Clean air on the oceans

IMO2020 marine emissions monitoring and specialty gases

By **Stephen B. Harrison**

There are fewer things more invigorating than standing on a beach and taking a few deep breaths of fresh air. But how can we be sure that this sea breeze is a clean one, free of harmful pollutant gases? For several years, the International Maritime Organisation (IMO) has stipulated low levels of sulfur emissions close to densely populated coastal areas, such as the Baltic sea, the English Channel and the coastal waters off the US.

As of 1st January this year, the low sulfur emission levels in the IMO regulations became effective worldwide. Furthermore, the measurement of nitric oxide emissions will also be required. This brings maritime air pollution control closely in line with power plants, cement works and oil refineries, where continuous emissions monitoring systems (CEMS) have been used for decades.

Two solutions for emissions reduction

The industrial gases industry has a key role both in maritime emissions reduction and enabling enforcement of the IMO2020 regulations with emissions monitoring.

One option to reduce sulfur emissions from ship exhausts is to burn fuel with a low sulfur content. This solution mirrors the land-based transportation sector where low sulfur petrol and diesel are the norm. Refineries are taking a variety of approaches to meet the changed demand for bunker fuels. Some will invest to increase the amount of low sulfur heavy fuel oil capacity and delayed-coker construction projects are underway in several locations.

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Whatever the refinery does with additional process units and configuration changes, one thing is for sure: increased sulfur removal will require increased quantities of hydrogen. Hydrogen reacts with sulfur to form hydrogen sulfide which can either be burned on the refinery or converted to elemental sulfur for the chemicals sector. This is good news for industrial gas and process equipment suppliers involved in onsite SMRs or pipeline supply of refinery hydrogen.

The second option for marine emissions reduction is for ships to use conventional high sulfur fuel oil and an exhaust gas cleaning systems (EGCS). This is like established technologies in land-based systems where power plants, for example, use scrubbers fed with lime to knock down sulfur emissions levels. With the demand for low sulfur fuels expected to increase, due to the IMO2020 regulations, the price for these fuels is also likely to rise. So, investment in an EGCS which enables the use of lower cost higher sulfur fuels may be highly attractive for shipping operators.

In general, EGCSs use either seawater in an open loop system or rely on internal recirculation of fresh water mixed with caustic soda or other alkaline chemical as the scrubbing medium in a closed loop system. Some ports have expressed concerns about the discharge of open loop scrubber wastewater, so the closed loop versions have an important role to play, despite their additional operating cost. However, the Finnish company Valmet has patented a scrubber process which can easily switch between the open or closed loop operation modes.

Speaking for Valmet as Product Manager of Scrubber Technology, Juha Jokiluma says that, "Valmet was one of the first companies to introduce the hybrid marine EGCS solution to the market. We have delivered several hybrid scrubber systems, including both open and closed loop operation modes, as well as dual water hybrid scrubbers that combine the benefits of both modes."

"This is particularly important in brackish waters such as river estuaries and means that the vessel can sail anywhere without over-dimensioning the scrubber system. Valmet has also developed its own water treatment system for treating closed loop wash water known as bleed-off. Cleaned water is continuously monitored to comply with strict IMO requirements and can be discharged overboard."

He goes on to explain the link to land-based scrubbing systems with the comment that "our expertise in flue gas desulfurisation (FGD) comes with decades of involvement in the pulp and paper industry and diverse experience with other boilers. With more than 150 land-based FGD systems as references, we were quickly able to grow to more than 100 marine EGCS as shipping operators geared up for IMO2020."

Another aspect that the land-based and marine systems have in common is the requirement for CEMS gas analysers for process automation.

Finding the right wavelength for marine emissions monitoring

With the increased focus on pollution control, gas analysis in the ship's funnel now stretches beyond process control and fuel efficiency to become a fully-fledged CEMS.

Carbon monoxide (CO) and carbon dioxide (CO_2) emissions can indicate engine performance and efficiency. Additionally, measurement of the sulfur dioxide (SO_2) emissions and total oxides of nitrogen (NOx) emissions are now also required for environmental compliance. The selection of instrumentation for these ocean-based measurements can draw from lessons learned in power plants and other established CEMS applications. However, since the fuel on board is generally a liquid hydrocarbon, not coal or natural gas, and the measurement focus is on chemical species not particulates, some additional considerations come into play.

> **150**
> Valmet has more than 150 land-based flue gas desulfurisation systems in use

The Swiss industrial automation company ABB have decades of experience in emissions monitoring and their product manager, Carolin Seubert, explains what to look for with marine CEMS. She says that, "Simplicity is the key for stack emissions measurements at sea. In a sophisticated automotive emissions test-cell a chemiluminescence detector might be ideal for car NOx exhaust gases. However, that analyser requires an ozone generator, catalytic converter and a gas diluter which might be suitable for land-based research teams, but on the high seas we need to be sensitive to the needs of shipping operators. That's why we →

have incorporated a non-dispersive ultra-violet (UV) Limas analyser into our marine CEMS. It uses light in the UV wavelength to analyse NOx concentrations."

"For the SO_2 and CO_2 measurements we rely on another technology using light in the infrared (IR) wavelength. This is based on our renowned Uras26 non dispersive IR gas analyser".

Seubert also goes on to explain another aspect related to sample handling. "The other key difference that we have responded to with our GAA330-M marine CEMS is sample preparation of the exhaust gases. The oily carry-over of unburned hydrocarbons from the combustion of liquid fuels means that hot-wet systems may get fouled quickly. Therefore, we selected a cold-dry sample handling system. We have tried to tune into the right wavelength for this new application and design a system with minimal maintenance requirements".

To make things even easier for marine operators, the UV and IR gas analysers in the ABB GAA330-M are fitted with gas cuvettes which are optical cells filled with gas mixtures of a known concentration that simplify calibration of the instrumentation.

"For further convenience, we offer mid-sized cylinders at 10 litres or 20 litres capacity for this offshore application. This seems to be the sweet spot combining portability and plenty of gas to ensure that calibration can take place on longer trips away from port..."

Seubert added, "It might be bad news for specialty gases suppliers, but it's good news for shipping operators that they do not need gas cylinders to calibrate their gas analysers. Anyhow, it might be a relief for industrial gases suppliers to know that despite this gas cuvette that we have incorporated into our devices, many operators still opt for the 'belt and braces' approach and also conduct periodic calibration with specialty gases."

Gas cylinder convenience and accreditation

Calibration of the CEMS instrumentation is a fundamental requirement for emissions monitoring compliance. An analyser that is not correctly calibrated cannot be relied upon to report the required precise environmental emissions data.

Where the highest levels of accuracy and traceability are required, accredited specialty gases calibration mixtures are the best solution. Accreditation bodies around the world have worked together to harmonise data and through this collaboration the international aspect of the IMO regulations can be globally standardised. This ensures that 10 parts-per-million (ppm) of SO_2 emissions measured in the smoke stack of a Russian oil tanker in the Black Sea is equivalent to an instrument on a Swedish passenger ferry crossing the Baltic to Estonia or the reading on a Chinese container ship steaming through the Strait of Malacca off the coast of Singapore.

Carburos Metálicos, Air Products subsidiary in Spain, produces accredited multi-component calibration gas mixtures containing carbon monoxide, carbon dioxide, nitric oxide and sulfur dioxide in a balance of nitrogen, in a single cylinder. The mixtures and available concentrations have been designed to ensure suitability for equipment calibration and compliance with the IMO2020 regulations. With production in Spain, the ISO 17025 accreditation for these gas mixtures is through ENAC.

Whilst accreditation is a hygiene factor that all specialty gas suppliers must meet, there are still some important differentiators for marine operators to consider when they choose a cylinder supplier. David Bryant, Air Products European Segment Programme Manager, Speciality and Medical Gases picks up the thread. "Space is at a premium on ships and carrying cylinders on board is not always easy," he said.

"Also, with the chance of rough seas, cylinders can move around if they are not properly secured. For these reasons, the fewer cylinders that the operator needs to take on the high seas, the better. This is where our multi-component mixtures score well – one cylinder contains all the gases that are needed to calibrate the suite of instruments required for marine CEMS."

"For further convenience, we offer mid-sized cylinders at 10 litres or 20 litres capacity for this offshore application. This seems to be the sweet spot combining portability and plenty of gas to ensure that calibration can take place on longer trips away from port and to ensure that the frequency of manual intervention related to a cylinder change-over is minimised."

About the author

Stephen B. Harrison is celebrating 30 years involvement in industrial gases this year. He was previously global head of Specialty Gases & Equipment at Linde Gases, and spent more than 15 years with BOC Gases. He is now a consultant.