marine lubricants

methanol and marine lubricants in a lower sulphur, lower emissions future

The drivers for alternative bunker fuels and why shipping is set to witness its most significant period of change in recent memory

Gone are the days when the majority of fleets operate with just one fuel and one cylinder lubrication oil. A combination of new and upcoming environmental legislation aimed at reducing ship emissions, along with vessel and engine optimizations to accommodate shifting commercial realities, means that ship engines today witness a far more complex range of operating conditions than ever before.

This is just the beginning of what is set to be the most significant period of industry change in recent memory, as both cost and environmental pressures push owners and operators to explore a diverse new range of alternative bunker fuels. Understanding the impact for shipping as it heads into a lower sulphur, lower emissions future has been critical for leading lubricants supplier Chevron in their development of new products to meet the challenges of today and tomorrow.

But having the right products is only part of the picture. Partnering with a forward-thinking supplier that provides industry leading support services is critical if owners and operators are to successfully join the pioneers in adopting future marine fuels.

Sulphur regulations: the road to 2020 and beyond

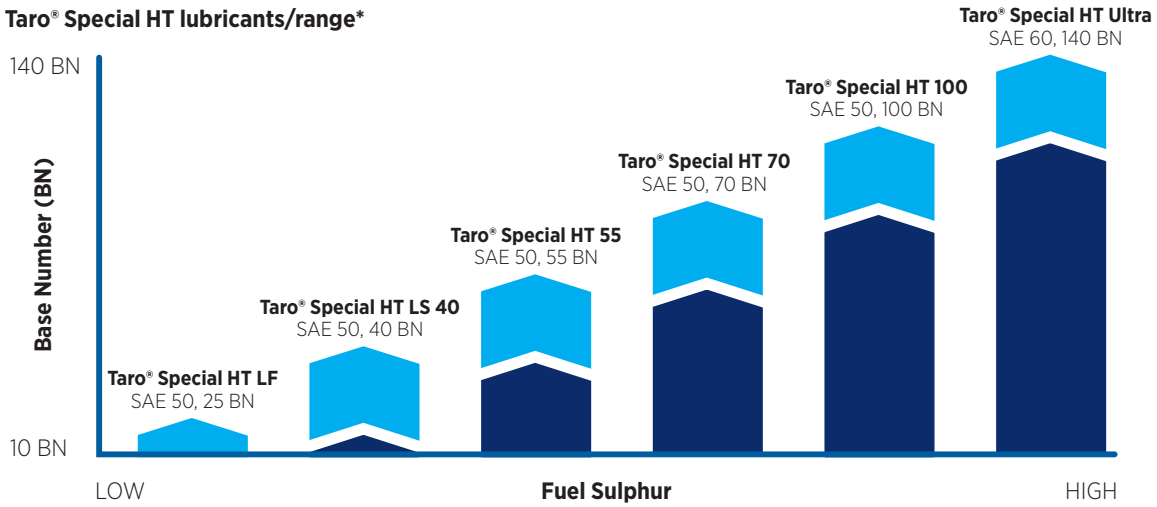
Ships have been burning oil bunkers for many decades now, but it was the entry into force of MARPOL Annex VI in 2005 that marked the beginning of what is set to be a sea-change for the sector. Since 2005 we have seen the introduction of emission control areas (ECAs), initially in Europe, then followed in 2012 by North America. In 2015 the sulphur content of bunker fuel being burned in these zones was capped at 0.10% by weight. Alongside this, countries such as China have introduced at-berth fuel regulations, limiting fuel to a maximum sulphur content of 0.50%. This means that vessels today already need to burn a range of fuels to meet these requirements.

However, the most notable change on shipping's horizon will come on January 1, 2020 when the global sulphur cap on marine fuel lowers to 0.50%. The realities of oil refining mean the industry's preferred bunker fuel of today, high sulphur heavy fuel oil (HFO), will only be able to be burned by those who install scrubbers, so they can achieve an equivalent method of compliance to those burning a compliant low sulphur fuel. In 2020 the vast majority of vessels are expected to switch to using Marine Gas Oil (MGO) or compliant blended fuels.

New fuels and lubricants for new challenges

Sulphur emissions and 2020 are only part of the story and the IMO is working on ways to tackle other ship emissions such as greenhouse gases (GHGs). With this in mind, industry innovators are looking beyond oil-based bunkers to a range of new, alternative bunker fuels that includes methanol, liquified natural gas (LNG), liquified petroleum gas (LPG), and ethane. Many of the vessels using these alternative fuels are dual-fueled, meaning the engines can run either on a higher sulphur conventional fuel or on a virtually zero sulphur content alternative fuel, resulting in more extreme operating conditions within the engine.

This highlights how a "one size fits all" approach to both fuels and lubricants is clearly no longer sufficient, and without proper guidance choosing the right cylinder oil with the correct BN and feed rate can be particularly challenging. Understanding this has been key to the development of Chevron's full range of cylinder lubricant oils — this agile approach is why it is the industry leader when it comes to lubricating engines burning the full array of alternative fuels. Chevron's Taro® cylinder lubricants range[1] from 25BN to 140BN covers virtually all fuel options and combinations.



Taro®[1] Special cylinder lubricants range, solutions for the majority of operations running today.

"When it comes to lubricating the engines of alternatively fueled vessels, Chevron is one of the true pioneers," says Chevron Marine Lubricants Account Manager, Bert Van Cleemput. "If we look at methanol-fueled vessels, today there are seven vessels operating with two-stroke methanol dual-fuel engines and Chevron is lubricating four of them. We are also lubricating the world's only four-stroke methanol dual-fuel vessel, *Stena Germanica*, which has been running on methanol since March 2015. For dual-fuel methanol two-stroke slow speed engines, we recommend Taro® Special HT LF[2], a high-performance 25 BN SAE 50-cylinder lubricant."

* *Taro® Special HT has been replaced by the Taro® Ultra range.*

1. *The Taro® Ultra 20BN to 140BN portfolio replaces the Taro® Special HT portfolio and is fully compatible and miscible.*
2. *Taro® Ultra 20 replaces Taro® Special HT LF and is fully compatible and miscible.*

A new generation: ocean-going methanol dual-fuel ships

Following their delivery in 2016, M/T *Mari Jone* and M/T *Mari Boyle* became two of the world's first ocean-going methanol dual-fuel ships. This project is the product of a collaboration between several leading industry innovators, including:

- Waterfront Shipping, a wholly owned subsidiary of Methanex Corporation and a global marine transportation company specializing in the safe, responsible and reliable transport of bulk chemicals and clean petroleum products to major international markets in North America, Asia Pacific, Europe and Latin America;
- Vancouver, Canada-based Methanex Corporation, the world's largest producer and supplier of methanol to major international markets in North America, Asia Pacific, Europe and South America;
- Private ship manager and investment group Marinvest Shipping AB;
- MAN Diesel & Turbo, the world's leading provider of large-bore diesel engines and turbomachinery;
- Chevron Marine Lubricants, part of Chevron Corporation, one of the world's largest integrated energy companies and a leader in providing marine lubrication solutions for alternatively fueled vessels.

Ship manager Marinvest are co-owners of the M/T *Mari Jone* and M/T *Mari Boyle* along with Waterfront Shipping who are also the charterers of the vessels.

The ME-LGI methanol dual-fuel engines aboard the vessels, developed by MAN Diesel & Turbo, allow for operation on methanol, heavy fuel oil (HFO), marine diesel oil (MDO) or marine gas oil (MGO). The vessels already have a combined 7,000 hours of operation using methanol bunkers.

Benefits of methanol fuel

Using methanol as a marine fuel is a relatively new idea, even within the context of alternative fuels, but it is easy to understand the attraction of its emerging use as a bunker fuel.

"Methanol is a clean-burning, cost-effective marine fuel, that meets the shipping industry's increasingly stringent emissions regulations," says Jason Chesko, Senior Manager, Global Market Development, Methanex.

Pure methanol was first isolated in 1661 and has been shipped globally for over 100 years. Today, methanol is one of the top five chemical commodities shipped around the world each year, and as it is already found in many of the world's seaports, its use as a marine fuel is not subject to the same availability and infrastructure concerns surrounding the viability of some other alternative marine fuels.

Methanol is widely used as a feedstock in the manufacture of a range of other chemicals and products such as plastics and paints. To meet International Methanol Producers and Consumers Association (IMPCA) specifications, the quality is both high (99.9% pure) and uniform. It is particularly attractive in the context of IMO 2020 and other expected future regulations as methanol is free from sulphur, and burning it in a diesel engine only requires the use of a very small amount of pilot fuel — typically around five percent of either HFO or a marine distillate such as MGO or MDO. The result is that compared to burning traditional bunkers using methanol as a marine fuel reduces the emissions of SOx by 99%, bringing them well within current and future global and ECA standards. At the same time, nitrogen oxides are reduced by up to 60% and particulate matter is reduced by 95%.

Methanex has production facilities in six countries around the world. Methanol can be produced from natural gas, and renewable sources such as municipal waste, biomass and recycled carbon dioxide. On an industrial scale, methanol is predominantly produced from natural gas by reforming the gas with steam and then converting and distilling the resulting synthesized gas mixture to create pure methanol. The result is a clear, liquid, organic chemical that is water soluble and readily biodegradable. The production process puts the CO^2 footprint for methanol bunkers on a par with diesel, but new ways to produce methanol are also being developed. For example,

a plant in Iceland produces methanol from recycled CO^2, and reports it releases 90% less CO^2 than the use of a comparable amount of energy from fossil fuels.

Energy density is one area where methanol is outperformed by oil-based fuels, and Chesko says vessels would need to burn a little more than twice the amount of methanol to produce the energy equivalent of MGO. While this can lead to considerations over the size of fuel tanks, methanol is a biodegradable liquid and in some vessels it can be stored in the ballast tanks to alleviate some of the issues around space. It also means that if spilled in water, it quickly and completely dilutes to non-toxic levels. On a calorific equivalent basis, methanol bunkers are currently priced at similar levels to MGO.

Under normal operating conditions methanol is a liquid fuel, so it is easier to work with compared to some other alternative fuels and has very similar onboard handling characteristics to diesel. As it is a low flashpoint fuel, methanol fueled vessels must incorporate certain design requirements such as the use of double wall piping to the engine, but even so, the premium for upgrading a newbuild vessel to a dual-fuel methanol capable vessel is typically less than five percent.

ME-LGI methanol dual-fuel two stroke engine vessels

The ME-LGI methanol dual-fuel engine developed by MAN Diesel & Turbo allows for operation on methanol, heavy fuel oil (HFO), marine diesel oil (MDO), or marine gas oil (MGO). Firing the engine with methanol requires the use of a small amount of pilot fuel, typically five percent of either HFO or MGO.

“It’s a completely new fuel injection system on these methanol engines,” notes Johan Kaltoft, Senior Project Manager, Diesel Research Centre, Marine Low Speed, Research & Development at MAN Diesel & Turbo.

The engines are configured with two injectors each for fuel oil and methanol. It is the injectors that are the limiting factor when it comes to the variety of fuels that can be used by multi-fueled vessels, rather than the number of different fuels a vessel is able to practically carry.

“LNG, for example, is a common rail injection so the pressure build-up is in the supply system. Methanol has a booster injection valve, so the pressure build-up is on the engine. The fact that these injection systems are different for each fuel limits as to what is going on in the engine, and at the moment that limit is two,” explains Kaltoft.

Under regular operation for M/T *Mari Jone* and M/T *Mari Boyle*, the methanol is transferred by means of the Framo deep well pump system from a dedicated slop tank which also acts as methanol fuel storage tank to the 79m3 methanol day service tank. From there, methanol is transferred via double wall piping to the engine at 10 bar low pressure using a separate fuel supply system. The methanol is used at ambient temperature, and a heat exchanger is available if required.

Methanol bunkering

Bunkering operations for the M/T *Mari Jone* and M/T *Mari Boyle* are straightforward. Firstly, there is no incremental cost or complexity due to the fact they are methanol bunkers because the vessels are already loading cargoes of methanol. Any methanol to be used as fuel is separated from the cargo and diverted to the slop tank, which is used as the fuel tank. This is then recorded in the oil record book as fuel, separate from the cargo record book. This methanol will then always be a fuel and cannot be sold as a cargo.

For other methanol fueled vessels such as the cruise ferry *Stena Germanica*, also lubricated by Chevron, methanol bunkers are delivered by truck. For larger applications a diesel bunker barge can easily be converted for methanol bunkering.

Real world vessel operation with methanol bunkers

The M/T *Mari Jone* and M/T *Mari Boyle*, two of seven of the world’s first generation of methanol fueled ships, now operate in a diverse range of global markets. They typically load methanol cargoes in New Zealand, Geismar in Louisiana, and Point Lisas in Trinidad. They also make calls in China, Korea, Australia, the US Gulf, Chile and Peru, and could also see operation in Europe.

Loading bunkers in such a wide range of ports means that the sulphur content of the HFO they burn alone varies from 1.8% to 3.5%. But by their very nature the dual-fuel methanol engines are subject to an even wider range of sulphur conditions: they could be burning 95% methanol, which has zero sulphur, along with either a low sulphur or high sulphur pilot fuel; they could be burning a 0.10% sulphur distillate fuel for ECA compliance; they could be burning up to a 3.5% maximum sulphur heavy fuel oil; or they could be burning a mix of 70% methanol along with either a high or low sulphur oil product.

“This makes it very tricky to know to which level to limit the cylinder oil to the liners, and what the BN of the cylinder lubricant has to be. In fact, one of the biggest concerns when we ordered the engines early on was the effect that dual-fuel operation has on the liners, and it is something no-one could really answer,” says Fredrik Stubner, Director Ship Management, Marinvest Shipping AB.

To meet this challenge, Marinvest turned to Chevron Marine Lubricants for not only their range of cylinder lubricants, but also their DOT.FAST® service to help with optimising the lubrication of the engines. DOT.FAST® provides both onboard and onshore analysis of drip oil giving an accurate measurement of total iron wear, including corrosive wear. Combining both the onboard DOT.FAST® Drip Oil Analyzer for total iron wear and a BN tester, it is the most effective service in the market today.

The role of used oil analysis

Analysis of unburned cylinder oil that has passed through the combustion chamber and passed the pistons and liners in the main engine is an effective way to monitor engine wear. It is recommended by all major OEMs today, and helps operators with a range of optimization requirements, such as guarding against excessive cylinder oil consumption and optimizing cylinder lubrication at different engine operating modes. Monitoring of used oil samples reduces costs for operators, by allowing preventative measures to be taken to protect valuable assets, and minimizing engine down time.

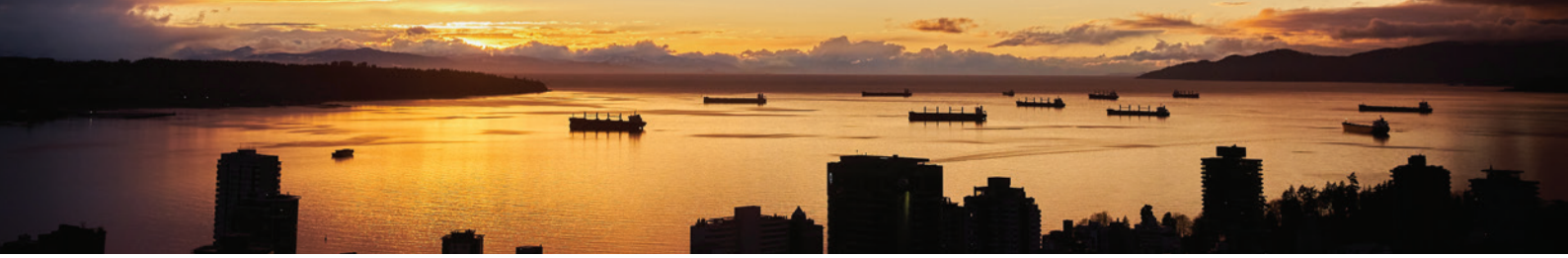
Chevron Account Manager Bert Van Cleemput has worked closely with Marinvest on creating a lubrication package for these pioneering vessels, and attributes the success of the project to the DOT.FAST® program, which early on indicated areas for improvement in feed rate settings and engine hardware.

“When we look at optimizing the feed rates and lubrication of two-stroke engines, the two main parameters are BN and Fe. For onboard analysis, the DOT.FAST® Drip Oil Analyzer is unique and innovative in the industry, delivering laboratory accurate test results right on the vessel. The DOT.FAST® Drip Oil Analyzer comes with everything required to prepare and test samples, including a custom-designed DispoRack™ and software to record, process and interpret results.

“DOT.FAST® onboard analysis delivers immediate feedback on cylinder running conditions, and provides an early indication of elevated levels of both abrasive and corrosive engine wear. At the same time, it helps optimize the cylinder oil feed rate and minimise the build-up of abrasive deposits, cylinder oil consumption, engine fouling, and the risk of scuffing.”

With the onshore analysis component of the DOT.FAST® service, samples sent to Chevron’s laboratory are fully analyzed for base number, iron, and all other elements. The results are tabulated and reviewed by technical experts, and recommendations are reported back to the ship. Using onshore analysis ensures the testing of drip oil samples to the highest industry standards in a quality certified laboratory, and provides comprehensive reporting with to-the-point commentary. Additional benefits include monitoring the effectiveness of onboard (heavy) fuel purification procedures through measurement of CAT Fines (Al+Si).

“DOT.FAST® from Chevron is a critical service in order to control and optimize the reliable lubrication of the engine. It allows us to see on a daily basis the iron content and the TBN number of the breakdown oil. It tells us immediately whether to adjust the cylinder oil feed rate up or down accordingly. There is no need to wait for shore analysis that would mean you lose time and miss the opportunity to act promptly to avoid excessive wear on the piston rings,” says Stubner.



As an extra precaution against cylinder wear, and to safeguard against human error with cylinder oil selection, the vessels are also set to employ MAN's Automated Cylinder Oil Mixing (ACOM) system to ensure the right cylinder oil dosage is utilized at all times. For new engines being delivered this system is now standard.

"Having the ACOM system will help us a lot as normally when we are talking about zero sulphur fuel you want a low BN cylinder oil, like Taro® Special HT LF[3], but in our case we can use methanol along with high sulphur fuel oil where a 140 BN oil might be better. We perform a fuel analysis on all bunkers prior to their use and then input this data into the ACOM system, this then blends the cylinder oils to create the perfect BN mix," explains Stubner.

Industry pioneers

Being among the first to operate with a new fuel will always bring with it unique challenges. In the case of M/T *Mari Jone* and M/T *Mari Boyle*, meeting these challenges has been possible through high levels of support from Marinvest, Waterfront Shipping, a dedicated team at MAN in Copenhagen, and the forward-thinking expertise and strong relationship building skills of Chevron's team of account managers and technical experts.

"The engines were designed and produced in just ten months. There was testing with one cylinder in Copenhagen at first for a few hours, and it worked, so it was then tested in Japan as well as Korea. Once the engine was built it was tested for a number of hours, but our crew onboard our ships were really the first to do it on a long-term basis. It's then you learn things — what has to be improved, what has to be changed, and so on. We feed that back to MAN in Copenhagen, that feeds back to us and we try it out," says Stubner.

"Of course, there is the potential for extra costs and complexities with such a project, such as requiring a dedicated crew, dealing with a prototype engine, and working with a new type of fuel. But was this difficult? I would say no. I am happy to say that it worked very well. It is a challenge only because it is new. When you tackle that hurdle it becomes quite ordinary and normal procedure," Stubner continued.

Future fuels and lubricants

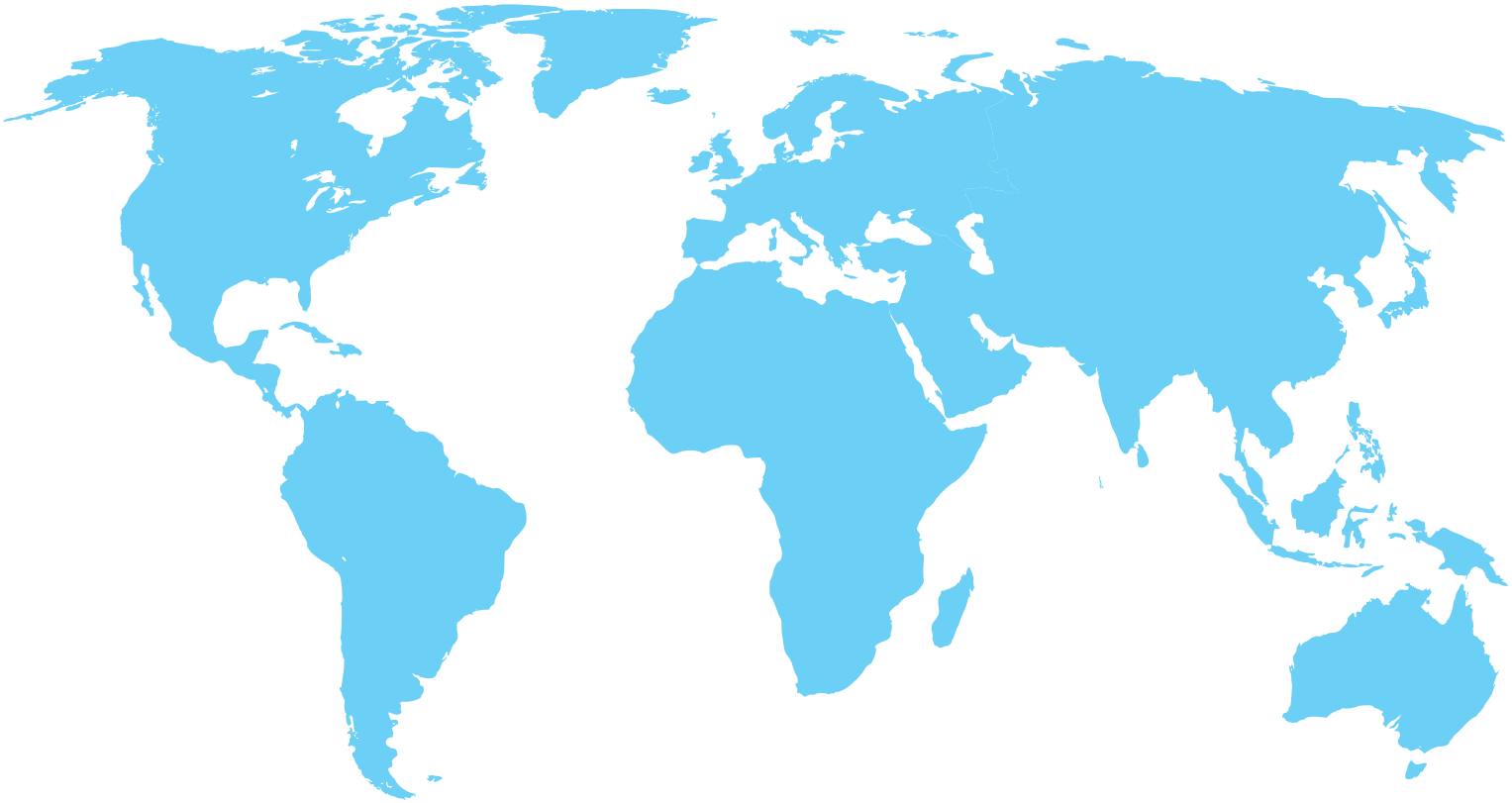
Methanol is just one out of a range of potential alternative marine fuels that — along with LNG, LPG and ethane, among others — is set to play an increasingly important role as shipping navigates its way into a lower sulphur, lower emissions future.

Ian Thurloway, Brand and Marketing Manager for Chevron Marine Lubricants notes: "We expect the implementation of IMO 2020 legislation to result in the use of a wider range of marine fuels, from distillates and low sulphur residual fuels, to new blends and other innovations appearing on the market. Chevron Marine Lubricants is well placed to meet the challenges posed by these changes and working closely with early adopters of alternative fuels such as Waterfront Shipping, Methanex and Marinvest is an example of our commitment to the new low emissions landscape of today and the future. We are proud to supply not only the largest fleet of methanol fueled vessels with our Taro® lubricants with great success, but also the majority of LNG dual-fuel propelled two-stroke vessels operating today."

Chevron's range of Taro®[4] cylinder lubricants from 25BN to ultra-high 140BN covers fuels with virtually any sulphur content ranging from <0.1% to the high sulphur HFOs. Taro® Special HT 100 has just received OEM approval for intermittent steaming in and out of ECA zones with no need to change the cylinder lubricant[1].

As an industry leader with one of the best supply networks in the world and a full range of products to meet the diverse range of needs of both today and tomorrow, Chevron remains committed to providing reliable solutions for the marine fuels of the future.

3. Taro® Ultra 20 replaces Taro® Special HT LF and is fully compatible and miscible.
4. The Taro® Ultra 20BN to 140BN portfolio replaces the Taro® Special HT portfolio and is fully compatible and miscible.



helping you navigate through IMO 2020