IMO2020 - Maritime CEMS and refinery changes

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For several years, the International Maritime Organisation (IMO) has stipulated low levels of sulphur emissions close to densely populated coastal areas, such as the Baltic sea, the English Channel and the coastal waters off the United States. As from the 1st of January 2020, the low sulphur emission levels in the IMO regulations became effective worldwide. This will bring marine air pollution control in line with power plants and refineries where continuous emissions monitoring systems (CEMS) monitoring NOx and SO_2 emissions have been used for decades.

Alternatives for emissions reduction

One option to reduce sulphur emissions from ship exhausts is to burn fuel with a low sulphur content. This solution mirrors the land-based transportation sector where low sulphur 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 sulphur heavy fuel oil capacity and delayed-coker construction projects are underway in several locations.

In 2018, ExxonMobil Petroleum & Chemical BVBA commissioned a delayed coker at its 320,000 barrels per day Antwerp refinery in Belgium. Designed to convert heavy, higher-sulphur residual oils into transportation fuels such as marine gas oil and diesel, the 50,000 barrels per day coker expanded the refinery's capacity to produce cleaner transportation fuels which will help meet the demand for lower-sulphur fuel oil to comply with the International Maritime Organization regulations.

The delayed coker was not an isolated project, it was part of a multi-billion Euro re-investment made at the Antwerp refinery over the past decade. The delayed coker follows other projects at the site, including a 130 MW cogeneration unit and a diesel hydrotreater. These increased

Commercial shipping at Fawley, UK

Oil refinery with refined products storage

the refinery's production capacity for low-sulphur diesel to enable modern cars and trucks to achieve lower exhaust emissions standards.

Whatever the refinery does with additional process units and configuration changes, one thing is for sure: increased sulphur removal will require increased quantities of hydrogen. Hydrogen reacts with sulphur to form hydrogen sulphide which can either be burned on the refinery or converted to elemental sulphur for the chemicals sector.

The second option for marine emissions reduction is for ships to use conventional high sulphur 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 sulphur emissions levels. With the demand for low sulphur 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 sulphur fuels may be highly attractive for shipping operators.

In general, EGCSs use either sea water 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 waste-water, so the closed loop versions have an important role to play, despite their additional operating cost. However, some scrubber processes can easily switch between the open or closed loop operation 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. Some scrubbers also incorporate a system for treating closed loop wash water known as bleed-off to comply with strict IMO requirements and can be discharged overboard.

Maritime CEMS

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 sulphur dioxide (SO_2) emissions and total oxides of nitrogen (NOx) emissions are now also required for environmental compliance. The selection of

Four drum delayed coker unit

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.

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

Maritime CEMS can learn from land-based systems

Marine CEMS systems are installed in the ship's funnel

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".

ABB GAA330-M marine CEMS – image courtesy of ABB

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. Seubert again: "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".

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