# Lessons learned and taking the next step

This paper reviews the effects of IMO 2020 on the global shipping industry and discusses the likely impact of future emission reductions in terms of both fuel and lubricant options as well as operational procedures.







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### Foreword

The success of IMO 2020 demonstrates what the marine industry can achieve when it coordinates its response to far-reaching change; despite the many challenges, the switchover to lower sulphur fuel oil was primarily plain sailing. This ability to adapt will be tested again by the IMO's ambition to reduce the carbon intensity of international shipping by at least 40% by 2030, moving to 70% by 2050, compared with 2008. Meeting these targets will require new technologies and an intensified level of consultation and cooperation around fuel and lubricant development, policies, standards and rules. Taking learnings from the successful implementation of IMO 2020, stakeholders from all aspects of the marine industry will need to pull together like never before.

This paper analyses the key challenges and possible solutions needed to meet these changes and includes insights from leading stakeholders from across the maritime sector. I would like to thank Christos Chryssakis, Senior Researcher, DNV, Ashley Jenkins, Director, John H Whitaker (Tankers), Lars Malmbratt, General Manager Marine Fuels, Stena Bulk, and Maximilian Rothkopf, Chief Operating Officer, Hapag-Lloyd for their invaluable contributions.



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#### Reflecting on IMO 2020

The International Maritime Organization's (IMO) 2020 global 0.50% sulphur cap radically changed the marine industry's fuel options. For most vessel operators this meant a switch to a new low sulphur fuel formulation, which caused understandable concerns about quality, reliability and stability. The pace of the introduction of the revised limit also prompted a major question – would the marine industry be ready in time?

History ultimately showed that despite the speed of the change and, understandable concerns, there were few major issues. Those same concerns had driven good planning and communication between stakeholders, and complications that did arise were well-understood and therefore manageable.

The complications that were encountered generally fell into five categories:

- Insufficient tank cleaning prior to bunkering new low sulphur fuels
- Changes to fuel viscosity
- Stability and compatibility issues complicating fuel handling
- Insufficient filtering for sediment removal
- Use of unsuitable cylinder oil

Modified on-board fuel handing procedures, in combination with the sector's wider ability to effectively plan and manage the switchover to low sulphur fuels, helped ensure that the implementation of IMO 2020 passed without major incident. The marine industry showed what it could achieve when it worked together – IMO 2020 was a success.

# The impact of IMO 2020 on lubricant selection

IMO 2020 also impacted the cylinder oils used to lubricate 2-stroke marine engines. These have traditionally been categorised by their total base number (BN), a measure of the alkalinity needed to counteract the sulphur in the fuel being used. Non-neutralised sulphur can form sulphuric acid during combustion, which can cause significant liner wear.

It was therefore expected that a reduction in BN would be needed for lubricants used in 2-stroke engines running on low sulphur fuels. A range of low BN formulations were trialled, from 20 to 60BN. Testing showed that a midpoint of 40BN was optimum; these oils therefore emerged as the main lubricants of choice for use with IMO-compliant fuels.

The current fuels mix is comprised primarily of 0.50% sulphur fuel formulations – currently around 65% of the bunker market by volume<sup>1</sup>. Vessels entering Emission Control Areas (ECAs) continue to need to switch to 0.10% sulphur fuels (unless fitted with a scrubber). Nonetheless, industry reports have attributed premature wear to certain lubricants while operating on fuels with these sulphur levels.

Industry experience of certain lubricant technologies during the early stages of the IMO 2020 switchover also showed deposit build-up on ring lands and grooves, attributed to insufficient lubricant detergency, thus shifting the industry's lubricant focus from corrosive wear to cleanliness and mechanical wear (while continuing to align with OEM requirements and recommendations).

Current marine cylinder oil formulations mainly consist of detergent additive technology, which combines acid-neutralising components and cleaning agents. However, lowering BN to match the reduced sulphur content in IMO-compliant fuels can also result in a reduction in cleanliness.

Ultimately, a lubricant strategy based on an appropriate formulation enables well-rounded and balanced performance, particularly when coupled with used oil analysis.

1 Based on 2021 data from Singapore (mpa.gov.sg)

## Choosing the optimum lubrication solution

There are three basic approaches to the lubrication of 2-stroke marine diesel engines: continuous operations, alternating operation and in-situ mixing of cylinder oils with different BN levels to achieve the desired BN blend. Each has potential benefits, although in practise not all offer the same ease of use.

For a range of reasons, not least ease of operation, the general consensus is that a continual-use 40BN cylinder oil is the preferred choice. However, some longstanding 40BN formulations, especially those using older additive technologies, may not offer suitable performance in newer engine designs.

It is therefore essential to use a cylinder oil specifically formulated to provide protection for two-stroke marine diesel engines operating on 0.50% sulphur fuels, as this will help combat deposit build-up and maintain engine cleanliness. When combined with a fully featured cylinder monitoring programme, these oils can additionally help operators prolong engine life.

ExxonMobil researchers continue to work closely with the major OEMs and customers to gain valuable insights on operational conditions; their input is therefore vital when developing next-generation lubricants. These insights, along with scrape down oil testing, will be important in a multi-fuel future, especially when fuel switching is involved, as vessel operators could face a range of issues related to engine operation.

#### Looking ahead to GHG reductions

Following the success of IMO 2020, the IMO's next ambition is to reduce the carbon intensity of international shipping by at least 40% by 2030, moving to 70% by 2050, compared with 2008. Additionally, the IMO aims to reduce absolute greenhouse gas emissions from international shipping by 50% by 2050, also compared to 2008 levels. However, it's not going to be easy to transition an estimated 300 million tonnes of conventional fuel to new, lower/zero carbon alternatives. To meet these bold targets, the marine industry will need to develop new fuels, lubricants and propulsion technologies, which could further complicate vessel operations.

#### A cut to shipping's carbon intensity

In May 2021 IMO's Marine Environment Protection Committee (MEPC) working group agreed on a set of draft guidelines to support mandatory measures to cut the carbon intensity of all ships. The draft guidelines, which were discussed during the 76th MEPC meeting in June 2021, settled on an 11% carbon intensity reduction target by 2026 compared to 2019 measurements.

The measures outlined during MEPC 76, which are expected to become effective in 2022 and 2023, are wide-ranging. They included adopting amendments to the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI that will require ships to reduce their greenhouse gas (GHG) emissions. These revisions, which combine technical and operational approaches to improve the energy efficiency of ships, also provide important building blocks for future GHG reduction measures.

The new measures will mandate that all ships calculate their Energy Efficiency Existing Ship Index (EEXI) to establish their annual operational carbon intensity indicator (CII) rating (A, B, C, D, E – where A is the best). Administrations, port authorities and other stakeholders will be encouraged to provide incentives to ships rated A or B. Vessels rated D for three consecutive years, or E, will be required to submit a plan that shows how the required index (C or above) would be achieved.

The amendments to MARPOL Annex VI are expected to enter into force on 1 November 2022, and the requirements for EEXI and CII certification are expected to come into effect on 1 January 2023.

#### Failure is not an option

IMO Secretary-General, Kitack Lim, has stated that "failure is not an option" but has expressed full confidence that his organisation can deliver on its commitment, albeit with additional planning and the support of the marine industry.

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Considerable further work on the implementation of the measures is still ahead of us, but I am confident that the IMO spirit of cooperation, shown during the past years, will enable swift progress with the development of technical guidelines and a Carbon Intensity Code.

The maritime sector is already on its voyage to 2030.

#### The likely impact of marine fuel

From a vessel operator's point of view there is a range of issues that will need to be addressed well in advance of anticipated changes, including likely changes to the marine fuel mix. Any final fuel decision will be based in part on the age and type of vessel, but will also likely be influenced by fuel availability.

"Vessel operators are struggling over what might be the right choice of fuels for the future and how long they can continue to use conventional formulations," according to Christos Chryssakis, Senior Researcher, DNV. "It's a very complex and uncertain picture. The choice isn't just about cost – it's also about performance and that might impact the speed of a vessel. There are clear operational considerations."

#### Vessel operators will therefore need to take into account:

- The fuel options that best meet their operational needs
- Which ports will bunker these fuels
- What cylinder oils will be needed to ensure ongoing engine protection

"The full answer to what fuel to select is to assess a combination of factors," adds Chryssakis. "What are the requirements for your vessel, its operational profile and routes? I don't think there's going to be a silver bullet or a single solution. It will also depend on the preferences of those running the ship."

#### Maintaining continuity of operation

"If a fuel becomes too complicated to use, even if it's cheap, we're not going to go for that. Knowing the bunker industry, we'll want our fuel choices to be as easy as possible to handle and use. Bunkering hiccups simply aren't acceptable," explains Lars Malmbratt, general manager marine fuels, Stena Bulk. "The lower price can sometimes be eaten up by extra waiting time, caused by handling issues. Smooth operation and widespread availability may come with a price, but it could be worth accepting."

According to Malmbratt, the simplest vessels to transition will be ferries and RoRo ships because they have predictable routes, making it easier to ensure continuity of fuel supply; one quayside, one dock. Nonetheless, vessel owners need to examine the full range of choices. As Malmbratt stated, "You can't be unprepared when things start to move. You don't have to change your entire fleet today, but you have to start the process now. Start working together with others – you have to think a bit differently because in future you may not be dealing with the usual bunker suppliers. Be curious and start learning."

The need for cooperation is echoed by, Chryssakis: "I think fuel developers should start sharing bunkering and handling information with the wider industry as soon as possible. It might not be possible to do this immediately for all fuel options, due to technical and commercial restrictions, but there has to be a start."



#### Potential impact on vessel design

"Whilst we might still be in a position to delay specific fuel decisions, we do not hold a similar comfort zone when it comes to making up our mind on new-building vessel orders," explains Dr. Maximilian Rothkopf, Chief Operating Officer, Hapag-Lloyd. "These need to follow supply and demand market forces and usually have a delivery schedule of two years and a life span of 25 years. As such, using engine technology that provides flexibility and the ability to also burn fuels developed in the future becomes one of the key drivers.

"At this stage, Hapag-Lloyd's path to decarbonisation includes dual fuel tonnage, with LNG playing a first step role. Because of its fossil nature, it is considered a bridging alternative until such time as synthetic fuels become available at scale for the marine sector."

#### Getting ready for change

Training will be hugely important, says Ashley Jenkins, Director, John H Whitaker (Tankers). "The responsible officers aboard both the delivery barge and the receiving vessel are skilled professionals but the training for handling, product segregation, storage and use, will need to be delivered in a timely and instructional manner. It will therefore be increasingly important for ship owners to source fuel from reputable suppliers who will develop training as part of their supply offer, as well as reliable quality of the product itself, of course."

He also believes that training in the sampling procedure for the receiving crew will be important if they are tasked with sending a sample to the charterer's designated testing agency. "It will then be the responsibility of the receiving crew to take the sample in a controlled and accurate manner. Even now with conventional fuel oil grades we have observed samples being taken by receiving crews without following adequate procedures; including dirty sample containers being re-used and snatch samples being taken instead of drip. When this occurs, the independent labs will then be working on a halflitre sample of fuel that may not be fully or accurately representative."

Chryssakis agrees that good training will be essential: "The fuel options have different properties, so there'll be different ways of handling them; that's something we'll need information on as soon as possible. There's a risk of running into problems if you don't know how the fuel should be handled. I think all suppliers understand this. And of course we always have trials first, which are going to be very helpful for making sure we get the right information. We're also working with the OEMs on developing lubricant formulations suitable for use with future fuel options."

#### What's coming down the pipe?

New fuels types will obviously need to be extensively tested and evaluated, but some formulations are already gaining traction. "We hear increasing talk amongst customers of biofuels; especially those blended with regular fuels to help facilitate the transition into lower emission technologies," says Jenkins. "We sincerely believe that biofuels will play an increasingly important role in the coming years. It is evolution rather than revolution, but we expect the pace of change will accelerate in the coming few years."

Malmbratt highlights a range of other potential fuel options and some of their associated considerations: "We're looking at a range of new fuels including methanol, which has different characteristics compared to conventional fuels so you have to educate crews about handling it. It's all part of a learning process and keeping up with new fuels will be a lot of work for technical managers. We're starting to look at ammonia and hydrogen, which are probably going to be even more complicated than methanol."

#### Unresolved issues

Despite all the good work there are still a number of issues to be addressed. For example, port authorities will need to ensure continuity of fuel availability and to prepare their facilities ahead of time to support a seamless transition to a lower emissions future. There is also a clear need to harmonise global bunkering and handling standards for new fuels, which will require an industry-wide approach to R&D.

"What makes it even more complicated, though, is that these requirements are changing every year now," explains Chryssakis. "And not only that, right now the clarity we have is only for the period from 2023 to 2026, which is actually a very short period. However, no one's going to be able to wait until the last minute; the regulations are coming, so the marine industry has to do something. I think the best thing it can do is start preparing the options. Basically, build some flexibility to your plans so you can adjust."

#### Rising to the meet the challenge

ExxonMobil is leveraging its core capabilities to meet society's needs for products essential for modern life, while addressing the challenge of climate change.

ExxonMobil has outlined its commitment to driving emissions reductions in support of a net-zero future in our Advancing Climate Solutions - 2022 Progress Report. Key aspects include:

- Aiming to achieve net-zero Scope 1 and 2 greenhouse gas emissions from ExxonMobil's operated assets by 2050, and taking a comprehensive approach centered on the development of detailed emission-reduction roadmaps for major operated assets.
- Plans to invest more than \$15 billion on initiatives to lower greenhouse gas emission over the next six years.
- Providing products to help customers reduce their emissions.

In the marine space, the company is developing new projects, repurposing existing refinery infrastructure, co-processing bio-feeds and executing purchase agreements that are advancing a number of options for producing lower-emission biofuels. ExxonMobil's commitment to research and development plays an important role in creating these next generation solutions; it has invested around \$300m during the last decade in the development of advanced biofuel from sources such as algae and plant waste.

ExxonMobil's efforts are reinforced by the recent establishment of ExxonMobil Low Carbon Solutions, a business that will work to commercialise and deploy emission-reduction technologies. This business will initially focus on carbon capture and storage (CCS) and is already advancing plans for more than 20 new CCS opportunities around the world. We will also leverage our significant experience in the production of hydrogen which, when coupled with CCS, is likely to play a critical role in a lower-carbon energy system.

## ExxonMobil's position is clear: we plan to deliver innovative solutions to help meet society's needs.



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