Wärtsilä NO\textsubscript{x} Reducer

Environmental Efficiency
Environmental efficiency

- Stringent legislations concerning NO$_{X}$.
- Retroactive legislations are introduced.
- Regulations in the shape of fees, taxes or incentive programs are brought on from many parties, including individual countries that have introduced fairway dues, NO$_{X}$ tax or NO$_{X}$ fund initiatives.
Revised Marpol Annex VI Regulation 13

- **NOX** (g/kWh)
- **Primary methods operation area**
  - Tier I >130 kW
    - New ships 2000
- **Secondary methods operation area**
  - Tier II >130 kW
    - New ships 2011
  - Tier III >130 kW
    - New ships 2016 in designated Emission Control Areas (ECA)

**Rated engine speed (rpm)**

June 2011
Nitrogen Oxides (NO\textsubscript{x}) are formed during the combustion process from oxygen (O\textsubscript{2}) and nitrogen (N\textsubscript{2}) in air.

The NO\textsubscript{x} Reducer SCR catalyst converts NO\textsubscript{x} molecules back to harmless O\textsubscript{2} and N\textsubscript{2} molecules by means of urea.
NO\textsubscript{X} reducer – description

• The Nitrogen Oxide Reducer (NOR) is designed by Wärtsilä and is based on selective catalytic reduction (SCR) technology. The NO\textsubscript{X} reducer portfolio covers Wärtsilä’s medium-speed engine portfolio for marine applications.

• The size of the NO\textsubscript{X} Reducer is optimised in terms of modularity, performance and costs. The typical NO\textsubscript{X} emission reduction is 90 %.

• The main component of the NO\textsubscript{X} reducer installation is the reactor with the catalyst inside. Other modular essential parts of NOR system are a reagent pumping unit, a reagent dosing unit, a control unit and an injection unit.
Nitrogen oxides (NO\textsubscript{x}) are reduced into nitrogen (N\textsubscript{2}) and water vapour (H\textsubscript{2}O) using ammonia or urea at a suitable temperature on the surface of the catalyst.

**Operating temperature**

\(~ 300 – 450 °C\)
Minimum recommended temperature in the SCR inlet vs fuel sulphur content
Catalytic elements

Proven catalytic elements for marine applications.

4 NO + 4 NH₃ + O₂ → 4 N₂ + 6 H₂O

Catalyst
Main components – Reactor

- Wide range of sizes designed for various customers’ needs.
- High level of standardization and modularisation.
- Reactor structure optimized for marine applications.
- Reactor can be run without reagent injection, only soot blowing remains in operation; no by-pass is required.
- Soot blowing inlets are located on opposite reactor walls for ensuring efficient cleaning which covers the whole element surface area.
Main components – Urea injection and mixing

- The injection unit feeds the optimum amount of urea solution with air to the mixing duct.

- Mixing duct gives the necessary time for urea to evaporate, decompose and mix with exhaust gas.

- Appropriate mixing duct arrangement ensures uniform flow around the injector to obtain homogeneous distribution of ammonia into the flow.

- When turned off, the injector is automatically purged by compressed air from urea solution in order not to have urea deposits in it.
Main components – Urea pumping unit

- The pumping unit supplies urea solution to multiple dosing units
- In large multiple engine installations it is possible to simply increase the number of pumps in order to deliver the desired amount of urea
- All piping is made of stainless steel
- Preferably accommodated close to the urea tank
Main components – Urea dosing unit

- Defines the correct dosing rate and adjusts urea flow accordingly with a control valve.

- Combines the control of urea solution dosage and compressed air with automatic injector cleaning features.

- All piping is made of stainless steel.

- An independent dosing unit for each NOR reactor.

- Recommended to be installed close to the urea injector.
The control system is a part of the dosing unit. It controls the NOR operation by monitoring engine parameters. An integrated interface to the engine automation system is provided. Hardware and software commonality with the engine automation system UNIC platform is included. Soot blowing control and safety features are also included.
Wärtsilä NOR performance

- High activity over a wide temperature range
- Efficient SCR process
- Durable catalyst against ageing and erosion

**Performance**

| NOx emission levels as per IMO Tier III* |

**Urea consumption**

| Typically 15-20 l/h / MW |

**Operation**

| Fuels: MGO / MDO / HFO with <1.0 % S content (higher sulphur content possible upon request) NOR delivery means ensuring the compatibility of the NOR system with the engine. |

*at sufficient high exhaust temperature conditions*
### Selection of NOR reactor for Wärtsilä engines

<table>
<thead>
<tr>
<th>Reactor size (mm)</th>
<th>Engine power output (kW)</th>
<th>Reactor inlet Flange DN</th>
<th>Reactor outlet Flange DN</th>
<th>Weight (kg) incl. catalyst elements</th>
<th>L (mm) (incl. insul.)</th>
<th>H (mm) (incl. insul.)</th>
<th>W (mm) (incl. insul.)</th>
<th>Mixing pipe, straight length (m)</th>
<th>Mixing pipe, total length (m) includes straight length</th>
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</table>

- NOR reactor is selected according to engine power.
NO$_X$ reducer system – typical consumables

- Reducing agent
- Compressed air for reducing agent injection and soot blowing
- Electricity (~1 kW per NOR unit)
- Catalytic elements

TYPICAL COST DISTRIBUTION
NOR Benefits

Owner Benefits

• Quality and functionality guaranteed by Wärtsilä

• Control system commonality for NOR and the engine

• Complete system user manual

• Catalyst system components and service available by Wartsila worldwide

• Training courses

Shipyard Benefits

• Fully integrated supply by one supplier

• Possible integration with noise attenuation system

• Single point responsibility

• Quick installation due to pre-fabricated and -tested modules

• Start up and commissioning

• Calibration expertise

• Short delivery time

June 2011