



ECOSPRAY

TECHNOLOGIES

MARINE

EXHAUST GAS CLEANING SOLUTIONS

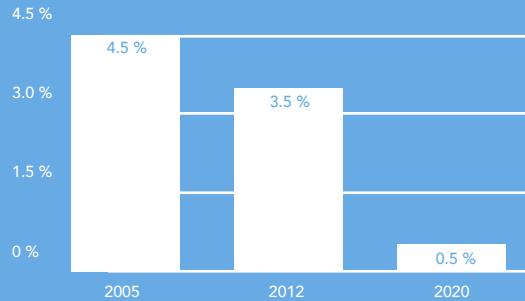
MEETING GLOBAL EMISSION REQUIREMENTS



Ecospray Technologies provides a range of solutions specifically designed for the marine industry, including DeSOx, DeNOx and diesel particulate removal to meet the most severe emission limits for both SOx and NOx (MARPOL 73/78 Annex VI and Amendments).

2020 GLOBAL SULFUR CAP

Under the new global limit, ships will have to use fuel oil with a sulfur content of no more than 0.5%, versus the current limit of 3.5%, or use an Exhaust Gas Cleaning System as a compliant option. This in addition to the 0.1% sulfur limits in Emission Control Areas (ECAs) already in force since January 2015.





BE READY FOR THE 2020 GLOBAL **SULFUR CAP**

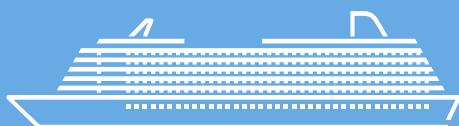
Ecospray's ECO-EGC™ Exhaust Gas Cleaning Systems (EGCS) are flexible and able to meet both compliance needs, 0.1% for ECAs and 0.5% for the 2020 global sulfur cap, using different optional configurations: open loop, closed loop and hybrid.

For shipping companies Ecospray scrubber systems represent the most economically attractive option for the 2020 fuel challenge.

Ecospray has developed the ECO-EGC™, a proprietary multi-pollutant Exhaust Gas Cleaning System that achieves superior emission performances.

With over 450 systems developed and installed worldwide (on & off-shore), Ecospray is one of world's largest marine EGCS makers with hundreds of successful systems in large vessels (cruise ships, ferries, cargos and tankers with single or multiple engines).

FACTS & FIGURES



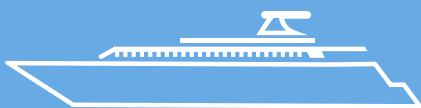
CRUISE



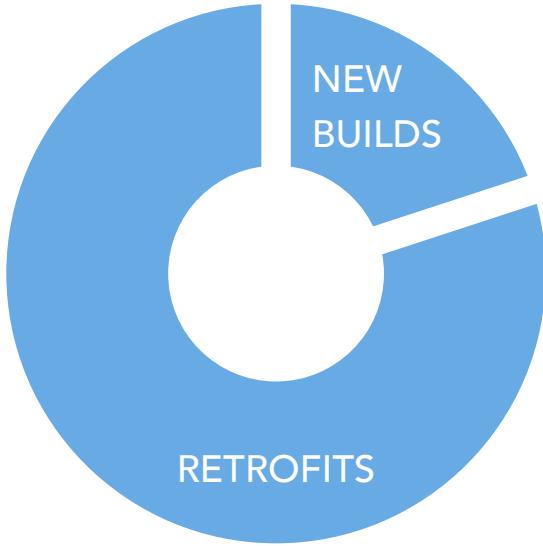
FERRY



CARGO



YACHT



OVER

260
SYSTEMS
INSTALLED

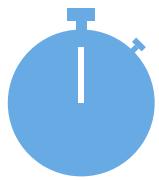
IN OVER

90
SHIPS IN THE
WORLD

300+
SYSTEMS ON
ORDER

Updated data end of 2018

TYPICAL
INSTALLATION TIME

 **2**
WEEKS
DRY-DOCK

5

INTERNATIONAL PATENTS FOR MARINE APPLICATIONS



CONTINUOUS
TRAINING
AFTER INSTALLATION



 **HELP DESK**
REMOTE ASSISTANCE

ABOUT
4500
HOURS/YEAR
TRAINING



 **SERVICE**
WORLDWIDE
TECHNICAL
ASSISTANCE



ECO-EGC™ MAKES THE DIFFERENCE

ECO-EGC™ PERFORMANCES:

- System operates comfortably up to 3.5% sulfur fuel at high engine loads, even in lower alkalinity conditions (Alaska, Baltic Sea) without caustic reagents.
- System confidently meets/exceeds all sulfur emission requirements.
- Wash water complies with regulations and all major water discharge standards.

The ECO-EGC™ can also be combined with ECO-CDF™ (Catalytic Dry Filter) or ECO-DOC™ (Diesel Oxidative Catalyst), achieving additional benefits:

- Significant reduction of black smoke in the exhaust gas emission.
- Virtually no heavy metals in the exhaust gas (with ECO-CDF™).
- Superior wash water quality in terms of PAH, hydrocarbon and turbidity.



MAIN FEATURES

Due to its extremely compact design and highly effective noise attenuation, the ECO-SOx™ ULTRA - COMPACT SEA WATER SCRUBBER perfectly replaces the existing silencer and does not require any funnel modification.

Ecospray's proprietary "Triple swirl" non-clogging centrifugal demister eliminates water carryover and drastically reduces the need for maintenance and cleaning even after months of dry operation.

The ECO-EGC™ process includes sea water injection that is regulated proportionally according to the engine loads and the SO₂ level at the funnel, in order to reduce as much as possible the energy consumption.

The ECO-EGC™ installation is typically completed in a 2-week dry-dock period.

The exclusive design of the Ecospray ECO-SOx™ optional paneled scrubber allows the installation while the ship is in service instead of waiting for the next dry dock.

The Ecospray proprietary condensation water catcher can be installed on the top of the funnel to solve the common problem of the condensation formed in cold weather conditions on the exhaust gas duct walls.

The ECO-EGC™ automation is time-tested and easy to operate.



ADDITIONAL FEATURES

TTSMS (Thermal Transient Shock Mitigation System) for inline scrubbers: consists of an inlet evaporative gas cooling system to mitigate the thermal transient shocks in the DeSOx tower during the start up in hot conditions. Very efficient for improving the lifetime of the tower in high temperature ($T > 350^{\circ} \text{C}$) applications.

Chevron demister for space saving: innovative demister geometry with unparalleled water droplets removal capability, compact design and minimum pressure drop.

Wash water filtration unit: system for filtering the entire wash water flow from the open loop tower and further increase the quality of the discharge water at the overboard (beyond compliance parameters) in terms of turbidity and heavy metals; helpful also for avoiding visible traces after a long time operation (soot deposits and/or shiny water) during port docking.



ECO-SOx™ ULTRA
COMPACT SEA
WATER SCRUBBER

THE SCRUBBER
SPECIALIST



ECO-SOx™ ULTRA COMPACT SEA WATER SCRUBBER

ECO-SOx™ ULTRA - COMPACT SEA WATER SCRUBBER is the key component upon which revolves the Ecospray EGCS's.

- Made in corrosion resistant alloy for wet and dry operating conditions.
- Compact design to reduce the installation costs and avoid any expensive funnel modifications.
- Low pressure drop.
- No limitations in sulfur fuel content.
- Simple installation: one sea water inlet and one wash water outlet.
- High efficiency proprietary water spray nozzles, no internal packing material.
- Sea water flow regulation according to the engine load and feedback received from the gas analyzer system ($\text{SO}_2 / \text{CO}_2$ ratio).
- Non-clogging proprietary centrifugal demister to eliminate the acidic water carryover and black spots from the funnel.

The ECO-SOx™ ULTRA may be completely customized in terms of external interfaces (inspection hatch position, supporting feet elevation, SW inlet and outlet).

The standard version can be upgraded with a chevron demister for specific space saving needs or/and for lower pressure drop requirements.



ECO-SOx™ ULTRA TYPICAL DIMENSION

POWER [MW]	DIAMETER [mm]	HEIGHT [mm]
6	1600	9100
8	1850	9300
10	2050	9500
12	2250	9800
14	2400	10050
16	2600	10300

Typical pressure drop 15 - 20 mbar



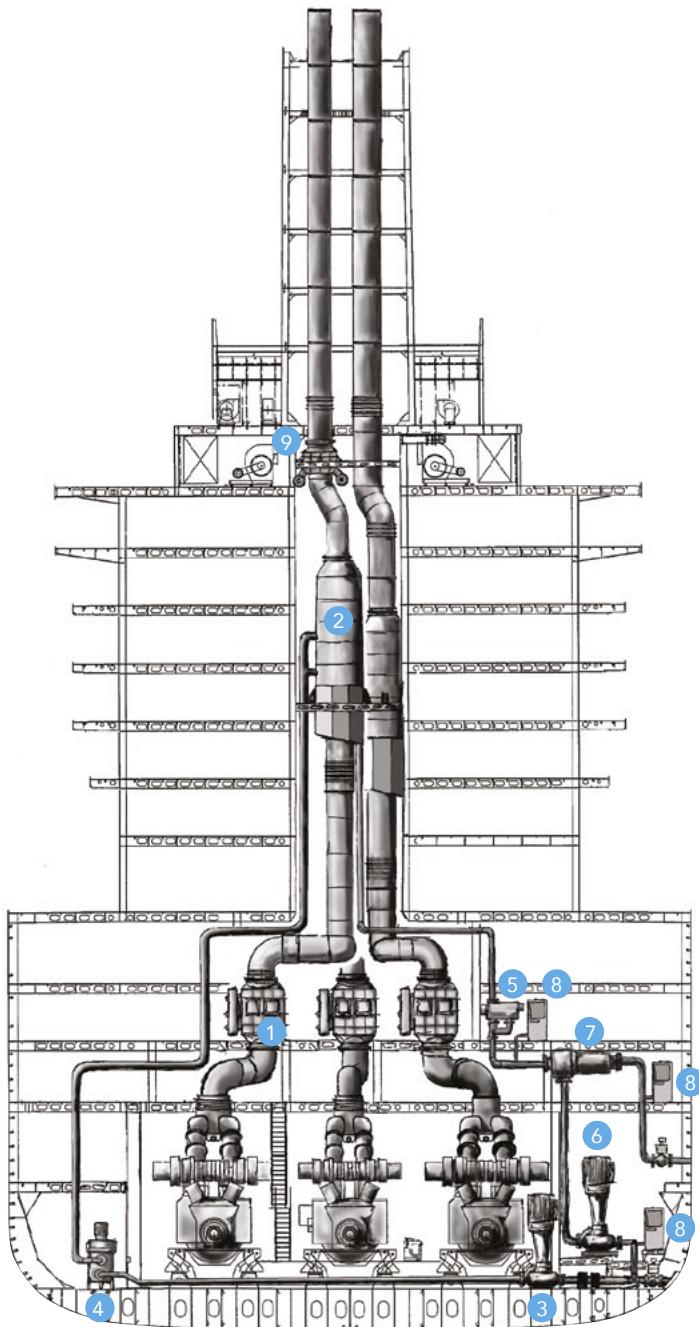
ECO-EGC™ OPEN LOOP SYSTEM

The ECO-EGC™ OPEN LOOP system uses only seawater to neutralize the SO₂ contained in the exhaust gas. The efficiency of the system always meets and even exceeds the IMO limits for both gas emissions and wash water quality, without limitations of sulfur content (up to 3.5%).

The inline DeSOx tower can operate either in wet or dry conditions. The OPEN LOOP system represents the most cost effective solution in terms of CAPEX and OPEX in order to meet with sulfur regulations using fuels different from the one in compliance.

As an option Ecospray can provide a unique and patented solution that consists of cleaning the gases from PM, soot and uncombusted HC with the ECO-CDF™ (Catalytic Dry Filter) or the ECO-DOC™ (Diesel Oxidation Catalyst).





EQUIPMENT:

1. CATALYTIC DRY FILTER /
DIESEL OXIDATION CATALYST
2. DeSOx TOWER
3. SEA WATER PUMP
4. SEA WATER FILTER
5. WASH WATER FILTER
6. BUFFERING PUMP
7. STATIC MIXER
8. WATER ANALYSIS RACK
9. PLUME REDUCER (OPTIONAL)



ECO-EGC™ HYBRID SYSTEM

The ECO-EGC™ HYBRID is a high performance solution purposely designed and applied in order to meet specific requirements in terms of wash water discharge, mainly in some port areas.

The ECO-EGC™ HYBRID system can operate in two different modes, either in the open loop or the closed loop mode.

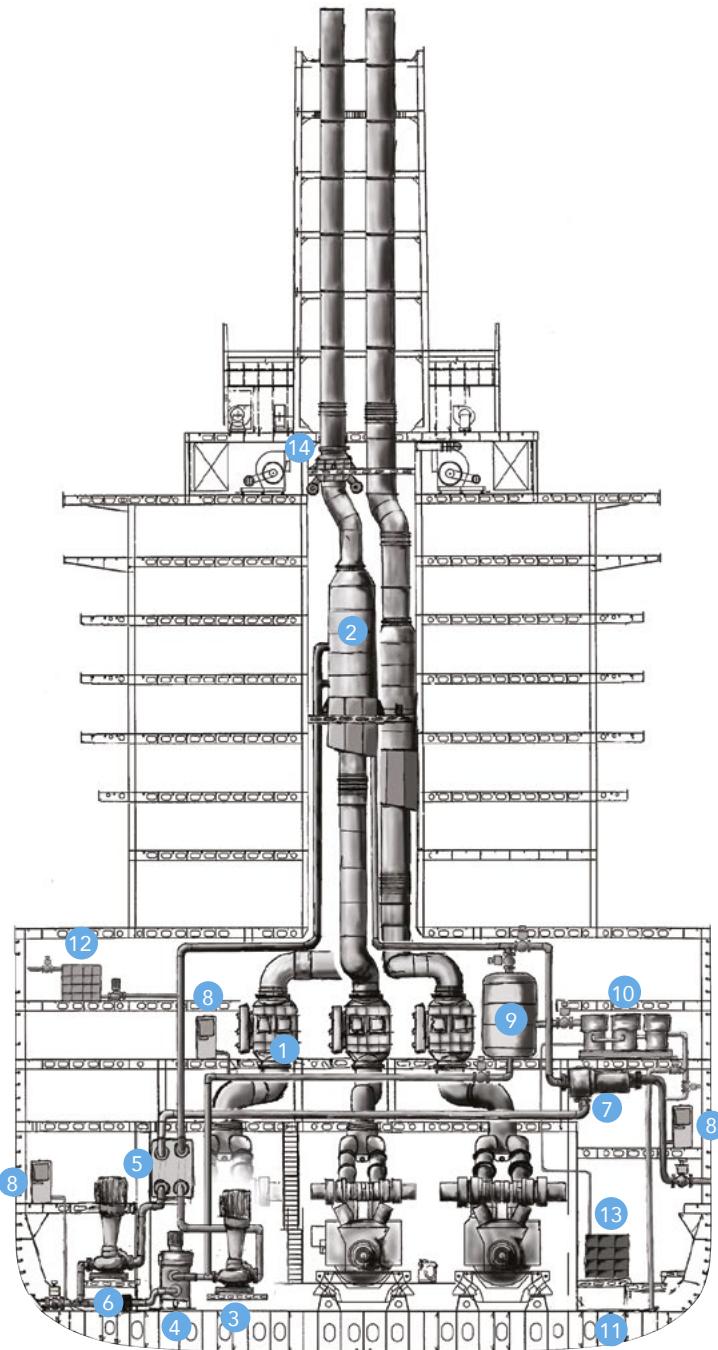
In the open loop version the SO₂ removal is controlled by sea water injection only, while in the closed loop one, the SO₂ removal is controlled by the addition of caustic reagent to the wash water.

The bleed off is sent to the water treatment system and then directly discharged overboard or sent to one integrated holding tank in case the "zero discharge" mode is required.

According to the holding tank volume, the system can operate in zero discharge mode even for a few days before releasing the collected blow down at a properly equipped port.

The wash water in the closed loop mode is cooled by a heat exchanger to minimize the steam white plume at the funnel.





EQUIPMENT:

1. CATALYTIC DRY FILTER /
DIESEL OXIDATION CATALYST
2. DeSOx TOWER
3. SEA WATER PUMP
4. SEA WATER FILTER
5. HEAT EXCHANGER
6. BUFFERING PUMP
7. STATIC MIXER
8. WATER ANALYSIS RACK
9. RECIRCULATION TANK
10. WATER TREATMENT SYSTEM
11. HOLDING TANK
12. CAUSTIC REAGENT TANK
13. SLUDGE TANK
14. PLUME REDUCER (OPTIONAL)

DeNOx SOLUTIONS FOR MARINE APPLICATIONS



Ecospray DeNOx systems for marine applications use SCR (Selective Catalytic Reduction) technology to remove nitrogen oxides from diesel engines exhaust gas and are designed to meet demanding IMO Tier III emission levels and more (up to 95% NOx reduction).

IMO Tier III levels are in force in NOx Emission Control Areas (called NECAs), currently in waters 200 nautical miles from the North American and US Caribbean shores. These areas are supposed to increase in the near future.

Ecospray is skilled in supplying not only the SCR system itself, but also in providing the shipyard or the owner with the EIAPP IMO Tier III certification of the whole engine plus the SCR working together with the primary Classification Societies leading the design, drawing approval and testing process up till the final certification.
Ecospray can pursue the approval path foreseen by the IMO Tier III rules i.e. as per Scheme A or Scheme B.



	SCHEME A	SCHEME B
APPLICABLE TO	ALL VESSELS	ALL VESSELS
BEST FOR	NEW SMALL / MEDIUM SIZE PROPULSION ENGINES NEW GENSETS	NEW BIG SIZE PROPULSION ENGINES PROPULSION ENGINES AND GENSETS UPGRADES FROM EPA/IMO TIER I/II TO IMO TIER III
TESTING TYPE	SINGLE STEP	DOUBLE STEP
TESTING LOCATION	ENGINE MAKER/CUSTOMER TEST BENCH (1:1 TESTING ENGINE+SCR)	1- SCALE TEST BENCH* 2- ON BOARD

*Available @ Ecospray premises, Alzano Scrivia (AL), Italy



ECO-NOx™ SCR FOR COMMERCIAL AND NAVY VESSELS

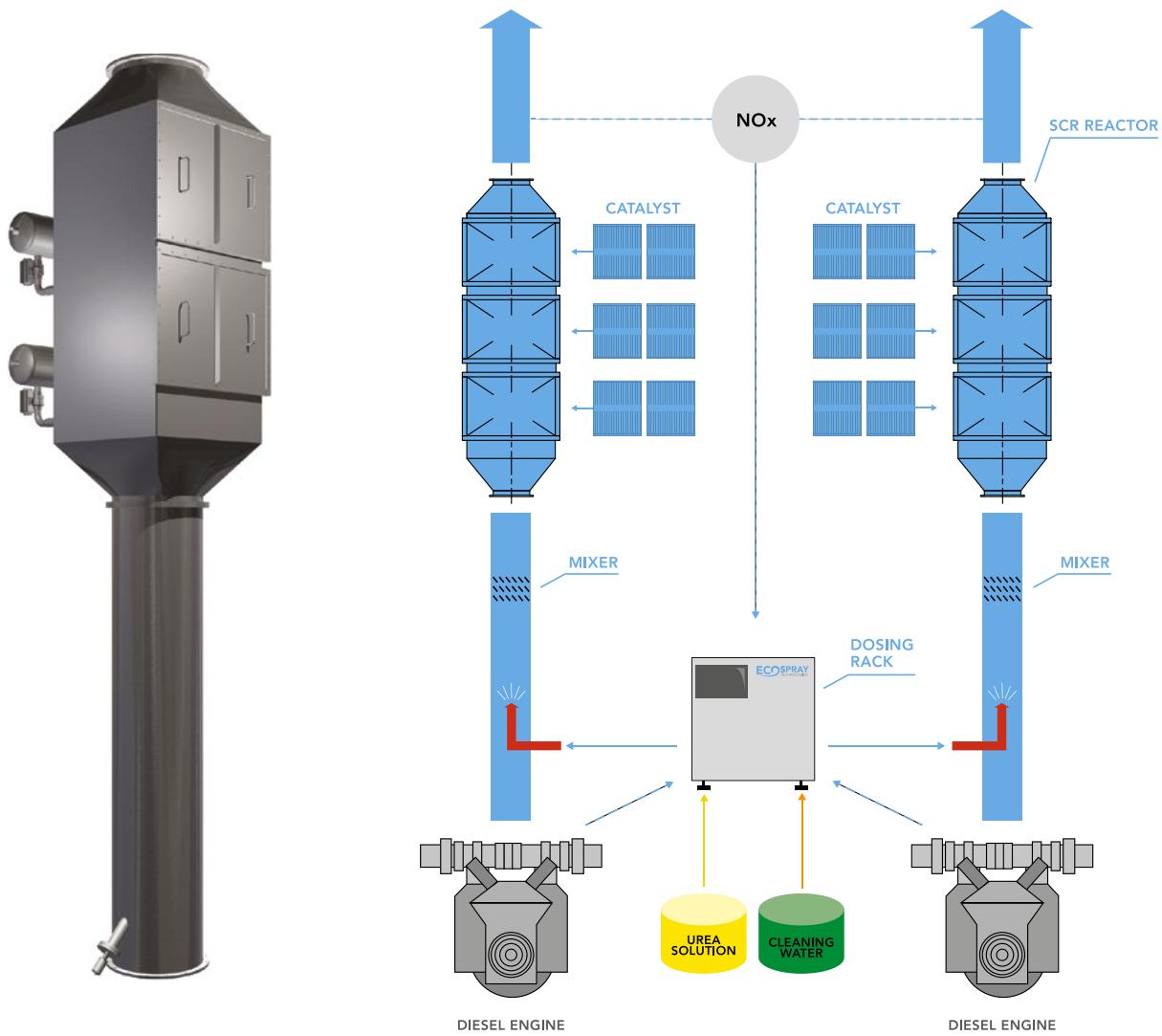
Typical application range: 1.6 MW – 16 MW, vertical and horizontal installation for propulsion engines and gensets.

The ECO-NOx™ SCR reduction process in marine applications begins by injecting urea solution (33% or 40%) before the SCR reactor into the gas flow.

The ECO-NOx™ uses proprietary self-cleaning urea spray nozzles to obtain a very fine spray that allows to achieve a most complete and uniform mixing between gas and urea.

The gas and reagent mix passes through a variable number of catalyst layers, as is appropriate for the required emission level. Ecospray has developed customized solutions with or without bypass, to adjust the level of emissions to the sailing areas (NECAs or others), and shock proof applications for navy vessels, where required.

ECO-NOx™ SCR FOR MARINE APPLICATIONS



ECO-NOx™ SCR TYPICAL LAYOUT

The layout can be customized according to the space restriction requirements.



ECO-NOx™ SCR FOR YACHTS

Typical application range: 150 KW – 4.3 MW, horizontal installation for propulsion engines and gensets.

Ecospray has developed a dedicated series of compact DeNOx SCRs to meet the IMO Tier III requirements and the limited and valuable space onboard.

The function of the silencer has been integrated as well to save additional space. Typical pressure drop 20 - 25 mbar.

These solutions aim to achieve environmental compliance with IMO Tier III, mandatory in NECA's for all > 24 m and > 500 GRT with keel-laying on or after 1st of January 2016 with engine output > 130 kW, and to support shipyards to be ready for the IMO Tier III requirements for all yachts > 24 m with keel-laying on or after the 1st of January 2021.

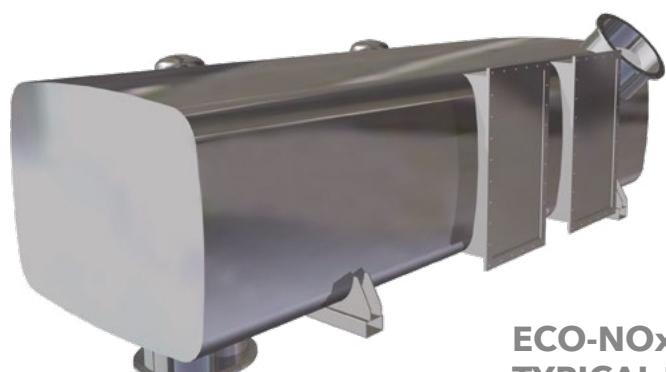
The function of the silencer has been integrated as well to save additional space. Typical pressure drop 20 - 25 mbar.



As a further enhancement, ECO-NOx™ SCR can embed also the particulate and soot removal function through the use of a patented CDF (Catalytic Dry Filter).

Such version, the ECO-TRIO™ DeNOx PLUS, provides:

- NOx removal within TIER III limits (if required, NOx removal over 95%)
- PM and soot removal > 95%
- Typical noise attenuation from 30 to 40 dB
- Reduction of PAH and heavy metals up to 95%
- Odor control
- No visible smoke at the funnel.



**ECO-NOx™ SCR
TYPICAL LAYOUT**

OUR

ACTIVITIES

- RESEARCH & DEVELOPMENT
- ENGINEERING
- PRODUCTION
- INSTALLATION SUPERVISION
- COMMISSIONING
- AFTER SALES SUPPORT
- TRAINING

Ecospray specializes in research & development, design and realization of innovative technologies for gas cleaning and/or gas cooling in diverse industrial processes other than marine applications. Ecospray solutions allow to meet emission regulations cost effectively while sustaining or enhancing operating efficiencies.



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TECHNOLOGIES

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