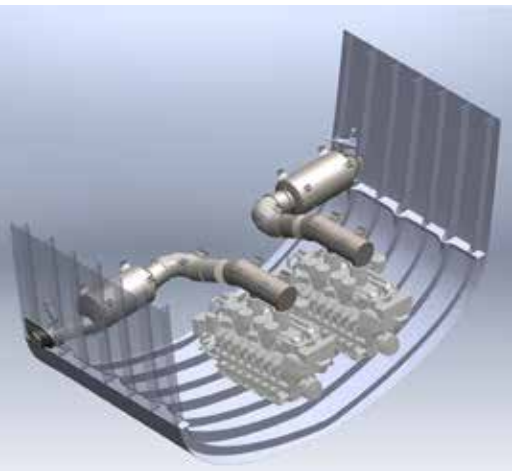
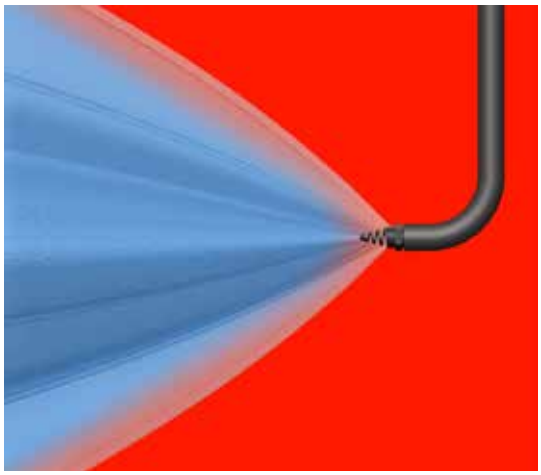
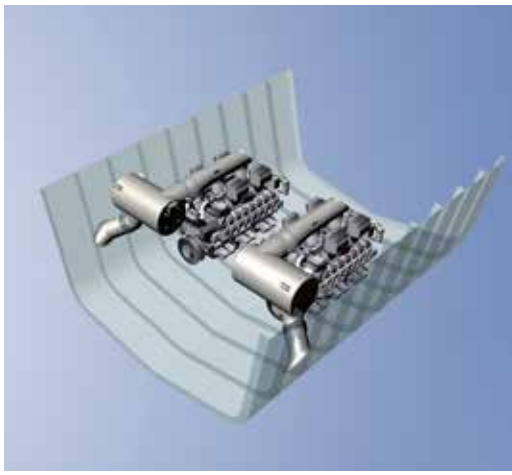
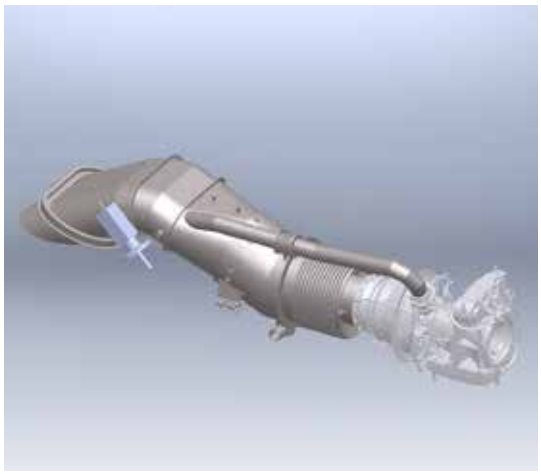
mecmar

complete exhaust gas systems for marine diesel engines and gas turbines






Mecmar AS®
Mechanical and
marine engineering

A Pioneer of Engineering

"Mecmar delivers groundbreaking engineering solutions, based on known scientific principles, in the marine diesel engine exhaust gas management field."

Mecmar develops and delivers solutions reflecting the combinations of maritime tradition, modern technology, superior workmanship and environmental sensibility.

The company principle to take on the challenge of being first in engineering solution applications in our selected field has placed Mecmar at the forefront of stealth solutions in naval vessels and in pollution reduction in all maritime applications through Exhaust Gas Treatment after combustion.

To retain the winning edge in Marine Exhaust Systems the highly skilled staff of Mecmar typically covers the following disciplines from design to final delivery:

- Mechanical Engineering
- Marine Engineering
- Naval Architecture
- Project Management
- Logistics Engineering and
- Quality Management

Documentation and Quality Management

"Mecmar is committed to achieve product delivery through a structured, auditable process. This approach ensures design and production-traceability, complete with well documented installation, commissioning and through life support data."

Mecmar conforms to ISO 9001

Depending on customer requirement Mecmar can deliver the following documentation:

- Computational Fluid Dyamics (CFD) analysis
- Back Pressure analysis
- Shock and Vibration analysis
- Weight data
- Attenuation Calculations
- Installation Documentation
- Commissioning Procedures
- Drawings and Parts Lists
- Installation Checkout procedures

Innovative Technology – Optimal Performance

"Mecmar is focused on long term performance in the marine market sector through reliable, state of the art yet simple and practical exhaust system designs with maximum benefits to the client."

Mecmar`s strategy is to offer the Marine market complete exhaust gas systems based on well known principles proven on smaller vessels and pleasure crafts. Experience has shown that these systems could be scaled, adapted and developed to match the power range and operational conditions applicable to commercial and naval vessels.

Our exhaust system technology growth and increasing demand for new deliveries bears testimony to the success of this approach.

Furthermore, we provide our customers with:

- Quality engineering activities based on cut ting edge technology.
- Products and systems displaying quality workmanship to the highest standard.
- Delivery of reliable and cost effective solutions.
- Interactive co-operation to ensure a full understanding of the requirements to shape the solution.
- A full range of support during installation, commissioning and testing where required.
- Complete in-service engineering support to build lasting partnerships in order to main tain our fielded systems.

Continued Growth – Research and Development

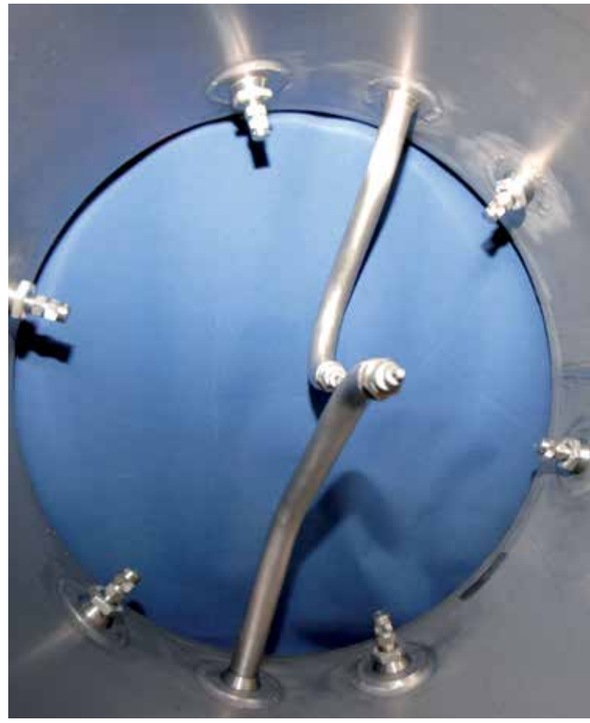
"Mecmar's growth is vested in continued investment in product development to track emerging technologies in pace with client and statutory demand."

In the quest for pioneering solutions based on proven applied technologies Mecmar invested in a development test installation.

Our test stand is fully calibrated and is used for developing Mecmar exhaust gas system technology. The test stand consists of a 735 kW engine installation. The engine has a hydraulic brake to dissipate the engine power and purpose built exhaust gas systems can be fitted for test and qualification purposes.

The installation is used to verify new product concepts such as Nitrous Oxide (NOx)-, Sulphur Oxide (SOx)-, particle- and noisereduction.

The latest development project involves direct injection of ammonia into the exhaust gas stream to refine the Selective Catalytic Reduction (SCR) application in Marine Diesel Exhaust Systems.



Customised Solutions

Mecmar supplies complete customized exhaust gas systems optimally designed for specific engine installations in each vessel

Since 1994, the Company has delivered more than 500 systems world-wide for various types of vessels such as high speed catamarans, monohull vessels, car ferries and offshore petroleum installations as well as naval vessels.

Exhaust Gas Systems for Marine Diesel Engines and Marine Gas Turbines

Mecmar will produce an exhaust system to suit the client's requirements. Initially the systems used a unique solution to inject sea water into the exhaust gas stream. The technology and material selection incorporated in the solution were developed and refined to meet the extremely challenging environment of heat, salt, corrosive exhaust gas products and the limited space onboard most vessels to integrate bulky exhaust systems.
The Marine Industry, with all types of vessels it employs, is a significant contributor to environmental pollution. Essentially the engine manufacturers have economically optimised the ability to burn fuel more efficiently and cleaner.

Ever increasing limits on exhaust pollutants is driving the Marine Industry in the same direction as it did the road vehicle industry, i.e. the use of post combustion treatment of the exhaust gas to meet the requirements for a cleaner environment.

During the last decade developments in energy conservation, increased sensitivity to, and subsequent legislation in terms of carbon footprints and pollution constraints, provided ever increasing challenges to engineers and industrial developments.
True to the pioneering spirit of Mecmar, new ways of improving the benefits of the proven Sea Water injection Exhaust Systems in Marine Applications are constantly sought.

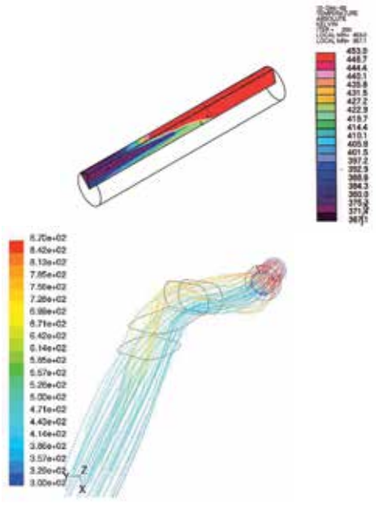
To this end the Mecmar Exhaust System solutions now incorporate the following options:

- Standard Sea Water Injection.
- Integrated Selective Catalytic Reduction with the standard system.
- Integrated Exhaust Gas Economisers with either or both the previous two options.

The Benefits of Sea Water Injection

The basic exhaust gas systems supplied by Mecmar are characterised by injection of sea water into the exhaust gas. Seawater is used to cool the exhaust gas, for reducing emission of harmful components to the atmosphere and to increase safety onboard the vessels. Further, as a consequence of cooling the exhaust gas, the volume of the exhaust gas to be handled is considerably reduced, and hence the systems are more compact and lighter when compared to conventional exhaust gas systems.

In the military application it also enhances the stealth characteristics of the vessel.



Pollutant Emission Reduction

Although not the only means to do so, introducing sea water into the exhaust stream reduces air pollution to a fractional component of that from conventional dry exhaust gas emissions.

Measurements performed and observations made on in service exhaust gas systems delivered by Mecmar indicate typically the following reduction emission to the atmosphere through water injection alone:

• Sulphur Oxides (Sox)	90-95 %
• Aldehydes	60-70 %
• Aromatic Hydrocarbons	30-50 %
• Nitrous Oxides (NOx)	6-10 %
• Particles	considerable

Safety

Low surface temperature in the exhaust gas system has removed a possible ignition source in case of an oil or fuel leakage, and hence the danger of fire and explosion is reduced. In addition, crew safety is enhanced due to more benign surface temperatures in the engine room area.

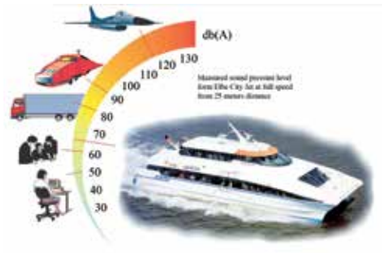
System Integration

The cooled Exhaust Gas has a significantly lower volume compared to conventional dry systems. The nett effect is that the piping systems and other components downstream from the seawater injection point is more compact and light, with a commensurate space, weight and cost saving to the shipbuilder.

The Mecmar systems are also characterised by the fact that the outlets are above or below the waterline through the ship's side or transom. This feature removes the need for space hungry exhaust trunking through the superstructure, freeing up internal space in the vessel and allowing superior all round visibility from the bridge and command positions.

Installation

Mecmar supplies the systems complete and ready for installation with all the necessary components. The high degree of completion leads to shorter installation time and better installation economy for the shipbuilder. Furthermore, the low weight of components leads to easier transportation and handling during installation.



Material Selection

In the hot area of the exhaust system before sea water injection Stainless Steel Alloys are used.

Due to its excellent corrosion resistance, low weight, high elasticity and good fatigue strength a titanium alloy is used in the sea water cooled parts of the exhaust gas system. The use of materials with good fatigue and anticorrosion

properties ensures that the lifetime of a Mecmar system exceeds a conventional full temperature system.

Exhaust gas system for marine diesel and gas turbines

Marine Diesel Engine Installations

A typical exhaust gas system delivered by Mecmar for a Diesel Engine Installation comprises the following main assemblies:

- Primary Silencer and Inlet Pipes
- Seawater Supply System and Pump
- Sea Water Injectors, Primary and Secondary
- Main Silencer
- Outlet Pipes
- Drainage System
- Flexible Bulkhead and Hull Penetrators
- Compensators
- Flexible Supporting Elements
- Temperature and Pressure Sensors
- Control and Monitoring System
- Reduction Agent Injection System (optional)
- SCR Unit (optional)
- Integrated SCR Control System (optional)
- Economiser or Waste Heat Boiler (optional)

The exhaust gas is led from each turbo charger through insulated inlet pipes to the primary silencer designed as a single chamber reflection muffler. In this part of the system, the exhaust gas is at high temperature. Where the SCR option is included the SCR Reactor replaces the primary silencer.

Downstream from the primary silencer, in the primary injector, sea water is injected through several nozzles into the exhaust gas, and the exhaust gas is quenched to approximately 60°C.

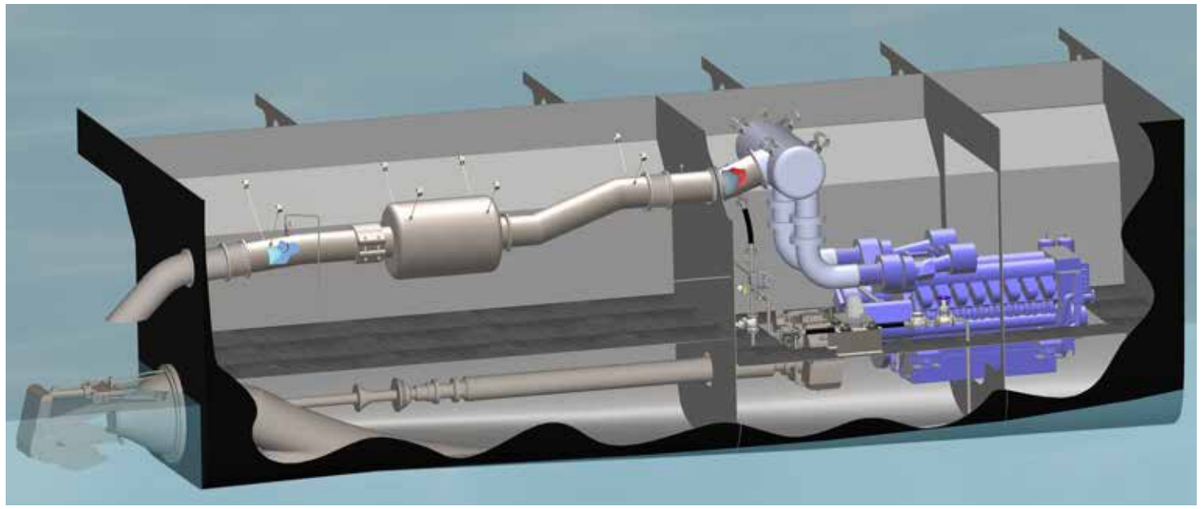
The main silencer attenuates the acoustic noise and leads the cooled exhaust gas from the primary injector to the outlet pipes. A secondary injector is normally installed downstream of the main silencer for the final cooling stage and to scrub particles from the exhaust gas.

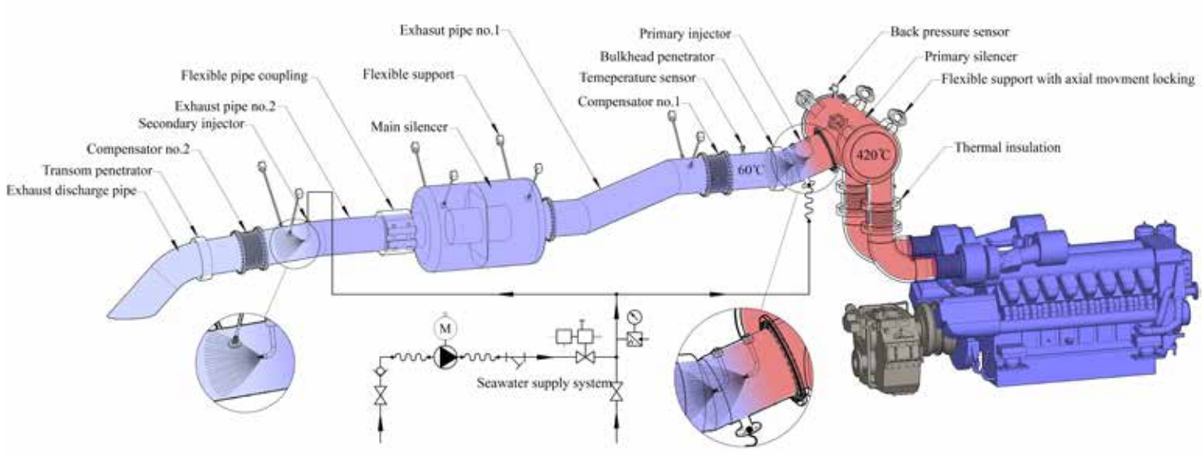
Residual water droplets that are not entrained in the exhaust gas through the main silencer are collected and the surplus water is drained and lead overboard by the exhaust piping.

Downstream from the main silencer the exhaust gas is routed overboard through the outlet pipe either to the ships side or through a transom outlet, depending on the engine configuration.

Where the SCR option is selected by the client, the SCR Reactor acts as a primary silencer as well as facilitating the catalytic reaction and is incorporated in the exhaust line before the Main Silencer. With this option there will be a reducing agent injection and mixing device included between the Engine manifold and the SCR Reactor.

Where the Waste Heat Boiler is selected it is integrated into the hot section of the line to maximize the benefit. The boiler has a cooling effect on the gas and therefore reduces the amount of heat to be extracted by the sea water injection process.





Gas Turbine Installations

As for the Diesel Engines, the sea water injection principle is equally applicable to Gas Turbine installations and Mecmar has successfully delivered exhaust systems for the luxury motor yacht market as well as for the military market.

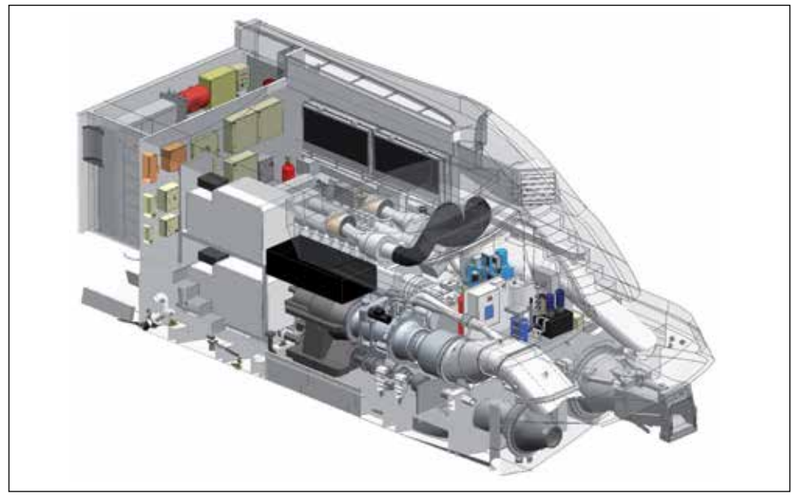
Seawater may be injected immediately downstream from the diffuser/compensator outlet of the Gas Turbine. Performance results achieved to date are similar to that of the Diesel Engine installations.

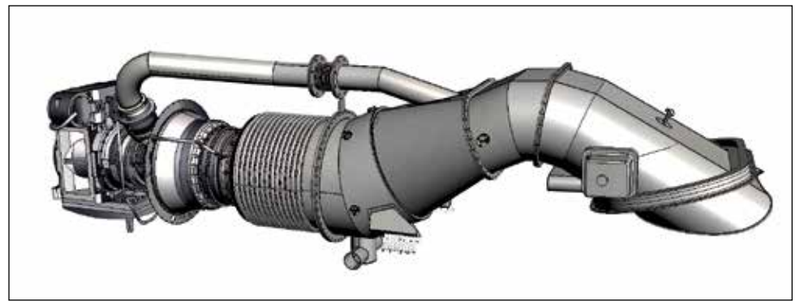
The control and monitoring principles are similar and the same logic is used in the Gas Turbine applications.

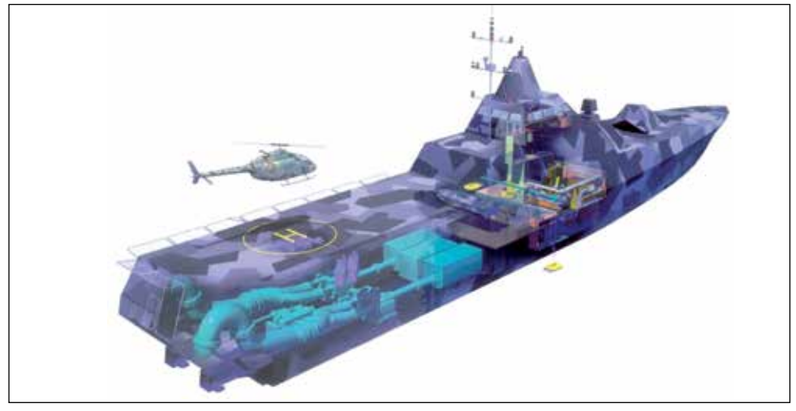
The system also uses two-stage injection. The main difference in the Gas Turbine application is the absence of the silencers, otherwise the mountings, exhaust pipes and ancillary equipmentare of the same type.

The functional and system description is therefore the same for the Diesel Engine and Gas Turbine application. Due to the power of the Gas Turbine installation the volume of exhaust gas and therefore the volume of water injected obviously varies and the pumps, piping and size of exhaust piping and ducting is much larger in order to handle the respective volume flows.

The SCR technology and waste heat boiler options have not yet been incorporated into the Gas Turbine exhaust system solutions.







Development Drivers

The intension with nitrous oxide (NOx) reduction in Marine combustion engine exhaust gas is to achieve a better environment; we therefore strive to remove all the NOx from the exhaust gas.

The following are a few of the detrimental effects of NOx in the atmosphere:

• It has proven direct and indirect effects on the environment and health.

• NOx is a part of the process of acid rain formation and leads to over-fertilization of lakes and soil.

• In the presence of unburned hydrocarbons and sunlight, NOx participates in the formation of photochemical smog and ozone.

Although there are other sources that produce NOx, the contribution from shipping to these emissions is significantly high.

To improve the Maritime profile in the global onslaught on pollution the International Maritime Organisation (IMO) decided as far back as 1997 to aim at reducing ship emissions of NOx world-wide by 30%. In order to realize the aim IMO demands against NOx reduction has been stepped up and is increasing. We are currently at a stage where the economical viability of improving on the engine and fuel side has been exhausted and the time where compliance with IMO NOx regulations will be impossible without any additional post combustion process or treatment of the exhaust gas.

Current Status

There are several methods utilised to reduce NOx emissions, typically:

• Adapting Operational Procedures.

• Optimising vessel design to minimise power requirements.

• Optimising engine design for clean burning and better specific fuel consumption.

• Exhaust gas cleaning through some form of after treatment.

• Sea water injection into the exhaust gas.

• Installation of selective catalytic converters in the exhaust line.

• Using alternative fuels.

• Using fuel additives to improve combustion efficiency.

Aligned with the company core business of designing and delivering customised and specialised exhaust systems to the marine industry, Mecmar chose to support the industry in their quest to comply with the regulations. To contribute to a better, cleaner and healthier environment, the existing designs were adapted by incorporating the SCR process to further improve the system efficiency in pollutant removal; specifically the NOx components. The following environmental benefits and emission reduction performance figures are achievable with a SCR System:

• NOx Reduction	80 – 98 %
• Hydro Carbon Reduction	80 – 90 %
• Soot Reduction	20 – 30 %
• Sound Attenuation	20 – 35 dB(A)

SCR Process Application

One method to reduce the NOx emission is to let the Nitrous Oxide react with Ammonia (NH3) as a reducing agent. In this way the NOx is transformed to Nitrogen Gas and Water Vapour. The following two are the governing reduction equations for the process:

• $4NH3 + 4NO + O2 \rightarrow 4N2 + 6H2O$
• $4NH3 + 2NO + 2NO2 \rightarrow 4N2 + 6H2O$

The components will normally only react at temperatures above 900°C; however, reaction can also be achieved at a much reduced exhaust gas temperature of about 280°C when using a catalyst.

To accelerate the reaction with a catalyst the exhaust gas is mixed with ammonia gas. The mixture is then passed over a honeycomb structure containing Vanadium Penta-Oxide as a catalyst. The catalytic structure is contained in the SCR Reactor where the Ammonia and the NOx in the exhaust gas will react and then create Nitrogen and Water Vapour.

Reducing Agent Alternatives

As illustrated before, Ammonia is the required reducing agent in the governing equations. In an exhaust system with an integrated SCR–system there are two options to obtain the Ammonia:

• From Urea or Carbamide which is commercially produced from ammonia and carbon dioxide. Urea is normally delivered in aqueous solution for use in SCR systems.

•It can be supplied in fluid form delivered in pressure containers, similar to LPG and used in a direct injection process.

Regardless of which option is used, either Urea or pure Ammonia, it is the Ammonia in gaseous form which is required to benefit from the catalyst. In the case of Urea there therefore has to be a two stage reaction, first to free the Ammonia out of the Urea and then to combine the Ammonia with the NOx in the SCR reactor to achieve the reduction

Direct Ammonia Injection

The global objective to achieve a greener environment has also focused on the effects that fossil fuel burning installations, and therefore internal combustion engines, have on this environment.

Applying Selective Catalytic Reduction (SCR) technology in the exhaust systems associated with internal combustion engines is a positive step in reducing their carbon footprint. The SCR unit requires ammonia for the reduction process.

The more common SCR systems used onboard ships use liquid urea as the injected agent. The required ammonia is then extracted before reaching the SCR unit. This system carries a penalty in that;

- A large urea storage tank is required; and
- The ammonia extraction requires a length of exhaust line after injection and before the SCR unit to allow the chemical reaction to take place in the presence of exhaust gas temperature.

There are many benefits associated with injecting ammonia directly into the exhaust gas. However, the most important one is the fact that this installation does not have such a space and weight impact as the urea injection system.

A space and weight constraint is the single most important aspect that opens up the SCR application regime to include the many smaller vessels in the shipping and marine industry that significantly contributes to the fuel based sources of NOx emissions.

On smaller vessels such as fast passenger ferries, the weight is critical and also the space is much more limited, making this the only feasible solution for SCR technology application.

The Mecmar direct ammonia injection system has essentially the same components as the typical urea injection system, but with the main difference of having no need for a urea storage tank and a simpler injection and control system that allows a more compact design.

Mecmar recognized the fact that ammonia is an unpleasant and aggressive gas when inhaled. Human safety therefore has to play a more important role when using pure ammonia in the system, specifically on passenger ferries where free ammonia can cause panic and further complicate an emergency situation.

The Mecmar design has therefore been focused on minimizing the probability of encountering free ammonia inside the vessel.

The ammonia bottles are stored astern the vessel, in a trunk into which a dedicated ammonia bottle module can be lowered. The stern trunk is well removed from the passenger area and all distribution lines between the external storage and the exhaust system is contained in a gas tight cofferdam arrangement that is monitored for ammonia leakage.

The design of the trunk isolates it from the deck area. At deck level the trunk is sealed off by means of a Butterworth hatch. At the base the trunk is vented to sea via a pressure relief valve. Any free ammonia, in the unlikely event of a leak, will therefore be vented below sea level where it can rapidly be diluted and dispersed.

The ammonia container uses a standardised design. The standard modular design will, however be vessel specific. The bottle volume, and hence the module size, is based on the operational profile that determines the required volume of ammonia needed for the route.

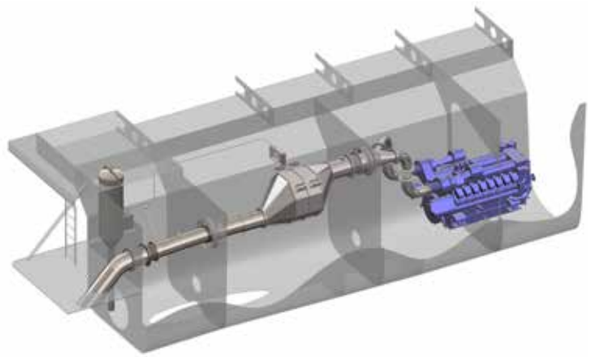
For easy handling and installation, the ammonia module is cylindrical and independent of angular orientation inside the trunk. It gets connected to the distribution piping system onboard by means of a leak-free instantaneous coupling at the base of the module. The receptacle part of the coupling station is situated at the base of the trunk. The coupling happens automatically under gravity when the module is lowered and locked into place. When the module is locked in position, the seal will be leak tested prior to opening the ammonia bottle to allow flow into the piping system.

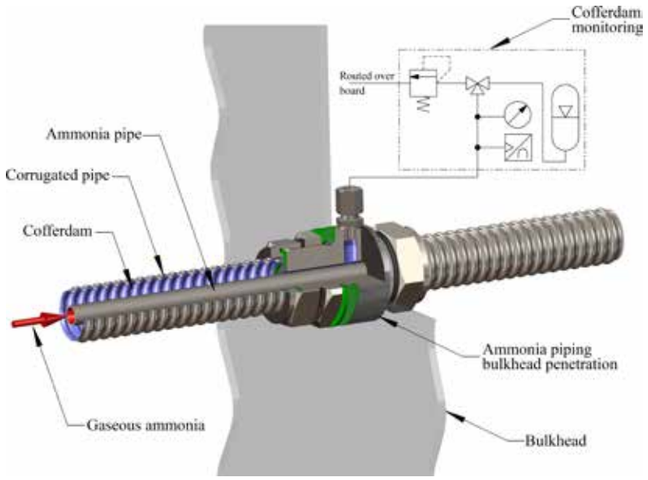
The system can be scaled up and may also be installed on larger vessels where the space and weight is critical or sensitive.

The main components are the same as for the systems already described, with the absence of the Urea storage tank, but including the following:

• Ammonia Bottle(s) Module(s)
• Ammonia Module Trunk

Mecmar fully subscribes to this application and believes that it will become the system of choice to supply the Ammonia required by the SCR process as applied to Marine Systems.



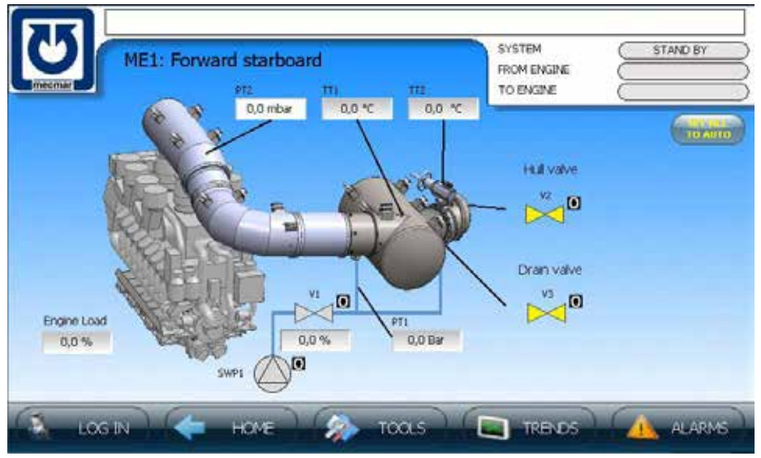


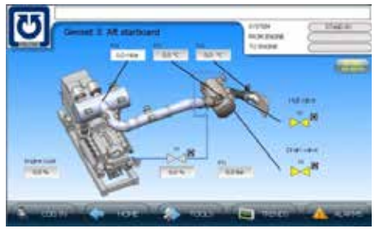
Control system

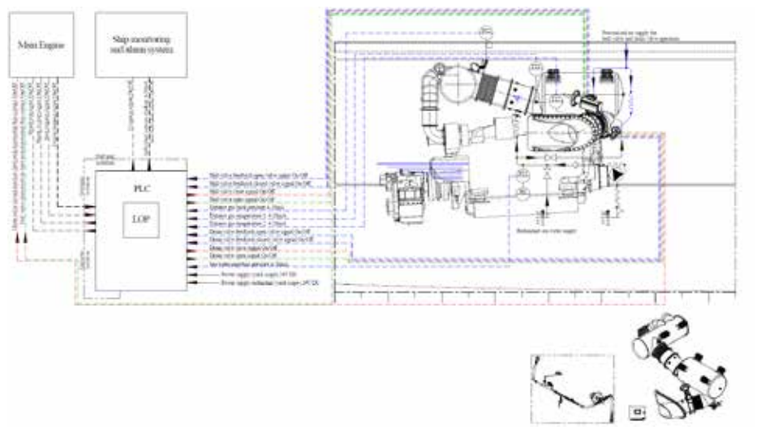
The control system delivered by Mecmar is custom made to suit each system requirement. It consists of a termination cabinet in which all the programmable logic controllers (PLC) are housed with the local operating panel (LOP) fitted in the front door of this cabinet. The communication between the Mecmar control system and the ships operating system (SMS) may be based on hardwired interfaces, or other standard communication protocols.

The control and monitoring systems perform the following functions:

- Monitoring of exhaust gas temperature.
- Monitoring of seawater pressure.
- Monitoring exhaust gas back pressure.
- Operation of the seawater supply system consisting of:
- Seawater pump.
- Seawater injection valve.
- Operation of hull valve and drain valve.
- Alarm handling.







Cap

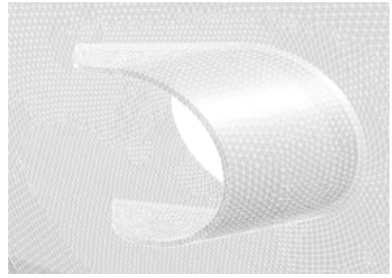
In order to reduce the total back pressure in the exhaust gas system during normal operation, cap is installed on the underwater exhaust gas system outlet.

This component is a fairing device for protecting the exhaust gas discharge outlet to be influenced by sea slamming towards the ship´s side during operation. While the vessel is sailing, the sea water flows around the cup which influences on total back pressure reduction.

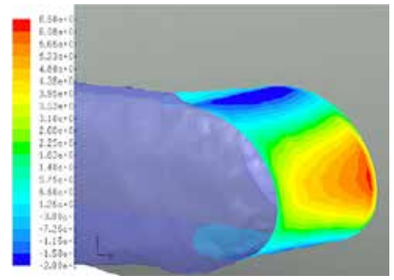
The cap is bolted to the ship´s side onto a dedicated flange surface which is an integral part of the lower hull penetration. This component is manufactured in Polyurethane Shore 90 A. The design of the cap is rugged yet flexible and capable of withstanding extreme deflection without being damaged.

Back Pressure and acoustics

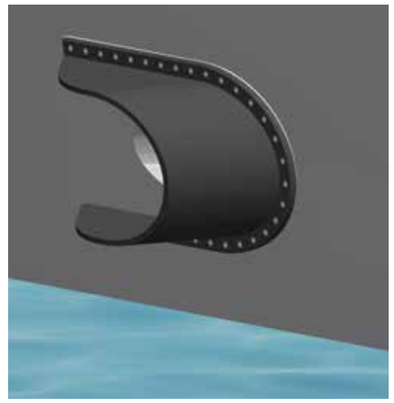
For all exhaust system, a compromise between size and backpressure is necessary. Furthermore, the engine room makes constraints on the exhaust system design. Mecmar uses seawater injection to minimize system size, while at the same time maintaining a low total backpressure for the engines. For engine room requiring no-standard exhaust system layouts; Mecmar employs CFD and acoustics analysis to verify that the design meets requested performance.



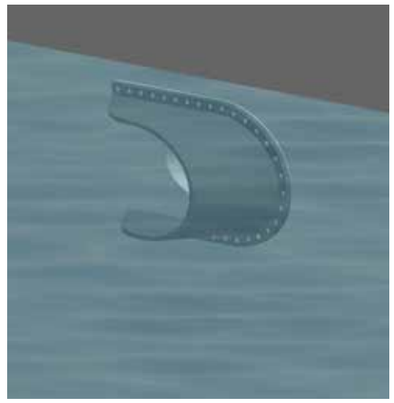
Surface mesh on hull/cap



Pressure contours on cap exterior surfaces

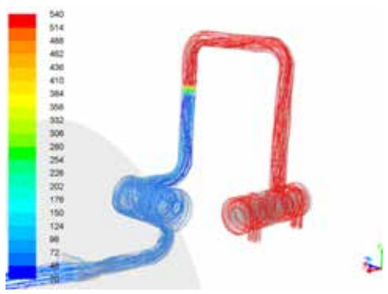


3D model of cap installed above waterline on a ship´s side



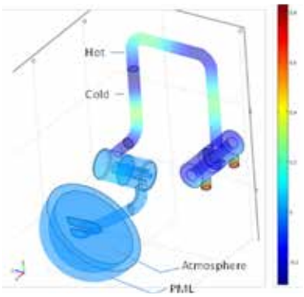
3D model of cap installed below waterline on a ship´s side

Photo of caps installed on a ship´s side



Flow pathlines through the exhaust gas system and colored by temperature

3D Model of complete exhaust gas system



Representation of exhaust gas systems for acoustics analysis. Volumes with different acoustic properties are indicated

As a family-run company we develop, manufacture and market state-of-the-art industrial valves. We have established an impressive track record with products deployed in the area of water treatment, power plant technology, chemical industry, shipbuilding, seawater desalination, solids handling and renewable energies. With more than 1000 employees worldwide, we are committed not only to producing standardized butterfly valves but also to delivering tailor-made solutions for highly sensible operations. This is why we find it difficult to forget our passion - even not at work.

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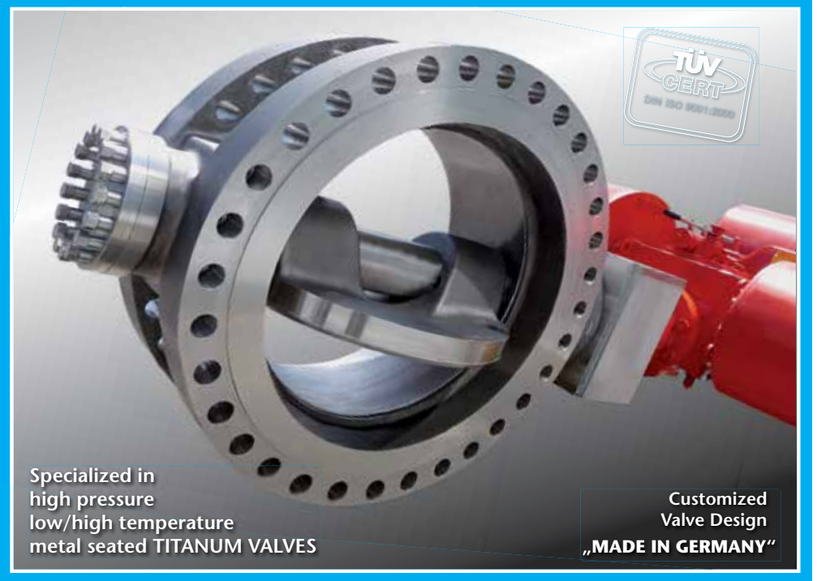

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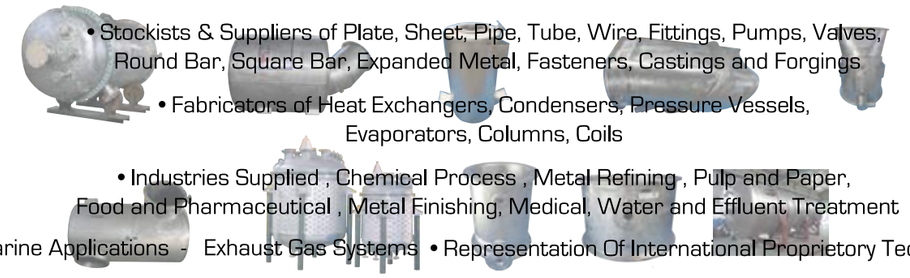

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Why Cable Mounts?

- No ageing
- Corrosion resistant
- High inherent damping *)
- Very low amplification at resonances *)
- Ability to absorbing and isolating very large shock energies
- Wide temperature range (-180°C to +300°C)
- Maintenance-free

*) The high inherent damping occurs as the strands of the wire rope make frictional resistance at vibration, creating thermal energy, which again induces inherent damping. Typical values for inherent damping in cable mounts (wire rope isolators) are 12 – 25% whilst the values are typical 3 – 5% for isolators with element made by natural rubber. Since the inherent damping is such significant in the wire rope the amplification at resonances becomes low, typical 2 – 4 times for cable mounts, compared with 12 – 15 times for isolators with natural rubber element. DNV, as an example, requires amplification below 10 times at resonances (sometimes less than 5 times is required) when accomplishing vibration testing. This requirement will normally not be met when using rubber isolators. On the other hand the requirement will be highly fulfilled if cable mounts are selected for the suspension. DNV has no demands on the degree of isolation. It is a fact that isolators with low inherent damping (which consequently means high amplification at resonance) have an improved degree of isolation (concerns frequency higher than the resonance frequency multiplied by 21/2 – relates to vibration theory) compared with isolators with high inherent damping. However, the most important is the amplification at resonances, i.e, it should be as minimal as possible.

www.vibratec.no

Vibratec akustikprodukter

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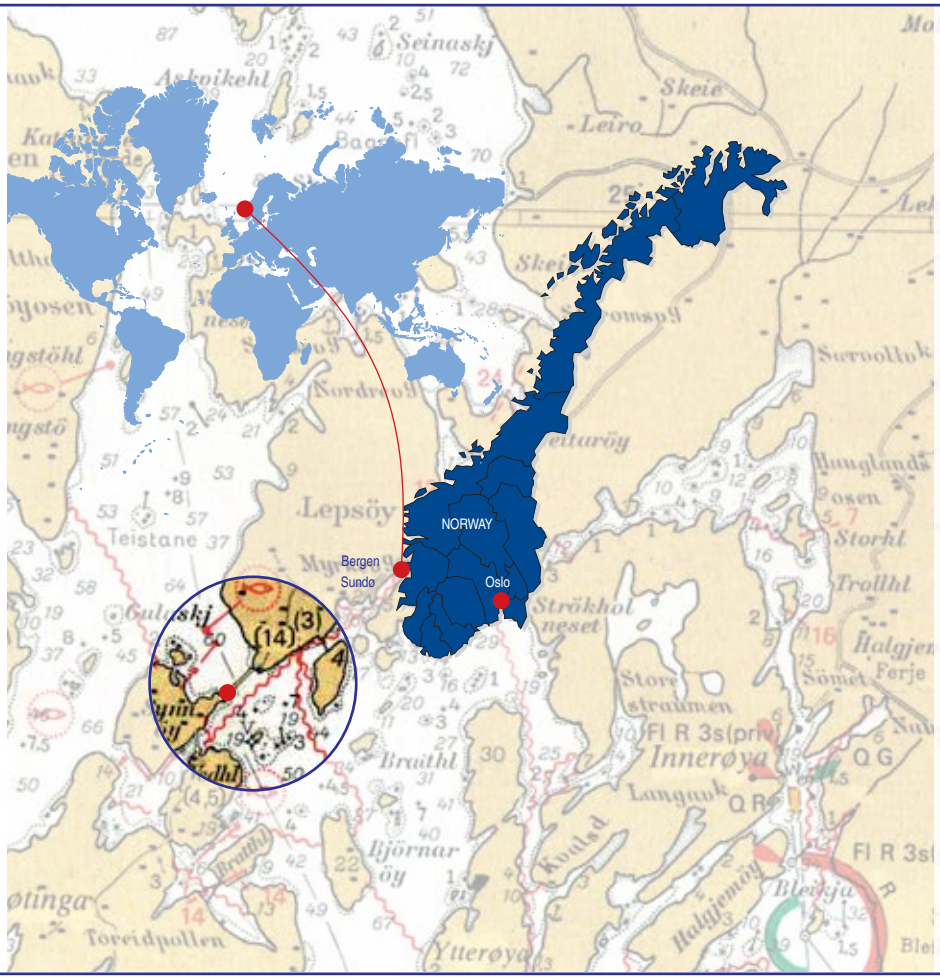

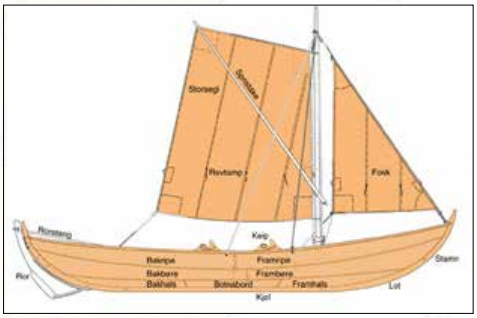

This type of boat has been very common in the outer regions of Hordaland for hundreds of years. It was named after the major important building site for this type of boat during the 18th century, at the mouth of the Oselva River in Os in Hordaland county. In the early 1800s, boat building was an important industry in Os and the neighboring village of Tysnes, on the other side of the fjord. The stylized figure of an Oselvar appears on the coat of arms of the municipality of Os.

Today several clubs and sailing associations are engaged in promoting the traditions of the Oselvar, both as a sports and leisure boat. In 2009, the boat was voted Norwegian national boat in a poll held by the Norwegian Society for Sea Rescue.

Location

Inspired by the beautiful coastal landscape of our location, obligated to the heritage of maritime tradition ande generations experience earning a living from the sea, Mecmar AS shall deliver to the market products and solutions reflecting combinations of tradition, knowledge of modern technology, superior workmanship, reliability and environmental sensitivity.

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