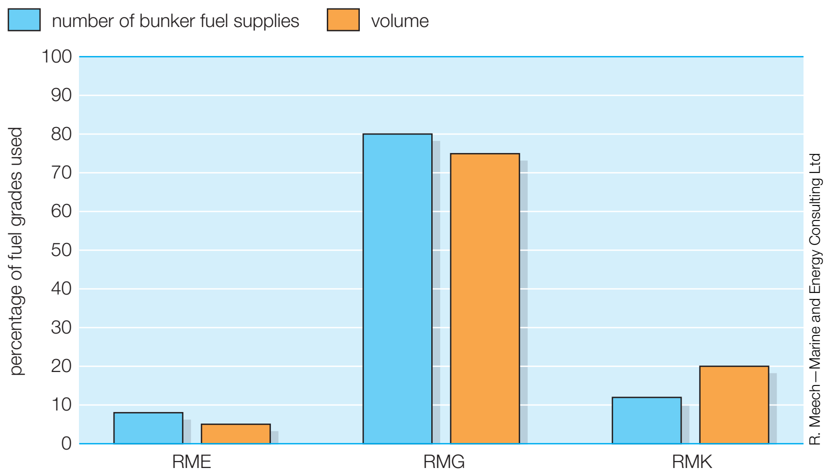
Transportation and fuels: looking ahead at the future of marine fuels

The International Bunker Industry Association (IBIA) takes a look at where we have come from, where we are and the possibilities for marine fuels in the years to come.

The global marine fuel market is generally accepted to be about 250 million tonnes per annum (pa). Today's marine fuel would be recognisable to those who bought, sold and used marine fuels for the past 70 years, except for new requirements a few years from now to reduce sulphur content. The storage and delivery logistics are fundamentally the same, and the worries, concerns and attitudes of the users are unchanged (chief engineers have always complained about poor quality fuel). Most of today's market is for residual fuel categorised as ISO grade RMG380. Almost all ocean-going ships over 5,000 deadweight tonnage (dwt) use this product as their main fuel grade. An increasing number of larger ships are now using heavier, more viscous fuels such as the RMK grade, that are proving to be more economic.

The fraction of vessels that are fuelled with lighter residual fuels is decreasing; the ubiquitous ISO RME180 fuel (180 cSt grade) used by general cargo vessels of the 1970s has been largely replaced by the RMG380 grade for all but the most demanding engines. The demand for distillates, once heavily biased towards heavier diesel and blended diesel, is now concentrated on gas oil of ISO grade DMA (Figure 1). The majority of vessels use this for their auxiliary machinery (only 10% of the vessel's total requirement) but almost all fishing vessels, seismic, offshore, warships, small coasters and high speed craft use distillates as their only fuel grade. The international marine distillate requirement today is about 40 million tonnes pa. This volume will increase dramatically when the regulations requiring the use of 0.1% sulphur fuels at sea come into force in specific regions in 2015. This will have a significant effect, because it will require ships to switch between residual and distillate fuels when entering and leaving an emission control area (ECA). These regulations have three main effects on the market: (1) the imposition of more fuel grades, with most grades split into high and low sulphur; (2) the need for segregation of on-board storage; and (3) an estimated 40% increase in fuel cost based on today's cost difference between residual and distillate fuels. The use of very low sulphur fuels (below 0.1% S) in certain areas is also leading to complications with the management of fuel storage and on-board systems. This is because operators must store a wider range of fuel types and manage the changeover process from fuel oil heated to over 140°C at the engine and distillates which may need to be chilled to 30°C.

Figure 1 Most common residual fuel grades (globally, 2012)



In January 2015, sulphur limits in ECAs will be mandated from 1.0% S down to 0.1% S. Besides managing the temperature at changeover (as described above), the operators must also manage the increase in distillate fuel costs and change the allocation of on-board storage to manage much higher volumes of distillate than were needed when the vessels were built. A typical oil tanker or bulk carrier of 100,000 tonnes dwt would have been built with storage for 2,500 m^3 of residual fuel and about 250 m^3 of distillate fuel. This will need to be reconfigured to about 1,800 m^3 high sulphur residual and 700 m^3 low sulphur distillate, in addition to the existing 200 m^3. This conversion will be needed to accommodate today's ECAs and allow for the expected classification of additional ECAs in the future.

Changes in the bunker market are initially linked to variation in global trade. It is anticipated that growth will reflect the expected increase in global GDP of about 4% pa over the next 5–10 years, according to the International Monetary Fund (IMF)[1]. The resulting increase in tonne-miles is predicted to grow at a slightly slower rate influenced by many factors including changing domestic/export ratios in major developing economies and shorter vessel routings. The marine

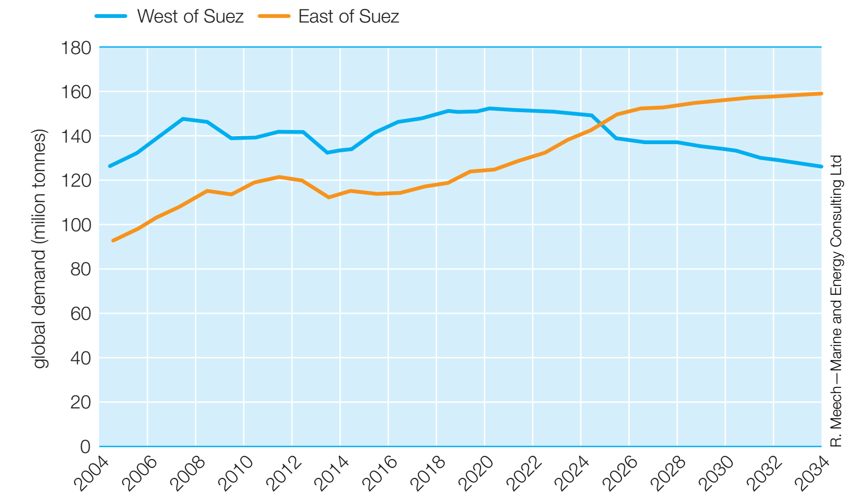
[1] IMF, *World Economic Outlook: Hopes, Realities, Risks* (April 2013); *World Economic Outlook: Transitions and Tensions* (October 2013).

fuels market growth will be lower than this, at about 1.6% pa over the next decade, reflecting the reduction in the age of the world fleet, newer ships being more efficient than older ones, improvements in ship efficiency recently mandated by International Maritime Organization (IMO), and the continued use of slow steaming as one important tool in reducing carbon dioxide levels. The higher price of bunkers, particularly lower sulphur fuels, will mean that the most fuel-efficient operators will survive. Over the coming decade, growth will be less than 2% in the market for residual and distillate bunkers because of slower trade flows, and the fuel efficiency of vessels will further improve. (LNG is likely to be less than 5 million tons in 2023, so not a real cause of reduced conventional bunker demand growth). We expect that the growth in marine fuel demand will be concentrated in the Middle East and Asia, while demand west of the Suez Canal will flatten at best and decline in North America (Figure 2).

The European and North American ECAs will increase global demand for 0.1% S by an additional 40–50 million tonnes of distillate. The minimum 60°C flash point for this product is expected to challenge refiners. While global availability will be adequate, some local difficulties are expected due to a mismatch between geographical demand and availability. This will require the movement of fuel cargos from one area to another with associated costs. The continued lack of consistency internationally on legislative requirements is a concern. For example, between 2014 and 2020, the industry must supply all residual grades with max 3.5% S, 1.5% S, and 1.0% S and distillate fuels with max 2.0% S, 1.5% S, 0.5% S and 0.1% S (Figure 3).

In Annex VI of the MARPOL Convention, the IMO requires that the global limit on marine fuel sulphur must be reduced from max 3.5% S to 0.5% S in 2020. At this time, this will effectively mean a switch from residual fuels to distillate fuels. However, the same Convention recognises the impact that the additional demand for 150 million tonnes of fuel could have on availability. Hence, the MARPOL Convention expects to complete a fuel availability study before 2018 with an option to defer the reduction in the global S limit from 2020 to 2025 if sufficient 0.5% S fuel is not likely to be available in 2020.

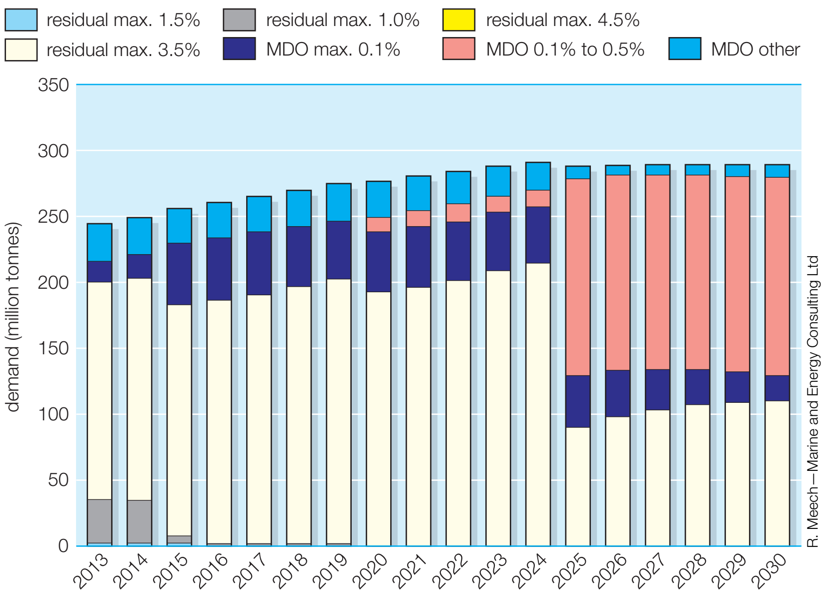
Figure 2 Global demand for marine fuels, 2004–2034



Unfortunately, IBIA is not in a position to answer this question, even though it is very important to know when sufficient product will be available to meet the demand. Indeed, the EU has already voted to switch to the new lower S limit in 2020 in all European Economic Exclusion Zones even though the IMO may choose to delay the introduction of the new S limit to 2025. The start date is obviously important because it will have an impact on ship, refinery and fuel supply investments.

Figure 3 Global demand for marine fuels by fuel grade, 2013–2030

Assumes 0.50% global limit implemented in 2025



Of course, R&D projects are looking at novel ways to produce 0.5% S blends, produce fuels from biomass and use conversion techniques to meet the market demand, but there is little optimism that these approaches can produce the commercial volumes required by the market in the short time available.

MARPOL limits on sulphur have focused to date on a global limit and on a special ECA limit for the fuel that is received on-board vessels. However, Regulation 4 of Annex VI allows the use of other techniques to achieve equivalent results, namely that ship emissions are at or below the level achieved when using fuel with the specified sulphur content. At the moment, the most common equivalent is aftertreatment of the exhaust (scrubbing) to permit the use of fuel with higher sulphur content. Exhaust gas scrubbing can be achieved through wet open-cycle scrubbers (salt water), wet closed-cycle scrubbers (fresh water with chemical treatment) and dry scrubbing (calcium hydroxide). These are all mature technologies but have some particular issues for the marine sector.

In addition to perceived technological risks in scrubbing equipment, investments have been limited because ship operators in ECAs can choose before 2015 between 0.1% S gas oil at about $900/tonne or invest in a scrubber and use higher-sulphur residual fuel at about $600/tonne. For a vessel operating in an ECA for more than 100 days pa, the payback time for the scrubbing investment is expected to be about three years. When the global limit has been fully introduced, all vessels will benefit by scrubbing higher-sulphur residual fuels rather than by consuming 0.5% S fuels that will be predominantly distillates and about $200–300/tonne more expensive on the basis of current market prices. There is also an interesting view that if scrubbing systems are fitted to most new ships in the future, then the demand for residual fuel, which is diminished in the near term by the adoption of lower sulphur distillate fuels, could have a resurgence. With continuing refinery investments to further convert low-priced residual to higher-value products, there may not be enough residual fuel available after 2035.

MARPOL also specifies limits for nitrous oxide (NO_x) emissions in ECAs. A combination of engine improvements and the use of selective catalytic reduction (SCR) will achieve the most stringent regulations which will apply to vessels constructed after 2016 operating in the

North American and Caribbean ECA. Technical issues associated with operating SCRs in combination with sulphur scrubbers are being addressed and seem unlikely to present major problems on future new ships.

The emissions regulations can also be met by using alternative fuels, most notably biodiesel and LNG. Biodiesel has significant cost disadvantages as well as some problems with long-term storage, microbial growth, and sensitivity to water and elevated temperatures, all of which are inherent in marine fuel systems. LNG is seen as the future fuel because it has far lower emissions than conventional fuels. In some regions, especially off the US coast, LNG could also be cheaper once the supply infrastructure is sufficiently developed to economically deliver LNG into ships' bunker tanks.

Under current IMO regulations, LNG can only be used by LNG tankers or when operating in restricted trade areas. This is being addressed by the IMO, which is producing a new set of rules for conventional vessels using methane as fuel with fuel storage as a cryogenic liquid. There are now more than 70 non-LNG tanker ships operating in restricted trade areas that are already storing and using LNG fuel. Many authorities see LNG as a significant solution for reducing energy and GHG emissions, some predicting that it will be used on up to 25% of new ships within the next 10 years. Much work is in progress on the supply infrastructure.

One worry for the shipping sector, especially in the ECA zones, is that pressure to use high priced 0.1% S gas oil will increasingly lead to intermodal shift, where cargo that is currently transported by sea will shift to land-based transport. While this could reduce the sulphur footprint for shipping, it will also result in a much higher overall GHG footprint, congestion on highways, and a higher burden on consumers and taxpayers. Shipowners will probably pick the 'least cost and best fit' option that meets their needs based on their own trading pattern.

Clearly, the bunker fuel industry is entering interesting times with tighter fuel specifications, shifting demand, and new fuel qualities and operating regimes. A transport sector that hasn't changed a lot over the past 70 years is about to experience the biggest change since the shift from coal to bunker fuels.

Author: Nigel Draffin

Nigel has worked in shipping for 48 years. He has served at sea on LNG tankers and Oil tankers. He has worked in technical and commercial positions in Shell International Marine and at E.A. Gibson Shipbrokers.

Nigel is Immediate Past Chairman of the International Bunker Industry Association and Technical Manager of LQM Petroleum Services, and lectures on courses on Bunkering worldwide.

He is a Marine Engineer, a qualified Quality System Auditor, an Arbitrator and Past Master of the Worshipful Company of Fuellers.