IUMI Policy Agenda

7. Fuels

Brief description

The shipping sector accounts for approx. 3% of global CO_2 emissions. International agreements on the need to combat climate change require the reduction of greenhouse gas emissions from shipping. In addition to regulatory pressures from the IMO, other stakeholders such as banks, charterers and the broader public are setting requirements for the environmental performance of vessels, for instance in connection with the financing of new ships and new chartering agreements. Therefore, the industry must examine low and zero carbon ship propulsion systems taking into account the entire value chain, not just the combustion cycle. Notwithstanding the imperative of the green energy transition, it is crucial to assess potential safety concerns associated with measures to reduce the carbon footprint. In light of the urgency to decarbonise shipping, proper risk management is critical and safety must not become an afterthought.

IMO's Sub-Committee on Carriage of Cargoes and Containers (CCC) initiated in September 2021 the development of guidelines on the safety of vessels using hydrogen as fuel under the International Code for Ships using Gases or Other Low-flashpoint Fuels (IGF Code). A proposal for a new output on the development of non-mandatory guidelines for safety of ships using ammonia as fuel was submitted to the Maritime Safety Committee (MSC) in July 2021. The Maritime Safety Committee (MSC) has deferred a decision on this until April 2022. Meanwhile, CCC has instructed a Correspondence Group to collect information on ammonia.

An important aspect of using alternative fuels safely is not only a comprehensive review of risks associated with the new fuels and propulsion methods, but also thorough consideration of how human performance may be influenced by new equipment, new ways of collaboration, and new procedures and processes for bunkering. At the same time, conventional fuel types will be in use for the foreseeable future and until the transition period is concluded.

This section of the Policy Agenda looks at regulatory measures and challenges related to conventional fuels. The second part provides and overview of safety aspects related to a selection of greener fuels, both conventional and alternative.

A. Regulations and challenges related to conventional fuels

MARPOL 2020 regulation

The MARPOL regulation limiting sulphur oxide emissions from ships with a global cap of 0.5% became mandatory on 1 January 2020.

Prior to this date, concerns had been raised in relation to fuel stability, differences in composition and blending from supplier to supplier and port to port, lower flashpoints than the minimum required by international safety regulations, inadequate safety margins for catalytic fines and ignition delays stemming from inferior combustibility. The Maritime Safety Committee (MSC) agreed in December 2018 to include in its biennial agenda an output on 'Development of further measures to enhance the safety of ships relating to the use of fuel oil', with a focus on safety issues related to flashpoint requirements. MSC 103 re-established in May 2021 the Correspondence Group on oil fuel safety to further consider draft requirements and guidelines until MSC 105 in April 2022. The CG is specifically tasked to consider flashpoint and the delivery of non-compliant fuel by oil fuel suppliers, but also measures related to other oil fuel parameters may be considered.

Guidance is offered by the International Organization for Standardization (ISO), classification societies, the International Council on Combustion Engines (CIMAC) and industry associations. In August 2019, a Joint Industry Group published a Guidance on the supply and use of 0.50%-sulphur marine fuel. The guidance is supported by IUMI as one of the project sponsors. The publication provides guidance for stakeholders across the marine fuels and shipping industries, from fuel blenders and suppliers to end users. It presents the specific safety and operational issues relating to the supply and use of max. 0.50%-sulphur fuels, an overview of fuel quality principles, and the controls that should be put in place to ensure that safety issues are identified, prevented and/or mitigated. It addresses issues such as fuel compatibility, fuel stability, and fuel handling and storage, and contains a comprehensive review of existing operational factors that can affect safety. There is also an ongoing review of the ISO standard 8217:2017, with publication anticipated in 2023.

To get a better understanding of the quality of the new fuels and possible safety implications following the implementation of the IMO 2020 sulphur regulation, BIMCO, ICS, INTERCARGO and INTERTANKO conducted a survey on fuel quality and safety among shore-based personnel in the period February – May 2020. Of the respondents, 14% had not experienced any off-spec or operational quality issues, while 62% had to some extent experienced increased sludge deposits. The report concludes that the transition to the 0.5% sulphur limit has not been without problems, and as fuel oil properties are fluctuating, quality and safety problems will continue to be a challenge for the global shipping industry.

The Cefor Technical Forum published their findings on key elements causing problems in relation to the use of the very low sulphur fuel oils (VLSFOs) in April 2021. The additional complexity of the bunkering and handling of the new fuels as well as issues related to tank cleaning, filtering, viscosity, stability and correct use of lube oil are all factors observed to have caused engine damage.

Fuel contamination

Contaminated supplies of biodiesel fuel that were first reported in the US Gulf region in February 2018 led to a range of technical problems, including blocked fuel filters, fuel pump seizures and even loss of main engine power. The cost of an engine damage could be up to USD 800,000 for an individual vessel. The loss of engine power from such contamination may lead to serious incidents such as collisions and groundings.

Testing to ISO 8217 levels will not necessarily show if the fuel is contaminated or not, as the suitability of biofuels requires gas chromatography and specialised equipment in a laboratory to determine any contamination. This test will generally take 7 to 10 days, and there are currently not enough laboratories to perform the necessary testing. Consequently, vessels are forced to sail with fuel in separate tanks and rely on the ability of the crew and equipment to make the fuel fit for use.

IUMI believes that the current system with the end-user taking all the risk is unacceptable. Rather than the end user, refineries should be compelled to do the testing and confirm the delivery of non-contaminated fuels. In parallel, the ISO review of low-sulphur fuels should also include an amendment of the ISO 8217 to deal with biofuels.

A joint MEPC-MSC circular addressing the delivery of compliant fuel oil by suppliers was approved by MEPC 74 and MSC 101 in May and June 2019, respectively. The circular recommends that Member States take appropriate action to ensure that fuel oil suppliers under their jurisdiction deliver compliant fuel.

In December 2018, BIMCO published a Marine Fuel Sulphur Content Clause for Time Charter Parties. The Clause states that charterers are obliged to provide fuel that complies with MARPOL requirements, and also use suppliers and bunker barge operators who comply with the same. Shipowners remain responsible for the fuel management.

B. Low/zero carbon fuels

Ammonia

Ammonia offers a potential long term solution for the maritime industry's transition towards a low carbon value chain. Green ammonia can be produced from renewable power by electrolysis of H_2O, making it a zero carbon fuel. However, due to the extreme toxicity of the fuel it is critical to assess the safety issues of ammonia in order to mitigate risks for people, assets and the environment. Risks such as toxicity and flammability must be addressed for both key equipment, spaces dedicated to ammonia storage and alternative vessel designs. Unless satisfactory safety systems and operations are implemented, the properties of ammonia may lead to an increased overall risk level associated with its use as fuel on vessels.

Battery-powered propulsion

Battery-powered propulsion is suitable for stop-and-go operating cycles such as ferries. Ferry operators in Europe, North America and Asia have been testing and deploying

hybrid propulsion systems for the last decade, and the technology has been adopted for passenger vessels of various sizes.

Thermal runaway constitutes the largest risk for batteries used in maritime operations. Thermal runaway occurs if the lithium-ion cells used in marine batteries are subjected to mechanical abuse, suffer from internal manufacturing defects, or operate over or under the correct voltage or internal temperature. In these situations, heat may be generated within the lithium-ion cells which may increase to a point whereby it melts the separators inside the cells. This reaction can result in the temperature increasing until the cell emits toxic and flammable gasses. If ignition occurs, these gasses can create a fire which can be difficult to extinguish. In large concentrations, these gasses are also capable of causing explosions. Preventing thermal runaway is therefore key, for instance through the use of active cooling systems and internal thermal barriers as part of an effective safety management system.

Biofuels

Biomass is a renewable fuel source. Its use for marine fuels can be considered a carbon neutral way of generating energy because the organic matter used to produce biofuels roughly absorb as much CO_2 during their lifetime as they release when burned. Biofuels are produced from organic matter that is largely unsuitable for food or feed. However, their potential to reduce the amount of arable land earmarked for normal food production is contentious.

For biodiesel, fuel lubricity, conductivity and corrosion are areas of concern. Due to oxidation, it tends to lose lubricity over long periods of time, which may cause wear on essential components. Because electrical conductivity can cause static charges, it is likely to need anti-static additives. Corrosion from the degradation of biodiesel can weaken steel holding tanks and pipelines over time, compromising storage and transportation. Biofuels with high acidity can cause increased wear on engine components, so the engine manufacturer should be consulted when considering the use of fatty acid methyl esters (FAME) in a conventional engine. In the latest specification, ISO 8217:2017 recommended limiting the proportion of FAME in distillate fuel oil blends to 7%, creating the first industry standard for fuel oil with a provision for biofuel.

Fuel cells

Fuel cells produce energy from an electro-chemical process. Two reactants, typically hydrogen and oxygen, merge within the fuel cell to produce water, releasing electrical energy and thermal energy in the process. Although hydrogen is the most commonly used fuel in fuel cells, methanol and ammonia are viable alternatives. The reactants consumed by the fuel cell are stored externally and are supplied to the fuel cell in a similar way as in conventional diesel engines. Hence, a fuel cell has the potential to produce power as long as it has a supply of reactants.

Hydrogen, methane and other gaseous fuels that are lighter than air need special ventilation arrangements to prevent the creation of hazardous areas. For many types of

fuel cells, the non-hydrogen supply is externally reformed to hydrogen and other by-products prior to introduction into the fuel cell, so the hydrogen portion of the fuel system needs special consideration. Fuel management, identifying the risks to personnel and managing the hazardous areas associated with the ships' physical layouts, operations and maintenance are key safety challenges with fuel cell systems. Toxic exposure, asphyxiation and explosions are among the risks to crews and the vessel.

Hydrogen

Hydrogen is a potential alternative fuel for ship propulsion. It requires energy to produce hydrogen which could originate from conventional fuels or non-fossil sources such as wind, hydro-electric or nuclear to make it low/zero carbon. For hydrogen, challenges relate to extremely low temperatures (-253°C) if stored as a liquefied gas, and high pressure (250–700 bar) if stored as compressed gas. The hydrogen molecule is the smallest of all molecules, making it challenging to contain. It also has a wide flammability range and ignites easily. The properties of hydrogen may therefore lead to an increased overall risk level associated with its use as fuel on ships unless satisfactory safety systems and operations are implemented.

Asphyxiation and explosions are potential risks for the crew and the vessel. For the onshore and offshore personnel, an extensive assessment of the hazards associated with physical layout, operations, maintenance, transfer and carriage of the fuel are necessary to ensure safe operations. Onboard ventilation, alarm systems and fire-protection strategies and other measures to limit the likelihood and effects of leakage will need to be designed into hydrogen-dedicated assets.

Liquid natural gas (LNG)

Liquefied natural gas (LNG) is the cleanest-burning fossil fuel currently available at scale; its use as a marine fuel is supported by advanced engine technologies that have been proven in practice. As a fuel, it reduces nitrogen oxide (NOx) emissions, eliminates most sulfur oxides (SOx) and particulate matter, and contributes to carbon dioxide (CO_2) reduction. However, methane slip is a cause for concern because methane, when considered as a greenhouse gas, is much more potent than CO_2.

Familiarity with the properties and characteristics of methane is critical to understanding the safety hazards associated with the use of LNG as a marine fuel. It is not considered to be corrosive nor toxic. Instead, the hazards are related to its storage, transport and combustion, and they also include cryogenic temperatures, vapour flammability and asphyxiation. Due to heat leakage through the insulation into the LNG cryogenic tanks, some of their contents continuously evaporate and generate boil-off gas, which increases tank pressure, potentially raising the risk of LNG and methane vapour releases. Those vapours are flammable and have the potential to asphyxiate workers. If a vapour spill comes in contact with a ship's structure, it causes brittleness and fracturing.

In a liquid state, LNG is not considered flammable and cannot ignite. However, LNG vapours become flammable when the percentage of methane in air reaches 5-15% and it

can ignite when introduced to an ignition source. The auto-ignition temperature of methane is relatively high (595ºC). When released from LNG, methane vapours will at first be heavier than air and then rapidly become lighter than air as it warms beyond -100ºC. It is therefore crucial that safeguards are in place to prevent a flammable mixture from occurring, and to ensure that any sources of ignition are nowhere near.

Nuclear

This source of power has been considered in the past and work was paused after Fukushima. Given the problems associated with other alternative fuels, research into the viability of nuclear propulsion for vessels is being actively undertaken with much hope focused on molten salt reactors.

Relevant authority / organisations and documents

- **IMO – MEPC & MSC**
  - ***MARPOL Regulation 14 & Annex VI:*** "Prevention of Air Pollution from Ships, allowing for special (SOx) Emission Control Areas".
  - ***MSC93/INF.8:*** Safety implications arising from the supply of "Out of Specification" Marine Fuels, submitted by ICS and IPTA, 13 March 2014.
  - ***MEPC70/INF.12:*** Study on fuel oil quality, submitted by INTERTANKO, 22 July 2016.
  - ***MEPC71/5/3:*** Report of the correspondence Group on Fuel oil quality, submitted by the United States, 31 March 2017.
  - ***ISWG-AP1/2/12:*** Safety implications associated with 2020 fuels and their respective challenges, submitted by Liberia, Marshall Islands, ICS, BIMCO, INTERTANKO, INTERCARGO and WSC, 15 May 2018.
  - ***MEPC 73/5/17:*** Joint industry guidance on potential safety and operational issues related to the supply and use of 0.50% maximum sulphur fuels, submitted by ISO, OCIMF, IPIECA, IMarEST, RINA and IBIA, 31 August 2018.
  - ***MSC100/8/1:*** Effective implementation of existing provisions for fuel quality and safety in IMO conventions, submitted by Liberia, ICS, INTERTANKO, IPTA and INTERFERRY, 28 September 2018.
  - ***MSC100/8/2:*** Safety implications and respective challenges associated with 2020 compliant fuels, submitted by Bahamas, Liberia, Marshall Islands, Panama, BIMCO, INTERCARGO and INTERTANKO, 28 September 2018.
  - ***MEPC.1/Circ.875:*** Guidance on best practice for fuel oil purchasers/users for assuring the quality of fuel oil used on board ships, 26 April 2018.
  - ***MEPC.1/Circ.875/Add.1:*** Guidance on best practice for fuel oil suppliers assuring the quality of fuel oil delivered to ships, 9 November 2018.
  - ***MEPC.1/Circ.878:*** Guidance on the development of a ship implementation plan for the consistent implementation of the 0.50% sulphur limit under MARPOL Annex VI, 9 November 2018.

- ***MSC100/WP.11:*** Report of the Drafting Group on Fuel Oil Safety Matters, 5 December 2018.
- ***MSC101/8/2:*** Development of further measures to enhance the safety of ships relating to the use of fuel oil, submitted by ICS, INTERTANKO, INTERCARGO and IPTA, 16 April 2019.
- ***Resolution MEPC.320(74):*** 2019 Guidelines for consistent implementation of the 0.50% sulphur limit under MARPOL Annex VI.
- ***MEPC.1/Circ. 881:*** Guidance for port state control on contingency measures for addressing non-compliant fuel oil, 21 May 2019.
- ***MEPC.1/Circ. 884:*** Guidance for best practice for member state/coastal state, 21 May 2019.
- ***MEPC.1/Circ.864/Rev.1:*** 2019 Guidelines for on board sampling for the verification of the sulphur content of the fuel oil used on board ships, 21 May 2019.
- ***CCC6/INF.6:*** FSA study on the use of low-flashpoint oil fuels, submitted by the EC and Member States, 10 June 2019.
- ***MSC101/WP.10:*** Development of further measures to enhance the safety of ships relating to the use of fuel oil, Report of the Working Group, 11 June 2019.
- ***MSC-MEPC.5/Circ.15:*** Delivery of compliant fuel oil by suppliers, 24 June 2019.
- ***MEPC75/5/2:*** Bunker Supplier Licensing Schemes, submitted by ICS, BIMCO, INTERTANKO and WSC, 27 December 2019.
- ***MSC102/6:*** Development of further measures to enhance the safety of ships relating to the use of fuel oil, report of the Correspondence Group, 18 February 2020.
- ***MSC102/INF.19:*** Lessons learned from the mechanical incident caused by non-compliant fuel oil that contains deleterious chemicals, submitted by China, 10 March 2020.
- ***MSC102/6/2:*** Comments on document 102/6, submitted by the Cook Islands and ICS, 24 March 2020.
- ***MSC.1/Circ. 1622:*** Guidelines for the acceptance of alternative metallic materials for cryogenic service in ships carrying liquefied gases in bulk and ships using gases for low-flashpoint fuels, 2 December 2020.
- ***MSC.1/Circ. 1599/Rev.1:*** Revised interim guidelines on the application of high manganese austenitic steel for cryogenic service, 4 December 2020.
- ***MEPC76/5:*** Review of 2020 marine fuels quality, submitted by ISO, 29 January 2021.
- ***CCC7/3/Rev***.1: Amendments to the IGF Code and developments of guidelines for low-flashpoint fuels – report of the Correspondence Group, 30 April 2021.
- ***CCC7/3/9***: Comments on CCC7/3/Rev.1 and proposal for developing guidelines for the use of ammonia and hydrogen as fuels, 14 June 2021.

- ***MSC104/15/9***: Development of non-mandatory guidelines for safety of ships using ammonia as fuel, submitted by Japan, Singapore, ICS and INTERCARGO, 2 July 2021.
- ***MSC104/15/30:*** Necessity of deliberations on operational safety measures and fire safety measures, submitted by Japan, 30 July 2021.
- ***A32/12/2:*** The development of safety requirements at the needed pace and detail to support the achievement of a decarbonization goal, submitted by IACS, 23 November 2021.

- **EU**
  - ***Sulphur Directive 1999/32/EC*** with amendments.
  - ***COM(2021)562:*** Proposal for a regulation on the use of renewable and low-carbon fuels in maritime transport and amending Directive 2009/16/EC ('FuelEU'), 14 July 2021.
- **CIMAC**
  - ***Congress 2013, Paper no. 51:*** "Onboard fuel oil cleaning, the ever-neglected process How to restrain cat-fine damages in two-stroke marine engines". Paper presented by experts from MAN Diesel and Turbo (Denmark), DNV Petroleum Services (Singapore), NanoNord (Denmark), Alfa Laval Tumba (Sweden).
  - ***Position Paper 6/2015:*** New 0.1% sulphur marine (ECA) fuels, June 2015.
  - ***WG7 Fuels:***
    - Guideline - Cold flow properties of marine fuel oils, January 2015.
    - Fuel quality Guide - Ignition and combustion, 2011.
    - 2018 marine fuel incidents, November 2018.
    - Guideline – Marine fuel handling in connection to stability and compatibility, November 2019.
  - ***Position Paper 01/2020:*** Zero carbon energy sources for shipping (ISWG-GHG7/5/1, submitted by EUROMOT, 5 February 2020)
    - White Paper 1: Production pathways for hydrogen with a zero carbon footprint
    - White paper 2: Zero and net zero carbon fuel options
- **UK P&I Club** Risk Focus: Loss of power
- **Joint Hull Committee** information pack: Marine engine damage due to catalytic fines in fuel, joint paper with Braemar (The Salvage Association), 26 September 2013
- **U.S.**
  - ***Environmental Protection Agency (EPA):*** North American Emission Control Area: http://www.epa.gov/otaq/oceanvessels.htm#north-american
  - ***Coast Guard:*** Safety Alert 10-18: U.S. Gulf Coast bunker contamination, 8 June 2018.
- **Wärtsila** Fuel Oil Requirements (Heavy Fuel Oil).
- **MAN:** Service Letter SL2014-593/DOJA, December 2014.

- **Gard** Loss Prevention Circular No. 01-14: Prevention of engine damage due to catalytic fines, February 2014.
- **IACS Machinery Panel:** No. 151 Recommendation for petroleum fuel treatment systems for marine diesel engines, July 2017.
- **ISO:**
  - ***8217:2017*** – Specifications of marine fuels, 21 March 2017.
  - ***ISO/PAS 23263:2019:*** Petroleum products – Fuels (class F) – Considerations for fuel suppliers and users regarding marine fuel quality in view of the implementation of maximum 0.5% sulfur in 2020, September 2019.
- **U.S. Coast Guard:**
  - Safety Alert 13-15: Ultra Low Sulphur Fuel Oil & Compliance with MARPOL Requirements, 19 November 2015.
- **IUMI:** Position Paper on Catalytic Fines and Engine Damage, 8 March 2016 (https://iumi.com/opinions/position-papers).
- **INTERTANKO** Critical review: Contaminated Bunkers damage hundreds of ships. Do authorities really care?, 10 August 2018.
- **International Chamber of Shipping:** Provisional guidance to shipping companies and crews on preparing for Compliance with the 2020 'Global Sulphur Cap', September 2018.
- **BIMCO:**
  - 2020 Marine sulphur content clause for time charter parties, 10 December 2018.
  - 2020 Fuel transition clause for time charter parties, 10 December 2018.
- **Joint Industry Guidance:** The supply and use of 0.50%-sulphur marine fuel, 20 August 2019.
- **Exhaust Gas Cleaning Systems Association (EGCSA):** Global marine SOx emissions regulation map: https://www.egcsa.com/map-regulations/
- **BIMCO, ICS, INTERCARGO and INTERTANKO:** 2020 Fuel Oil Quality and Safety Survey, 19 August 2020.
- **Cefor:**
  - Technical Forum Memo 9: Post-IMO 2020 experiences, 7 April 2021.

Timeline / important dates

- **Sulphur limits:**
  - Californian waters: 0.1% sulphur limit as of 1 August 2012.
  - European and North American ECAs: 0.1% sulphur limit as of 1 January 2015.
  - MARPOL – outside ECAs: 0.5% sulphur limit as of 1 January 2020.
  - China:
    - Coastal territorial waters, except coastline Hong Kong, Macao and Taiwan: 0.5% sulphur limit as of 1 January 2019.
    - Inland water ECAs: 0.1% sulphur limit as of 1 January 2020.

        - Regulated waters of Hainan Island: 0.1% sulphur limit as of 1 January 2022.
    - South Korean ECA:
        - Certain ports introduces 0.1% sulphur limit from 1 September 2020.
        - 0.1% sulphur limit when navigation in the ECA area from 1 January 2022.
- IACS Unified Requirement: 2Q 2016.
- MEPC 74: 13 - 17 May 2019.
- MEPC 75: 16-20 November 2020; adoption of guidelines and treatment of MARPOL samples.
- MSC 104: 4-8 October 2021.
- MSC Correspondence Group consideration of fuel oil safety until MSC 105 in 2022.
- MSC 105: 20-29 April 2022.
- IMO Energy Efficiency Existing Ship Index (EEXI) enters into force 1 January 2023.
- New ISO 8217 standard expected to be published in 2023.

IUMI will:

- Encourage an amendment of the 60mg/kg limit for cat fines and the inclusion of biofuels in the ISO standard.
- Support a review by MSC of the safety aspects of implementing the 0.5% sulphur limit that took effect from 2020.
- Suggest that refineries are compelled to test and confirm the delivery of non-contaminated fuels.
- Increase awareness for alternative low and zero carbon fuel types and propulsion methods, and contribute towards any necessary safety regulation amendments.