

Maritime Summary Note n°216 -January 2020

« Global Sulphur Cap 2020 : Overview »

This ISEMAR Summary Note follows the November 2018 note "Shipping Emissions: Economic and Technological Issues," which provided an overview of the various propulsion solutions available to operators. A third Summary Note, scheduled for February 2020, will continue this analysis by addressing emerging solutions to meet future environmental regulations.

The global merchant fleet comprises approximately 60,000 ocean-going vessels, consuming nearly 4 million barrels of crude oil per day (568,000 tonnes of heavy fuel oil), which represents 4% of total global consumption and generates 2.5% of global greenhouse gas (GHG) emissions, or 940 Mt of CO₂ per year. Contrary to the misconception that shipping is the largest GHG emitter, the electricity and heat production sector is the primary global source, accounting for 31% of anthropogenic GHG emissions. However, according to a study by the International Maritime Organization (IMO), global shipping emissions could increase by up to 250% by 2050, which would then represent 17% of global emissions. The IMO has therefore implemented an ambitious "decarbonization" program for the maritime sector. Adopted in 1997, Annex VI of the MARPOL 73/78 Convention introduced emission limits for the main atmospheric pollutants from ship exhaust gases (sulfur oxides SO_x and nitrogen oxides NO_x). This Annex lowers the global sulfur content cap to 0.5% m/m (a unit of weight concentration known as mass by mass) since January 1, 2020 (down from 3.5% m/m previously). For comparison, automotive regulations limit sulfur content to 0.001% m/m. SO_x are known for their harmful effects on human health (respiratory problems, lung diseases, etc.) and cause acid rain, which damages crops, forests, and aquatic species, while further contributing to ocean acidification. This regulation will cover all ships operating in open seas or within the national waters of countries that have ratified MARPOL 73/78 Annex VI. In December 2019, 96 States had ratified it, representing 97% of global tonnage. In the longer term, the IMO's strategy is to reduce total annual GHG emissions from shipping by at least 50% by 2050 compared to 2008, and carbon intensity emissions by 40% by 2030. It aims for a 70% reduction in this intensity by 2050 compared to 2008. This strategy will be revised in 2023. What operational solutions have shipping stakeholders adopted in order to comply with the regulations?

Operational solutions: speed and design

Slow steaming, which consists of reducing a vessel's speed, became widespread during the 2008 crisis to cut costs. Reducing speed directly impacts fuel consumption, with an exponential effect. Lowering the speed by one knot (from 12 to 11 knots) reduces a ship's consumption by 18%. This reduction reaches 30% if the speed drops to 10 knots. Today, it is strongly encouraged by French, Greek, and Danish shipowners to meet the short-term goals set out in the Paris Climate Agreement of December 12, 2015, and in the IMO strategy to combat the emissions in question. It is a simple, fast, and inexpensive solution that requires no technical modification to the vessel. Beyond climate aspects, it also offers environmental benefits by reducing underwater noise and collision risks with marine mammals. Conversely, detractors view it as merely a "half-measure" whose effectiveness is difficult to measure, arguing that it would lead to an increase in the number of ships in operation (overcapacity to maintain constant logistical flows) and thus, ultimately, to an increase in GHG emissions. Some also fear that slow steaming causes additional operational costs due to longer transit times and tied-up cargo at sea. Another solution, proposed by Japan, consists of limiting the engine power of existing vessels (ships with a gross tonnage over 5,000 units). This would reduce power by 50% for bulk carriers and

66% for container ships. This solution is favored by one of the world's most representative maritime organizations, BIMCO (58% of global tonnage) and is supported by the International Chamber of Shipping, as well as by the Maersk shipping line. A consensus remains to be found between speed limitation and power limitation, with the main goal being not to lose sight of the objective to "decarbonize" shipping. In line with the IMO, France, Denmark, Germany, and Spain favor "goal-based measures," which assign emission reduction targets to ships while leaving the choice of means to achieve them up to the shipowners. These means must be transparent, effective, and subject to port State control.

The other operational lever for reducing the carbon footprint of ships lies in design and the Energy Efficiency Design Index (EEDI) for new ships, as well as in the Ship Energy Efficiency Management Plan (SEEMP) for all existing vessels, which can still be improved (hull shapes, anti-fouling paint, air lubrication technology for ship hulls, etc.). Logistics patterns and shipping routes backed by new technologies and artificial intelligence can also be a source of financial savings, energy efficiency, and environmental gains. Investment in R&D must be encouraged.

Conventional solutions

• Scrubbers

In order to comply with the 2020 regulations, shipowners had to make technological choices. What is the status today? According to the Exhaust Gas Cleaning Systems Association (EGCSA), 4,000 ships will be equipped with scrubbers by 2020-2021. This represents less than one in ten ships. However, there has been a spectacular increase in this equipment, as only 618 ships were equipped with scrubbers in 2017. Scrubbers make it possible to maintain the economic advantage of using Heavy Fuel Oil (HFO) while complying with the 2020 sulfur legislation. The disadvantage for the shipowner is the cost of this downtime—several weeks in a shipyard in addition to the price of the scrubbers themselves (the installation cost is estimated at between \$5 million and \$10 million per ship). For the largest vessels, the cost of a technical stop can be estimated at between \$30,000 and \$50,000 per day. For shipyards, the IMO regulation has represented, and will continue to represent for some time, a considerable windfall of work, to the point that they are sometimes running late due to a shortage of labor and a dense order book.

There are several types of scrubbers, including dry and wet systems (using seawater, freshwater, or both). The latter are available as open-loop systems (where washwater is discharged into the sea) or closed-loop systems, where sulfur is filtered and then stored on board the vessels. Hybrid scrubbers (combining closed and open loops) also exist. According to the classification society DNV GL, the proportion of open-loop scrubbers reaches 80%, compared to 16.5% for hybrid systems and barely 0.2% for closed-loop scrubbers. Bulk carriers, tankers, and chemical tankers are currently their primary "customers." These ships must continuously record the proper functioning of their purification systems. In the event of a failure, the fuel used must comply with regulations, under penalty of prosecution by the port State of call. The main concern for shipowners lies in the reliability of the system (a recurring problem with early corrosion of recording sensors). The use of scrubbers requires the crew to be properly trained. Closed-loop scrubbers must have washwater holding tanks (at the expense of cargo space), which are discharged at the port. This discharge represents a cost for the shipowner and is carried out via a truck-pumping system.

For financial and/or technical reasons, many ports do not yet have the necessary equipment to receive and treat this washwater. Open-loop scrubbers offer the advantage of being cheaper and more space-efficient than closed-loop ones. However, questions remain regarding the discharge of exhaust gas washwater into the sea and its impact on the marine environment. A recent study by the Swedish Environmental Research Institute¹ highlights the harmful effects of scrubber residues when discharged into the sea, noting that they cause excess mortality among micro-plancton. This has led delegates of the IMO's Marine Environment Protection Committee (MEPC) to urge caution and request further studies on the ecological impact of these discharges.

Due to environmental concerns, an increasing number of States are now denying access to their territorial waters for vessels equipped with open-loop scrubbers, accusing this technology of shifting the

¹ Scrubbers: Closing the loop Activity 3: Summary Environmental analysis of marine exhaust gas scrubbers on two Stena Line ships, IVL Swedish Environmental Research Institute, décembre 2018.

problem from the air to the water. The list of these States continues to grow², with Malaysia being the latest country to do so.

We can also mention the €50,000 fine imposed by the state of Hamburg on a shipowner for violating port regulations and discharging washwater into the Elbe. The fear of being denied port access dooms open-loop scrubbers in the more or less short term. Finally, questions can be raised about the relevance of only eliminating SO_x from engine exhaust gases and not CO₂ emissions, NO_x, as well as fine particulate matter, the latter of which will be subject to restrictions in the coming years.

• Low-sulfur marine fuels

The other solution, and probably the simplest to implement, is the adoption of fuels that comply with the new regulation, using Marine Gas Oil (MGO) or Marine Diesel Oil (MDO) with very low sulfur content, which consist of various distillate blends. Very Low Sulphur Fuel Oil (VLSFO) and Ultra Low Sulphur Fuel Oil (ULSFO) are also available. Distillate fuels do not require major modifications to existing ship engines, which facilitates the switch to MGO/MDO without any capital expenditure or significant downtime. However, mixing fuel from different sources (heavy fuel oil with lighter fuel oil) should generally be avoided. Fuel tanks used for HFO will first require cleaning before bunkering MGO to prevent any non-compliance. It is likely that the use of low-sulfur fuel will lead to disputes with suppliers regarding fuel quality, related to sulfur content, or potential instabilities in distillate blends (filter clogging, engine failures, etc.). The use of distillate fuels therefore results in higher bunkering costs.

According to a Lloyd's List article from December 2019, fears of non-compliance and the unavailability of Low Sulphur Fuel Oil (LSFO) tend to fade. LSFO is already said to account for half of the sales in the world's major bunkering ports. However, supply bottlenecks are likely to appear, not because of a shortage but due to a rebalancing of shipowners' needs. Refineries had to increase their production capacity to meet the growing demand from the maritime industry. The IMO's sulfur regulation has completely reshuffled the deck in the marine fuel market. According to DNV GL forecasts from November 2019, HFO—which can only be used by ships equipped with scrubbers—will represent only 12% of the marine fuel energy mix in 2020, whereas it amounted to 82% in 2019.

In parallel, low-sulfur fuels (0.5% m/m), which accounted for only 2% in 2019, will be predominantly used in 2020, with a respective share of 64%. The high cost of LSFO could lead shipowners to shift toward larger-capacity vessels in order to reduce unit overcosts (through service mergers). This issue of 0.5% m/m fuel pricing is crucial for shipowners, given that fuel is the largest item in a vessel's operating expenses (Opex). The price gap between HFO and LSFO has fluctuated between \$100 and \$200/tonne in recent months. The drop in HFO demand (by 2 to 3 million barrels/day) will mechanically push its price down by \$150–\$200/tonne. Conversely, this new regulation will require an additional 2 to 3 million barrels of MGO per day, which risks causing new tensions in the distillate market. The price difference between HFO and MGO could increase from \$200/tonne to over \$700/tonne on average, according to various sources. Throughout December 2019, the price of low-sulfur fuels steadily increased, while HFO prices stabilized or slightly declined³. Most analysts predict that refining margins will improve in the years following the implementation of the regulation. The increase in the price of these fuels will drive up transport costs, which will be passed on to the final customer.

The maritime authorities of the port of call monitor fuel compliance through Port State Control (PSC). During an onboard inspection, their officers conduct a documentary check using the IAPP (International Air Pollution Prevention) certificate, and request that the vessel provide the Bunker Delivery Notes and the Oil Record Books, where entries are recorded.

all fuel-related operations of the vessel: type of fuel used, ship's position, and quantity on board. Officers also conduct in-situ inspections by taking fuel samples from the engine room, which are then sent to State-certified laboratories to verify the quality of the fuel being used. Denmark and the Netherlands wish to use sniffer drones to analyze the sulfur content in ship exhaust gases. In France, the violation of Annex VI of MARPOL 73/78 is punishable by one year of imprisonment and a €200,000 fine (Articles

² Singapore, China, almost all ports in the Northern Range, the States of California and Massachusetts, Connecticut, Hawaii, the Panama Canal, Ireland, Norway, Fujairah in the United Arab Emirates, and most recently Malaysia.

³ In Fujairah, the price of VLSFO on December 1st was \$573/tonne, whereas on January 1st it stood at \$771/tonne, representing a 34.5% increase.

L. 218-15 et seq. of the Environmental Code). If a legal entity is responsible for the offense, the fine can be multiplied by five. This applies unless the unavailability of compliant fuel can be proven. In that case, the captain must notify the flag State and the authorities of the port of destination.

• Liquefied Natural Gas (LNG)

Regarding LNG, in 2020, there would be 163 vessels in operation, 83 on order, and 123 using a hybrid propulsion system. The majority of ships using LNG as fuel are ferries and Ro-Ro vessels, with 43 already in service. These are followed by offshore supply vessels and tankers. In terms of vessels on order, the most significant growth areas for the coming years are the container ship and cruise ship segments, with 62 vessels evenly split between the two. The use of LNG reduces CO₂ emissions by approximately 20% and achieves a near-total absence of SO_x, NO_x, and fine particulate matter emissions. Some French shipowners, such as the cruise company Ponant, CMA CGM, Brittany Ferries, and Corsica Linea, have chosen to equip part of their new fleets with LNG engines. Natural gas is a fossil fuel that emits less CO₂ than oil or coal, but its effectiveness depends largely on the ability to minimize methane slip during the extraction, transport, and bunkering phases⁴.

The cost of a vessel is also higher, at around €150 million, which is €5 million to €20 million more than a conventional thermal propulsion ship. Retrofitting an existing vessel is extremely complex, if not impossible. LNG bunkering requires about twice as much space as HFO for the same amount of energy produced. In addition, LNG-powered ships will need to carry more fuel or make more frequent stops for bunkering. Given the small number of LNG-certified officers, crew training will be central to avoiding any risk of accident. The use of LNG as a means of propulsion in maritime transport depends on the availability of a global network of bunkering infrastructure, which is still at a developmental stage. LNG bunkering is currently available in Europe, Incheon (Korea), Buenos Aires (Argentina), Singapore, the United States, and Fujairah, among others. Other bunkering sites are currently being developed, for example, in the Western Mediterranean, the Gulf of Mexico, the Middle East, Singapore, China, South Korea, and Japan.

Towards a paradigm shift?

However, can we truly say that HFO no longer has an economic future? Once crude oil is produced from a field, it is sent to a refinery where the various hydrocarbons in the crude are separated, converted, and treated to manufacture usable petroleum products. These range from the lightest, such as butane and propane (gaseous state), then gasoline, kerosene, diesel, fuel oil (HFO), and finally the heaviest, bitumen. The production of heavy products is intrinsic to the processes of the oil industry and continues to be sold worldwide, notably for the benefit of power plants. HFO will therefore continue to exist and to be transported by sea by all types of tankers, including VLCCs. This transport remains high-risk in the event of an oil spill, unless it is banned from territorial waters, as Iceland recently did.

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⁴ According to a study by the Norwegian institute SINTEF, the use of LNG could increase the quantity of GHGs emitted into the atmosphere. Methane is said to have an even greater impact on climate change than CO₂.