Inland Waterways Engines

Power	CO	HC	HC + NOx	NOx	PM
kW	g/kWh				
19<P<75	5.0	-	4.7	-	0.3
75<P<130	5.0	-	5.4	-	0.14
130<P<300	3.5	1.0	-	2.1	0.1
P 300	3.5	0.19	-	1.8	0.015*

* Additionally particles by count PN [#] < 10^{12}

Emission Control Areas (ECAs)

Designated under regulation 13 of MARPOL Annex VI (NOx emission control)

IMO Tier III

Engine rotation speed RPM	NOx g/kWh
n < 130	3.4
130 < n < 2000	$9 \times n^{\wedge -0.2}$
n > 2000	1.96

Exhaust Gas After Treatment in the market

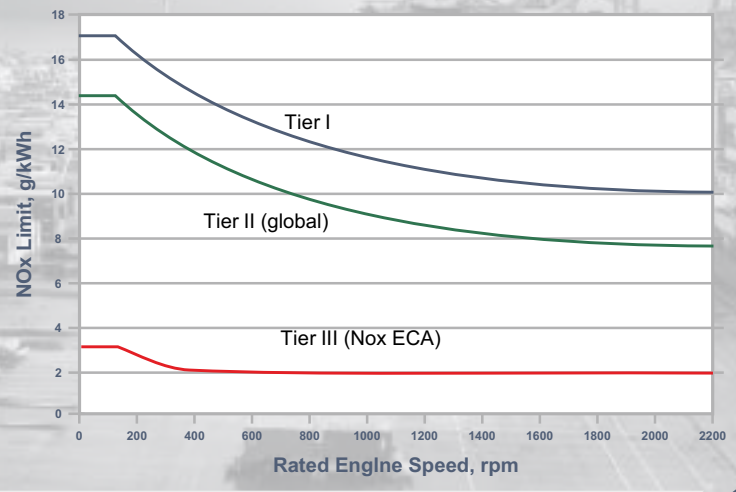
Emission	Abatement
Soot	Soot Filter
NOx	SCR (Selective Catalytic Reduction)
Hydrocarbons	Oxidation Catalyst
SOx	Scrubber Not in Breezemarine scope
Noise	Exhaust Gas Silencer

Figure 1 . MARPOL Annex VI NOx emission limits

Table 1. MARPOL Annex VI NOx emission limits

Tier	Date	NOx Limit, g/kWh		
		n < 130	130≤ n < 2000	n ≥ 2000
Tier I	2000	17.0	$45 \cdot n^{-0.2}$	9.8
Tier II	2011	14.4	$44 \cdot n^{-0.23}$	7.7
Tier III	2016†	3.4	$9 \cdot n^{-0.2}$	1.96

† In NOx Emission Control Areas (Tier II standards apply outside ECAs).



NOx Reduction
The SCR System

The SCR Process

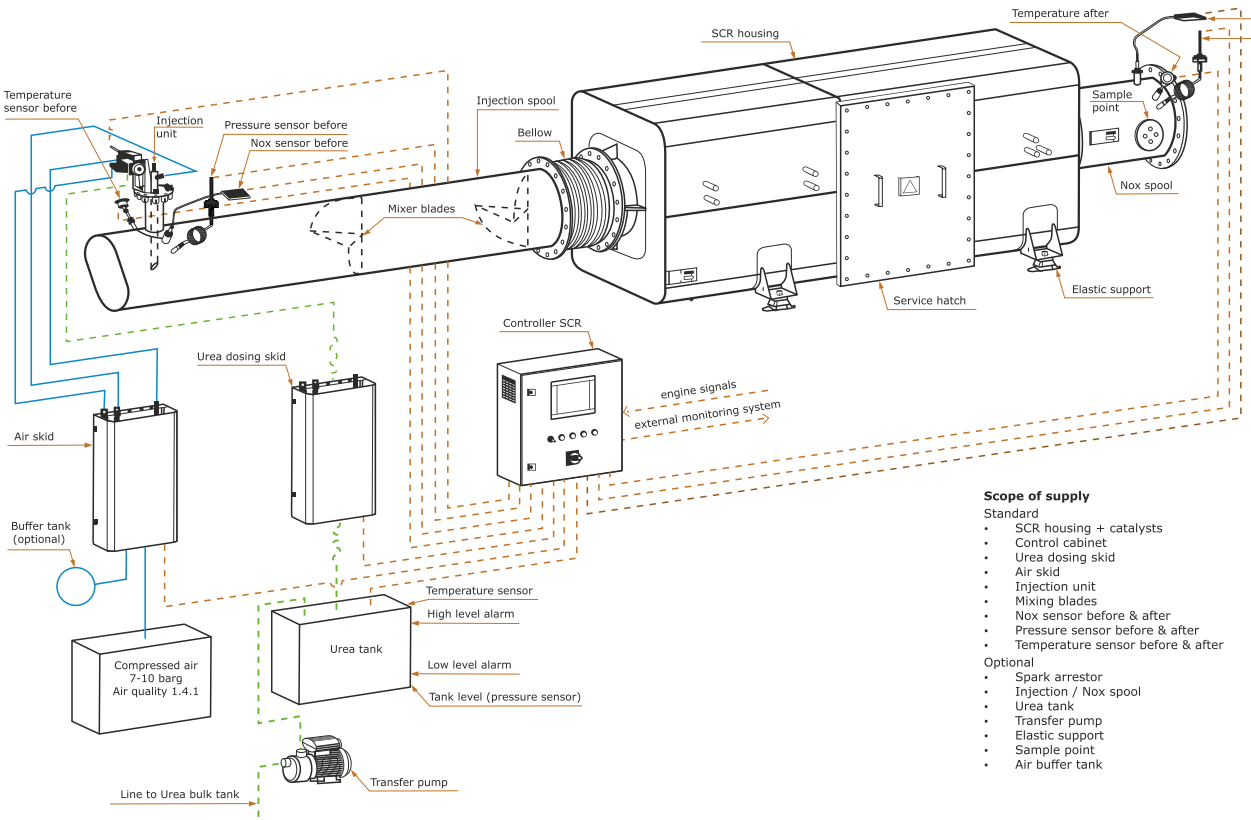
- Is the most effective and widely accepted technology to reduce NOx.
- The process uses a reagent, ammonia (NH_3) mixed with the exhaust gasses and guided through catalyst.
- Provided the process is controlled appropriately, the end products are inert nitrogen (N_2), vapour (H_2O) and carbon dioxide(CO_2).

Typical SCR Performance

NOx Reduction: > 85% (sufficient to meet IMO Tier III requirement)

Catalyst Operational life: > at least 16.000 hours of operation

GA MINOx M



Line	Descript
- - - - -	signal
———	air
- - - - -	urea

Scope of supply

Standard
- SCR housing + catalysts
- Control cabinet
- Urea dosing skid
- Air skid
- Injection unit
- Mixing blades
- Nox sensor before & after
- Pressure sensor before & after
- Temperature sensor before & after

Optional
- Spark arrestor
- Injection / Nox spool
- Urea tank
- Transfer pump
- Elastic support
- Sample point
- Air buffer tank

Customer's scope of supply

Electrical input
- Power Supply
- CAN-bus engine signal
- Urea level signal

Physical
- Compressed air
- Injection spool
- Urea tank
  Bulk and/or day tank
- Bellow
- Thermal insulation

Field cabling and piping
- Electical
- CAN-bus
- Air piping
- Urea piping

Urea Consumption

Theoretically, to reduce 1kg of NOx requires:

2,0 kg of urea 32,5%, or

1,6 kg of urea 40%

Example Exhaust Silencer/ Catalyst Housing

Example Special design Exhaust Silencer/ Catalyst Housing

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Example Special design Exhaust Silencer/ Catalyst Housing

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Compact Funnel Design (Serves 4 engines)

Certification

According to:

- NOx Technical Code associated to SCR Guidelines (MEPC resolution 198(62)

&

- Classification societies' rules

Certification process involves:

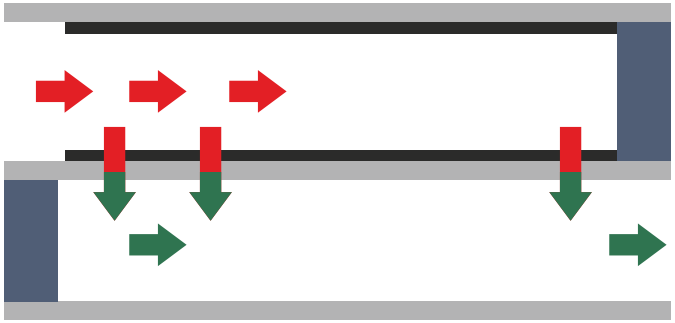
- Component certification
- Certification of the system function & performance (EIAPP)
- Certification of the ship with the system (IAPP)

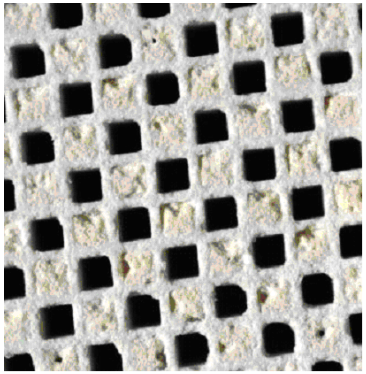
Soot Filtration
The DPF System

Soot Filtration

Working Principal

- The exhaust gasses are forced through the porous walls of the filter.
- The gasses are free to pass while the soot is collected against the honeycomb walls.





Filter Regeneration

- Each filter has a limited storage capacity defined by its volume.
- After a certain period the filter needs to be relieved from its load otherwise the backpressure will exceed engine limit.
- Relieving the filter is achieved by burning the collected soot.
- This process is called filter regeneration

Regeneration Strategies

- **Full Catalytic (DPF Without fuel burner regeneration)**

  Sufficient thermal energy is available in the exhaust gas to initiate and maintain soot combustion.

- **Catalytic, (DPF with Fuel Burner supported regeneration)**

  Insufficient or inconsistently sufficient thermal energy available in the exhaust gas. Energy added by the fuel burner.

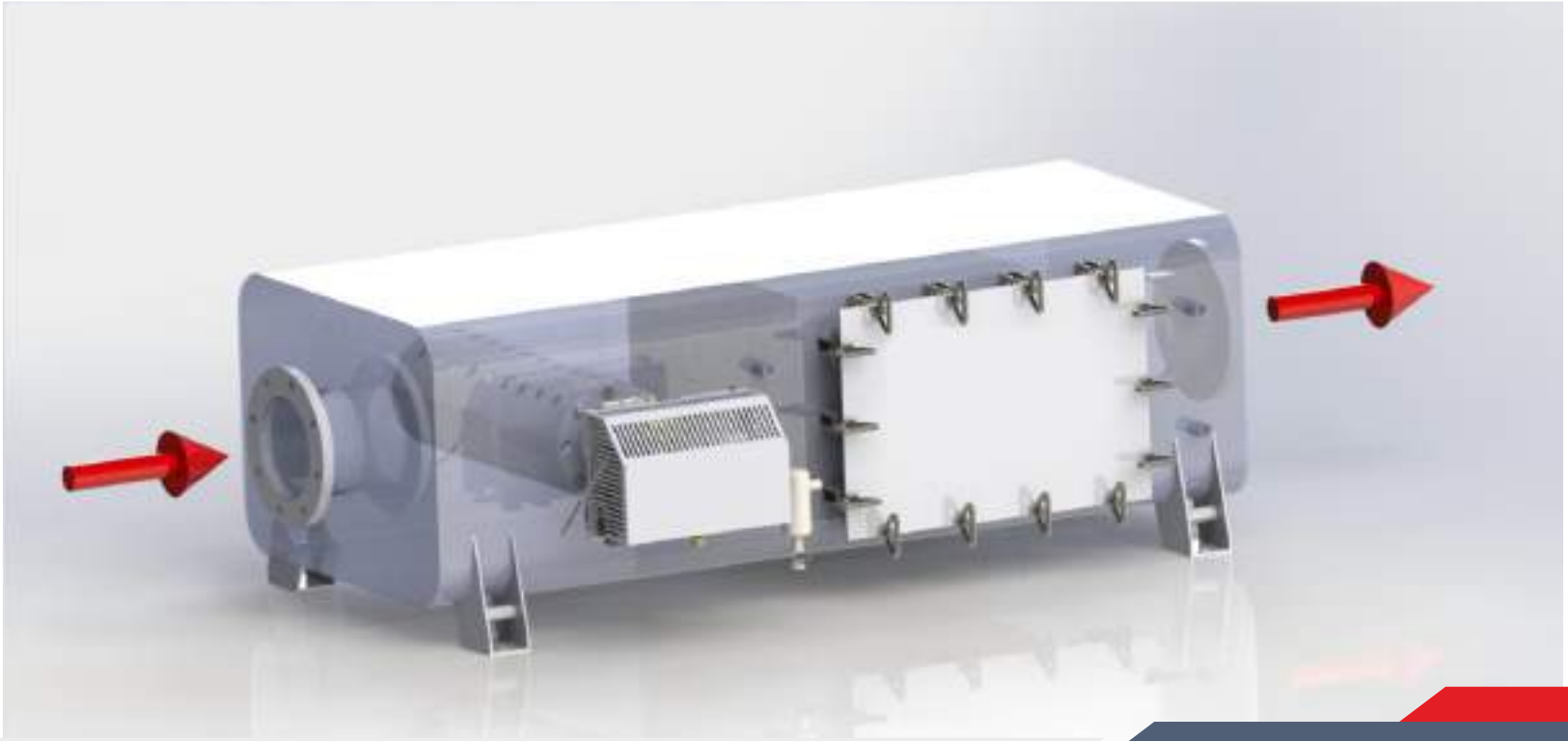
A catalytic system is designed to enable retrofit of a fuel burner in case engine load profile does not meet the required energy conditions

Soot Filter Systems

Main Features	Benefits
Ceramic filter elements	High efficiency
Filter elements in Silicon Carbide	Long operational life
Filters catalysed	Reduction of exhaust odour
Advanced catalyst formulation	Compatible with all Marine Distillate Fuels*
High storage capacity	Long service intervals
Filters easily accessible	Short Down -Time
Filters individually packed	Easy to service
Integrated in heat resistant stainless steel housing	Durable

*acc. ISO 8217 :2010

Typical Housing Design



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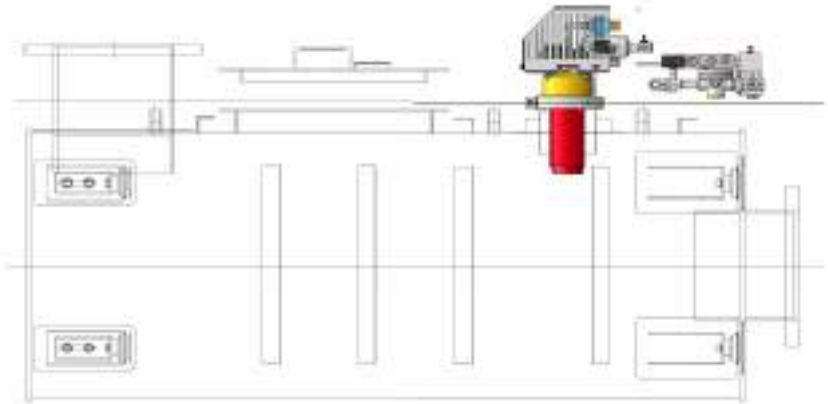
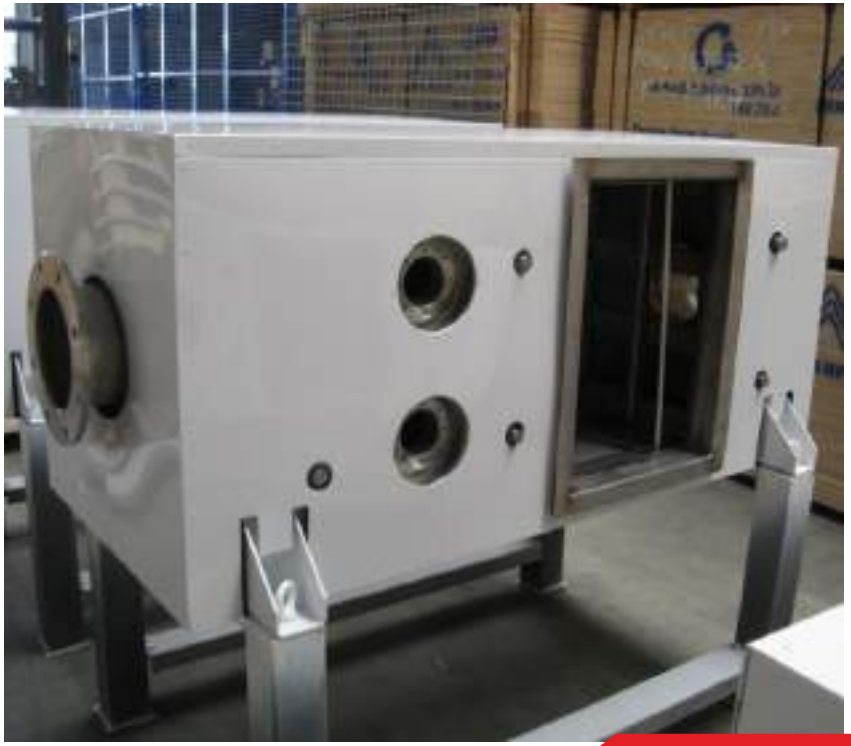
System Components

Housing for Vertical Orientation



Typical Installation

Housing for Horizontal Installation



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before printing this presentation.

SET THE FIRST STEP TO OUR ENVIRONMENT OF TOMORROW; CONTACT US!

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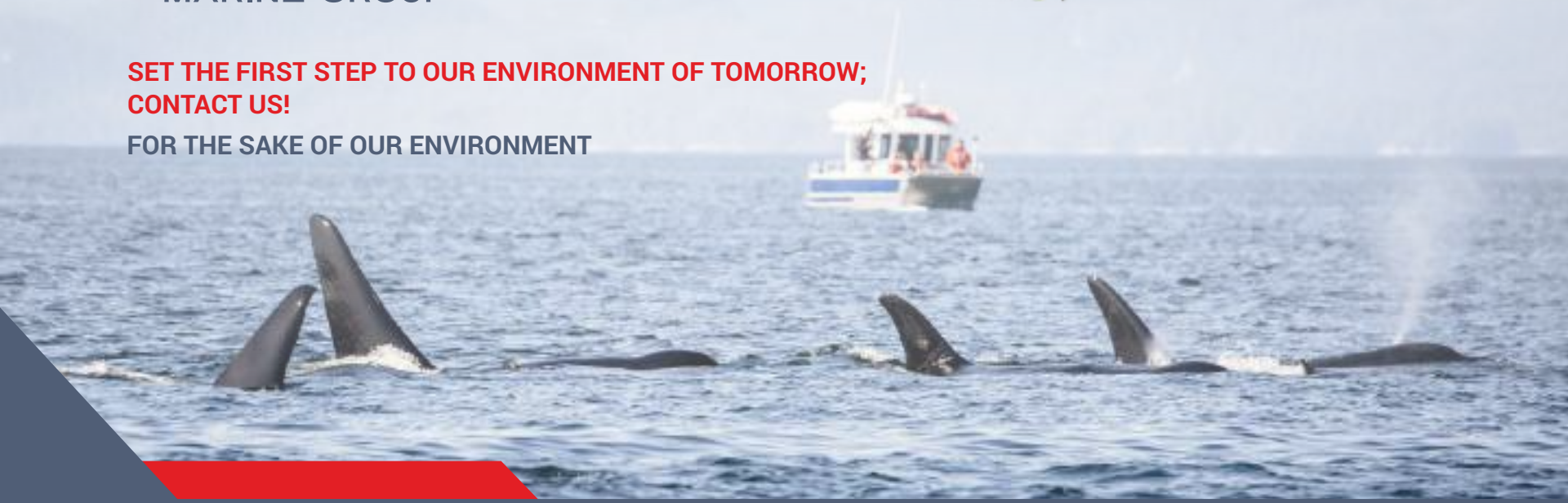

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