Eminox

Eminox Marine Emissions White Paper:

The global shipping industry, emissions regulations, and the technology that tackles the challenges of compliance

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In this whitepaper, Dr. David Phillips, Engineering Director, Eminox establishes what emissions regulation compliance looks like, explores the challenges faced by the shipping industry and offers guidance on how to transition towards the global emissions reduction target.

1. Introduction

With over 90% of world trade transported by sea, it is not surprising that the emissions generated by the shipping industry makes it one of the world's largest producers of greenhouse gases (GHG).

Quite unique when it comes to emissions regulations, the marine industry has multiple organisations that regulate those emissions. The International Maritime Organisation (IMO) is perhaps the most well-known, however the European Union (EU) and US Environmental Protection Agency (EPA) amongst others, all have different legislative requirements.

The fragmented nature of the global legislative requirements surrounding emissions in the marine industry does bring about a set of challenges that can be hard to decipher.

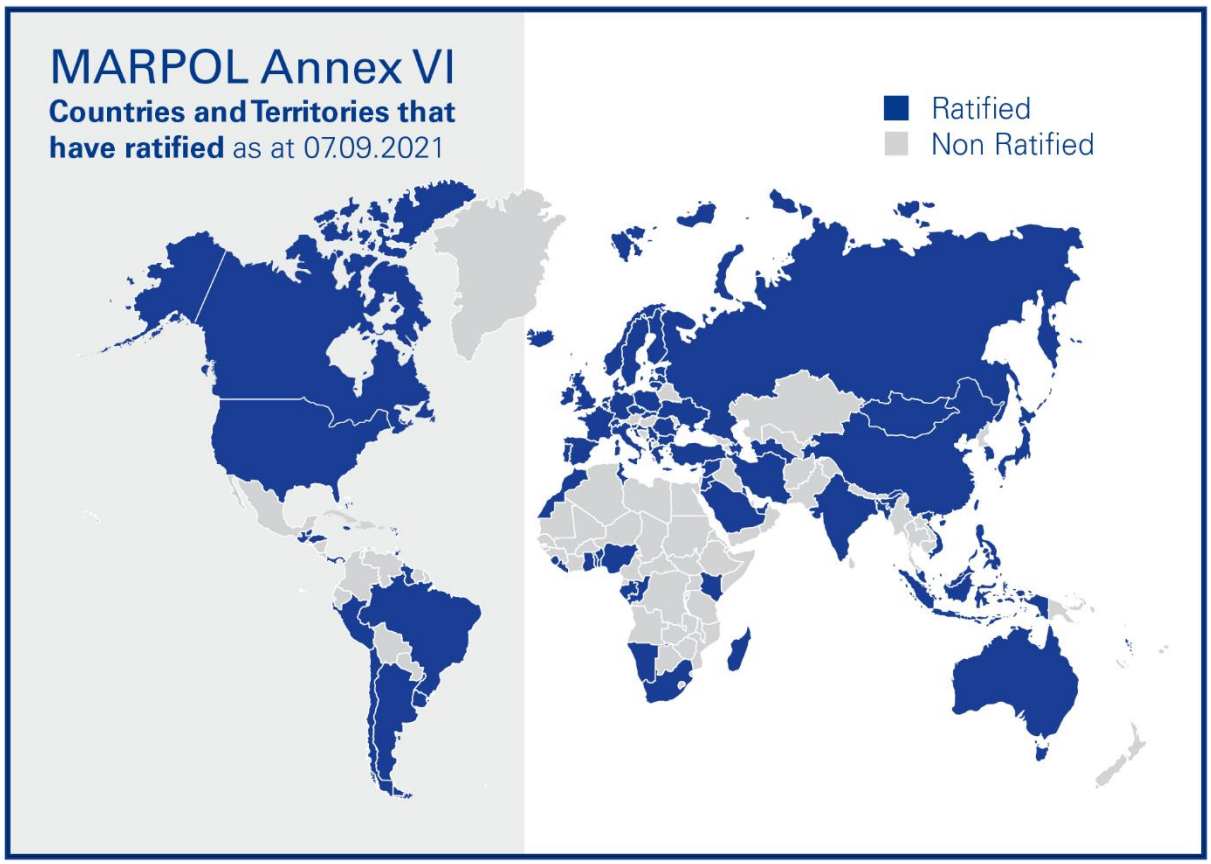
By the very nature of the sector, vessels are required to operate across different areas and as such must comply with those different emissions regulations including those set by individual ports. It is this that is proving challenging for those working in all sectors of the marine industry.

The IMO, in its latest Tier III regulations, has set ambitious goals to reduce emissions by 50% by 2050. Also, in those latest regulations it created several Emission Control Areas (ECA) that specifically support the reduction of Nitrogen Oxides (NOx).

2. Current regulations and what they mean

It was in 2000 that IMO's MARPOL Annex VI was first adopted with the introduction of IMO Tier I. Since then, each subsequent regulation, IMO Tier II, and now IMO Tier III, has continued the drive to lower harmful emissions generated through global shipping channels.

Ratification of the regulations amongst the IMO member nations has been strong however, (as per the graphic below) it does show areas where the regulations have yet to be adopted.



The latest IMO Tier III is an international set of standards designed to protect public health and improve air quality by controlling emissions from ships with a specific focus in reducing nitrogen oxide (NOx) emissions.

All stakeholders in the shipping industry, such as ship builders, operators, owners, service providers and engine manufacturers, must consider these emissions regulations and find ways in which they can comply with the standards. One significant way to achieve this is through the specification and installation of the correct exhaust system in vessels that manages emissions and removes the harmful elements.

The variance in standards across the globe does mean that in the interim, until all vessels have transitioned to become compliant and have the necessary compliant aftertreatment systems, those working in the shipping industry must be fully aware of the regulations they are required to adhere to, wherever their vessel is and the regulations it must comply with.

VESSEL BUILT **BEFORE 2016**	VESSEL BUILT **AFTER 2016**
1 If vessel built **2000 - 2001** - for world wide trade including ECA - **TIER I** standards.	1 Vessel built after **2016** - to trade in North America ECA or US Caribbean ECA area - **TIER III**
2 If vessel built **2011 - 2016** - for world wide trade including ECA - **TIER II** standards.	2 Vessel built after **2021** - to trade in Baltic Sea ECA & North Sea ECA area - **TIER III**
3 If major modifications (replacement / addition) after **2016** - to trade in ECA areas - **TIER III** Standards else TIER II	

Certain countries still allow non-compliant vessels to enter their waters, whereas other areas adopt much stricter practices. For example, in California, ships must be fully compliant before they enter Californian water, 24nm from the coastline.

It is this type of discrepancy that is providing the challenges and some confusion.

Other regional regulations, such as Stage V emission limits for Inland Waterway (IWW) vessels, which was adopted by the European Parliament in 2016 and is a legally binding requirement since January 1st, 2019, brings further challenges.

For a vessel sailing across multiple legislative geographic areas, the compliance can prove to be time consuming and prohibitive to efficiency.

However, technology is available to ensure the highest levels of compliance are achieved meaning vessels could travel freely across the globe without any compliance concerns and support the 2050 visionary target.

This surely, should be the aim of ship manufacturers, operators, engine manufacturers to play their part in the reduction of global emissions and the damaging impact it has on the environment. But what is preventing this ideal scenario?

3. What challenges does the shipping industry face to tackle vessel emissions?

Two challenges are the most significant.

A – Legislation and regulations that differ wildly

B – An unawareness of the latest emission technologies

Whilst the regulations appear to be robust, the actual compliance and enforcement is not without its loopholes.

When ship builders, operators, and even engine manufacturers are looking for solutions to meet the most up to date regulations (IMO III and Stage V IWW) it can be challenging to find a solution that fits with other requirements such as not compromising available space on a vessel and concerns that emissions technologies can affect the performance of a medium speed engine vessel.

Typically operating at between 400 and 1200 RPM, upgrading these fuel driven engines with the latest emission reduction technologies, holds the short-term key to making a significant impact on reducing air and water pollution across the global shipping industry.

Historically, some emissions reduction technologies on such a scale have perhaps not been the ideal solution, and with legislations being somewhat vague, decisions have been made not to invest.

However, market leading companies have drawn on decades of experience in emissions reduction technologies to facilitate high performing solutions that deliver tangible benefits.

These scalable solutions, which support engine output between 1MW and 10MW, are addressing some of the challenges the industry is facing.

The solutions are compact, essential when retrofitting exhaust aftertreatment systems to vessels, and their close coupled, low back pressure, fuel efficient solutions are delivering tangible benefits for ship builders, ship owners, ship operators and service providers alike. Furthermore, they are supporting the engine manufacturers in producing the latest engines that are fully compliant with the strictest current regulations.

4. The solution and how it works

Typical large exhaust aftertreatment systems employ arrays of square substrates forming catalyst reactor beds housed in large enclosures. Low CPSI substrates help to minimise

the overall pressure drop over the system and help to reduce the risk of particulate matter causing blockages.

The traditional selective catalytic reduction (SCR) layout is a reactor module with a long upstream pipe containing a urea injector and mixer assembly with the path length between the point of injection and the SCR catalysts ensuring high ammonia uniformity; however, for systems that also need to achieve particulate matter (PM) reduction this mixing solution occupies valuable real estate required for a diesel particulate filter (DPF) unit.

Where required, DPF systems utilising burners often employ silicon carbide substrates to withstand the extreme heat generated, increasing both the cost and weight of the overall solution; whereas applications that use low temperature, NO_2 assisted, passive soot regeneration carry the additional cost of large PGM (Platinum Group Metals) catalysts whilst suffering compatibility issues with sulphur in fuel greater than 50ppm.

By developing a compact industrial exhaust aftertreatment solution to meet the demanding Stage V Inland Waterways requirements for the medium speed engine market, compliance with the most stringent global regulations can be achieved.

The most optimised DPF units comprise an array of cordierite filter modules, installed into a grid, with individual module sealing to prevent soot by-pass. In service, the soot level in the filters is managed using an oxygen driven regeneration, with the thermal management controlled using hydrocarbon oxidation over PGM catalysts with flow regulated by a novel divertor valve arrangement.

The SCR unit also contains an array of ceramic catalyst modules installed into a grid structure downstream of a close coupled urea mixer geometry which eliminates the need for a long mixing pipe arrangement creating space for the DPF unit. Increasing the SCR substrate cell density helps to maximise the catalyst surface area which, in turn, reduces the overall catalyst volume required. The removeable modules in both the DPF and SCR units maximise serviceability whilst minimising total cost of ownership; the DPF modules can be cleaned using either a pneumatic or hydraulic process typically at c6,000 hour intervals and the SCR modules can be replaced at the end of their useful life typically c 12,000 hours.

Furthermore, and most importantly, sophisticated control solutions ensure the aftertreatment system and the engine communicate effectively, and advanced technologies can ensure systems are developed, tested, and reach compliance without prior access to the ship being required.

5. What does the future look like?

IMO regulations are being continuously reviewed to ensure best practice is determined across the maritime industry. Further amendments are due this year, and it is expected that these will continue to drive towards the 50% reduction in emissions required by 2050.

The marine industry, and its governing bodies, clearly have the end goal in sight and it is the designers, manufacturers, and installers of solutions driven technology to show all sectors of the shipping industry just what is possible.

With sustainability and emissions becoming a major consideration for many businesses and their CSR policies, it is reasonable to think that emissions, compliance with regulations, and a vision for not just meeting those regulations but exceeding them, will become a factor in the decision-making process affecting all stakeholders including the sourcing of shipping services, new vessels, retrofit systems and engine providers.

In the longer term, a transition to alternative fuel sources will be inevitable and ultimately be the change which shapes the future. Consideration should be given to the impact on emissions that these fuel sources would have. In some respect they are not as favourable as one might perceive. Whilst they will provide a much-needed alternative to fossil fuels, and will reduce CO_2 emissions, they will still pose compliance issues with current regulations. As such, emissions reduction solutions will still be required, either as an OE engine part or as an aftermarket retrofit solution.

In a recent white paper by DNV, a global quality assurance and risk management company, it was identified that 'LNG, LPG, methanol, biofuel and hydrogen as the most promising solutions.'

Such alternative fuel sources could be a powerful tool in the decarbonisation of the shipping industry, however as compliance becomes every stricter, emissions control systems will still play a huge role in removing dangerous gases from the exhaust system of marine vessels.

Furthermore, the challenges of generating enough alternative fuel remain a key concern for the future of the shipping industry

That said, the work being done by alternative fuel producers will pay dividends in due course. When it does, emissions reduction providers will be there with the technologies needed to achieve or maintain global emissions regulations.

6. Conclusion

Reducing marine emissions remains a global focus and it is essential that as an industry we drive forward the solutions which will enable us to meet the current headline figure of a 50% reduction in GHG by 2050, as stipulated by the IMO.

To do this we are calling for stronger legislation, applicable to the retrofit of marine vessels to accelerate emissions reduction. There is an urgent need for the harmonisation of global legislation for marine and inland waterways to support all stakeholders and achieve congruence.

We believe this legislation should set global standards for not only nitrogen oxides (NOx) but also particulate matter (PM) to offer a more robust emissions solution and that a combined DPF and SCR solution is the preferred technology to clean up vessels of all sizes due to high-performance levels.

Meeting these standards requires everyone, from alternative fuel producers, those who specify emissions reduction technologies, through to the ship operators who want to have the cleanest and most compliant vessels, to do their part.

As designers, developers, and manufacturers of exhaust aftertreatment systems Eminox has drawn on the proven systems for other vehicles and equipment and created systems that excel at not only achieving the strictest of global emission regulations, but also satisfies the requirements of ship builders and operators. We understand the need for systems which are compact, easily controlled, and compatible with a range of marine and stationary/power generation engines.

Using this expertise, global understanding, and manufacturing capabilities means Eminox technology can be tailored for different vessels using platforms approved by regulatory authorities which will deliver future proofed compliance.

7. Eminox and the part it plays

With decades of experience in designing and manufacturing exhaust aftertreatment systems for heavy duty vehicles, Eminox is leading the way with its compact solution for reducing marine emissions.

It will continue to work closely with governing and legislative bodies to raise awareness, compliance, and standards.

Contact the Eminox team to discover more about emission solutions and how it can help you meet your emission challenges.