FOBAS FUEL INSIGHT

Fuel quality report 2024

Looking back at the first half of 2024 and forward to the year ahead

Introduction

We will take a look back at some of the key trends and areas of concern with marine fuels over 2024. Fuel as always is a vital consideration and expense for any ship operator and with fast changing regulations and fuel formulations there is more attention than ever needed to understand the quality and availability of marine fuels around the world and what to look out for. With the new ISO8217 standard recently released in June and the increasing use of bio-fuel blends along with EU and IMO regulations to consider, the year ahead will likely continue to provide challenges for the marine fuel industry.

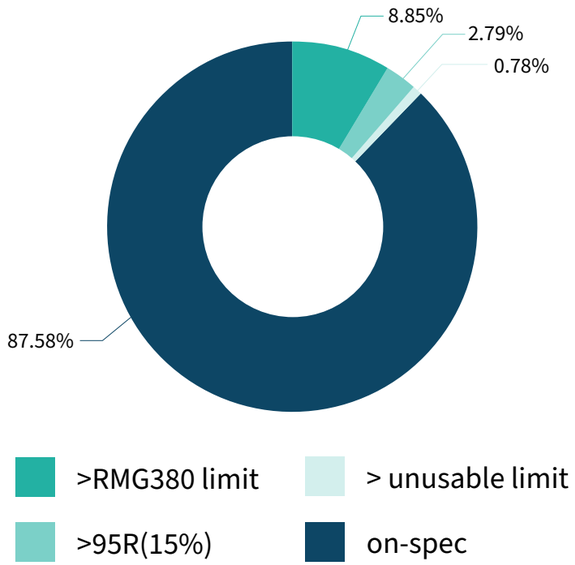
2024 at a glance

2024 has seen some challenges but on the whole the fuel market has been fairly steady from a quality perspective. No major widespread incidents such as seen in recent years but recurring problems such as fuel stability, sulphur and flash point regulation non-compliance and increasingly the introduction of bio-fuels into the market.

Off-specification* fuels

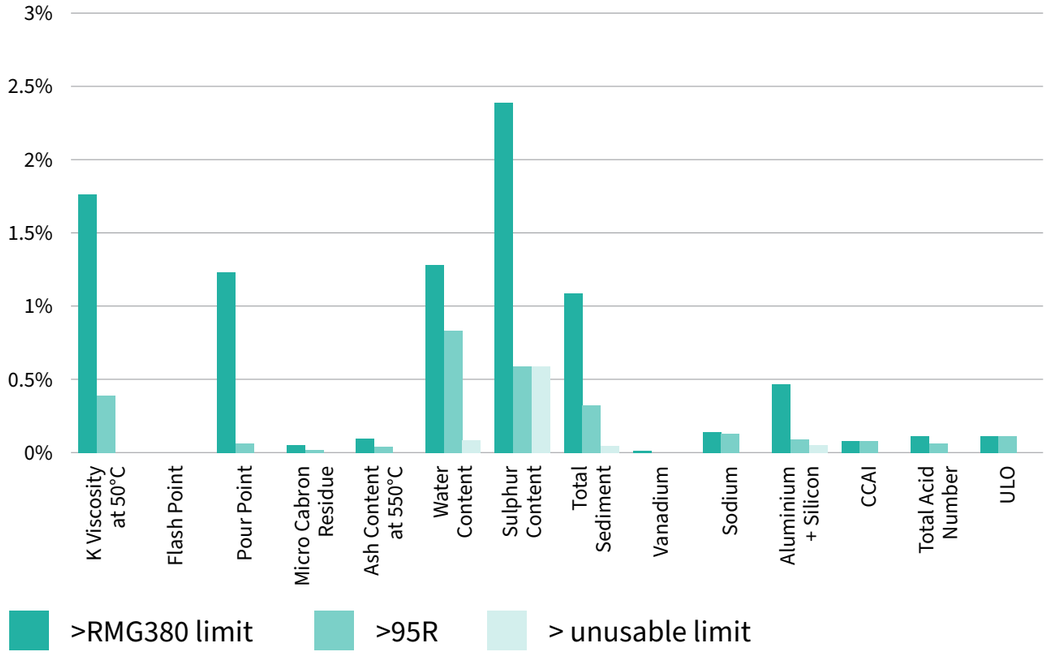
Residual based fuel oils

Figure 1: Residual off-spec



- ISO8217 RMG380 limits used for ease of comparison (some high-density viscosity grades bunkered RMK500, some specifically low viscosity RMD80/RME180 but majority are RMG380)
- 95% Confidence Limit test tolerance range as given in ISO8217/ISO4259
- Many off-spec fuels can still be used. “Unusable” limit taken either from a regulation ie. Sulphur/Flash Point, or levels where fuel management would become very difficult ie. Water/ sediments/cat-fines

Figure 2: Residual off-spec (RMG380 2010 limits)

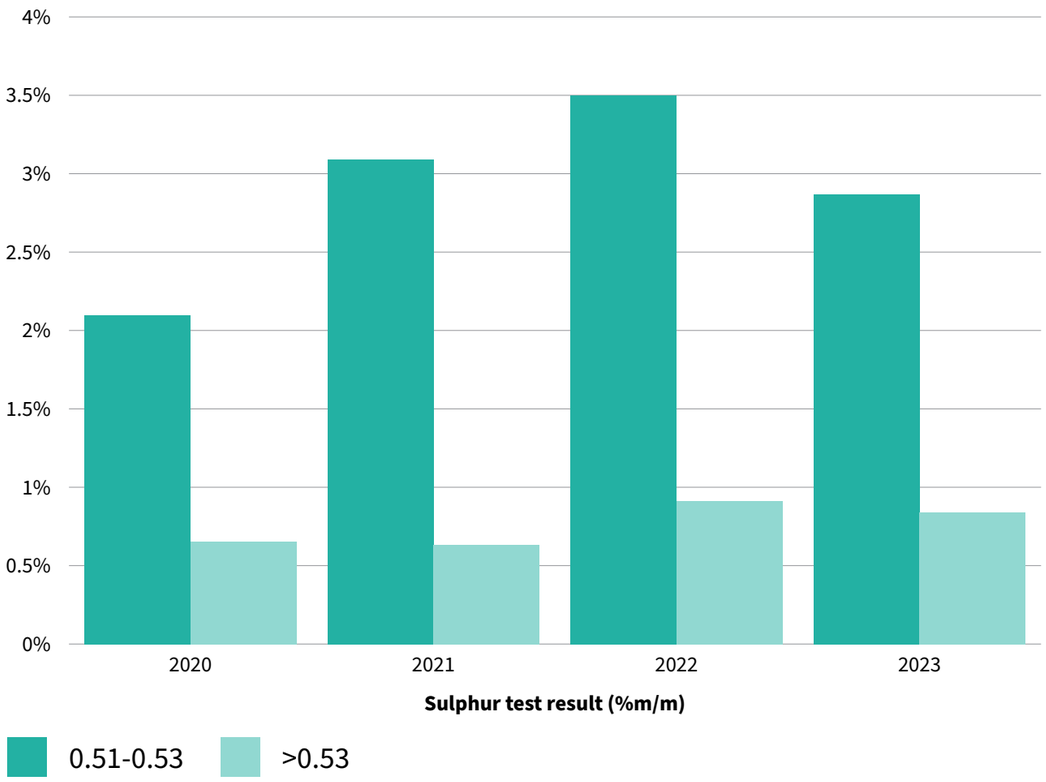


Off specification being defined as when the fuel has exceeded the given ISO 8217 parameter limit + the 95% confidence 0.59R test precision allowance. So for example 0.50% Sulphur limit is off spec when it has exceeded (0.50+0.03) 0.53%

The majority of residual fuels bunkered in 2024 were on-spec (figure 1), particularly when allowing for the 95% confidence range of the specific limit. One of the biggest issues remains off-spec sulphur results. Close to **3% of Residual based VLSFO fuels, based on the recipients sample, had a tested sulphur of between 0.50%m/m and 0.53%m/m *(figure 2)*;** these fuels can be considered still usable, and in compliance with Marpol Annex VI and the 0.50% limit, any onboard samples taken during an inspection have this same tolerance range up to 0.53%m/m applied. However, results in this range still cause some confusion and concern with ship operators, and suppliers should therefore still be aiming to meet the 0.50% limit exactly with the margin of error on the lower side of the limit (i.e. 0.47%m/m or below). This has slightly improved on 2022 *(figure 3)* but still an issue. However with close to 0.9% of VLSFO fuels having sulphur tested to be >0.53%m/m, this becomes a bigger problem for the vessel and they now have potentially non-compliant fuel and unless they have a EGCS onboard, in which case they would likely not be bunkering VLSFO anyway, there are not many other options except for de-bunkering (exceptions may be given due to safety or environmental reasons but only by relevant authorities eg. Vessel flag Administration).

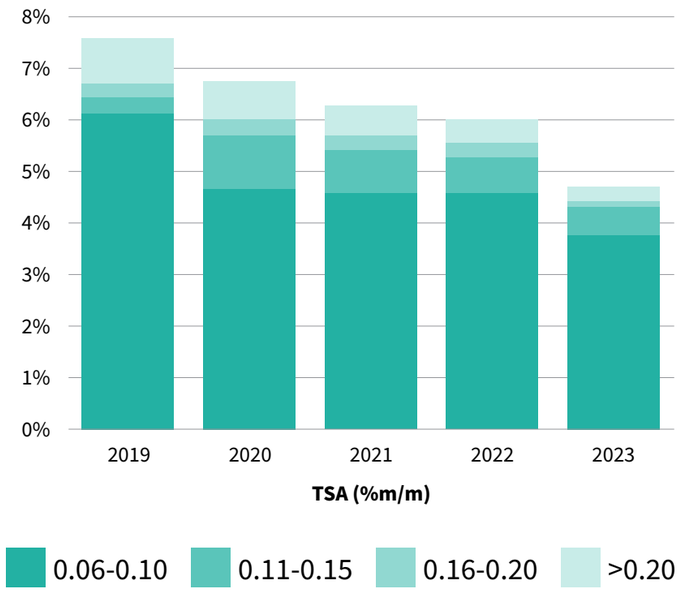
Inevitably , on receipt of a note of protest on the sulphur content, the supplier will check their own drawn sample which, in accordance to IMO Annex VI Appendix VI guidance, the sulphur content must not exceed 0.50% m/m.

Figure 3: VLSFO Sulphur



Total Sediment remains one of the biggest issues with residual fuels, although there is a generally improving trend over the last few years *(figure 4)*. The high Total Sediment results can be due to a number of issues, most commonly due to asphaltene instability in the fuel blend. This is a much bigger problem in some ports and regions than others. From some of the major ports Houston stands out a problem area *(figure 5)*, with Antwerp also high. These ports tend to have a wide range of suppliers and traders, and a wider portfolio of blend stocks available from the local refinery, this therefore leads to a higher risk of incompatible and unstable blends than places such as Fujairah where less blending is generally needed. Santos stands out as having very low results and in fact many South American ports where the crude oil source is generally naturally low in Sulphur and therefore no blending needed to achieve <0.50%m/m Sulphur and therefor much less stability risks.

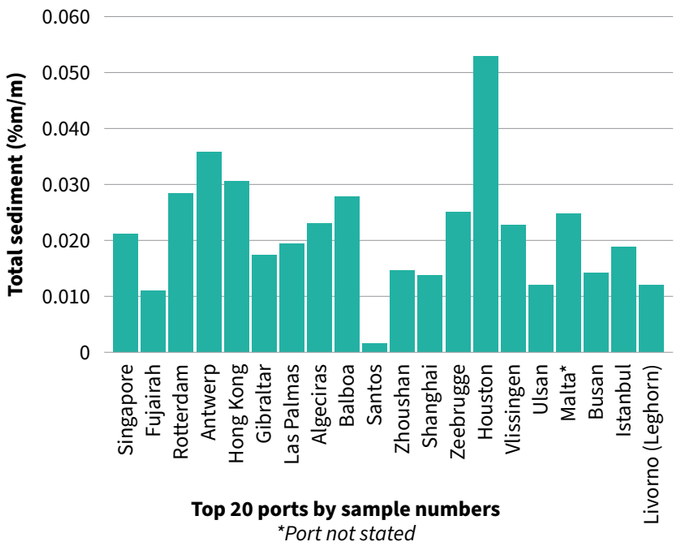
Figure 4: TSA



- TSA (Total Sediment Accelerated) ISO10307 2B

Figure 5: Average of Total Sediment

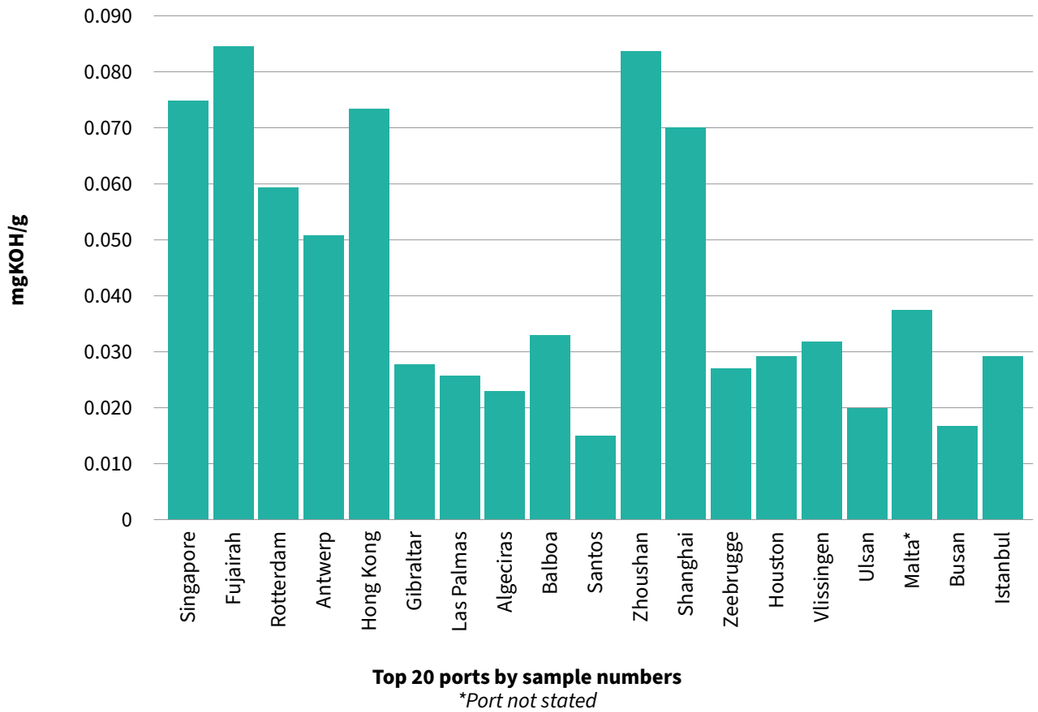
2024 1st Jan-30th June



- Total Sediment as reported (could be TSA (Total Sediment Accelerated ISO10307 2B or TSP (Total Sediment Potential ISO10307 2A
- Sediment results reported as <0.01%m/m taken as 0.00 for calculation
- Certain ports worse than others, particularly Antwerp and Houston

Another interesting parameter to look into is the acid number of residual fuels (figure 6). In terms of off-spec results, these are rare to see however there is a lot of variation within the allowed range, up to 2.50mgKOH/g, and big differences between different ports and regions. Certain South American ports, particularly around northern Brazil and Venezuela can have very high acid number fuels, they are not included in our top 20 ports *(figure 6)*, but it is interesting to note, from these regions in particular these very high acid number fuels always show the presence of naphthenic acids when investigated further and are generally good quality fuels. In fact, the highest acid number results are often not the most concerning, particularly in ports where this is common. It can be the fuels with acid number in the **0.50 – 1.00 range** where we see more issues, as at these levels it is often lower than would be expected for a high naphthenic acid fuel but is still well above zero and therefore suggestive of some other types of organic acids present (we will cover this more when looking at forensic test results).

Figure 6: Average acid number

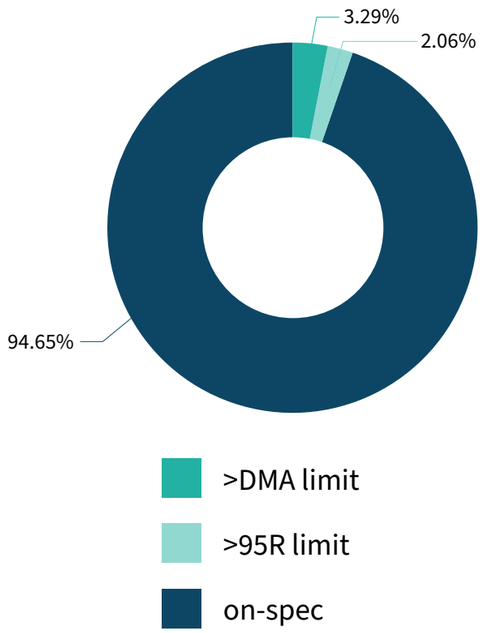


Top 20 ports by sample numbers
**Port not stated*

Distillate fuel oils

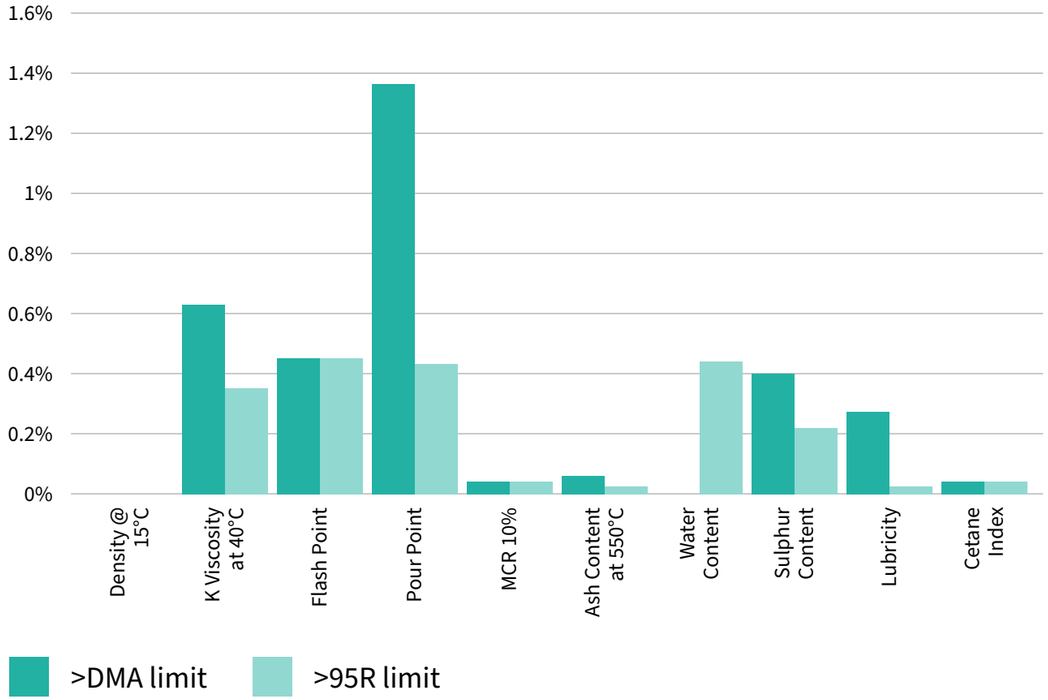
Generally, Distillate fuels are a cleaner and more controlled product in comparison to residual fuel grades, however there are still particular concerns that need to be paid attention to, such as cold flow properties and bio-fuel blending, along with regulatory parameters namely Flash point and Sulphur. It is rare for an MGO fuel to be of bad enough quality to cause serious damage or need to be de-bunkered, however sulphur and flash point off-specs in particular can leave a fuel non-compliant with IMO or local regulations and unable to be used.

Figure 7: MGO (DMA limits) off-spec



- ISO8217 DMA limits used, almost all MGO fuels are bunkered against DMA

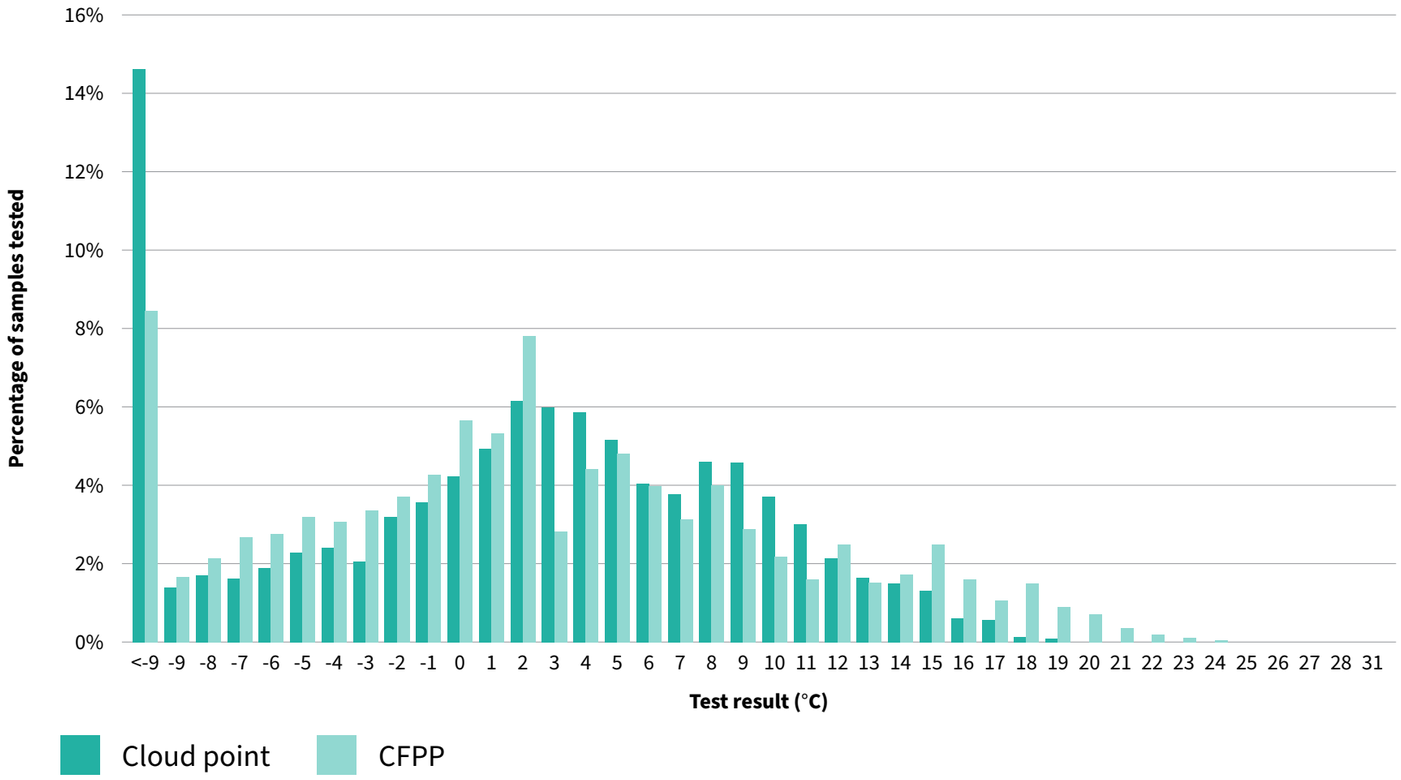
Figure 8: Distillate off-spec (ISO8217 2017 DMA limits)



Viscosity is occasionally off-spec however usually only marginally above the 6 cSt limit and rarely a serious operational concern.

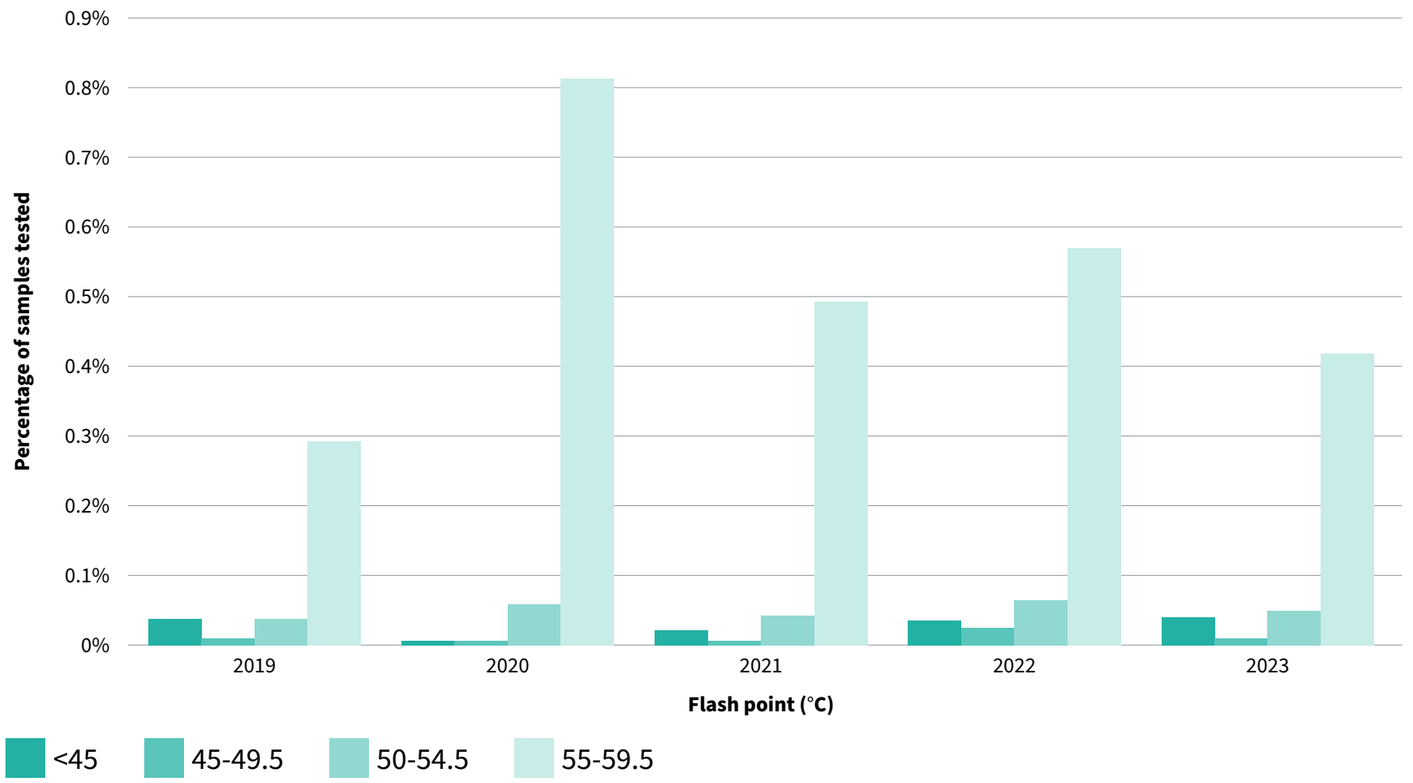
Pour point is seen in the 0 – 6 Deg C range on occasion, often in ports such as Singapore where there are fewer local concerns with high pour point fuels. The bigger concern often with distillate fuels is the Cloud point, and CFPP (Cold filter plugging point) in particular which gives an indication of the temperature where enough wax is present to start accumulating at fuel filters. These parameters do not have specified limits in ISO8217 although there is a requirement for suppliers to provide a result for both if requested and it should then be up to the vessel operator to assess the suitability of the fuel based on fuel system heating and vessel trading pattern.

Figure 9: MGO cloud point and CFPP results



Low flash point results are an ongoing issue with marine distillate fuels, in that they are not totally eliminated. The 2023 off-spec results can be seen compared against the previous four years (figure 10). The vast majority are marginal cases, usually in the 55-60 Deg C range. Many countries have limits in this range for automotive diesel and this can be one reason for the low flash points, in some cases certain vessel such as yachts bunkering at small ports may be offered a fuel grade that is in effect a land grade diesel and not blended to meet the SOLAS 60 Deg C limit.

Figure 10: MGO Flash point



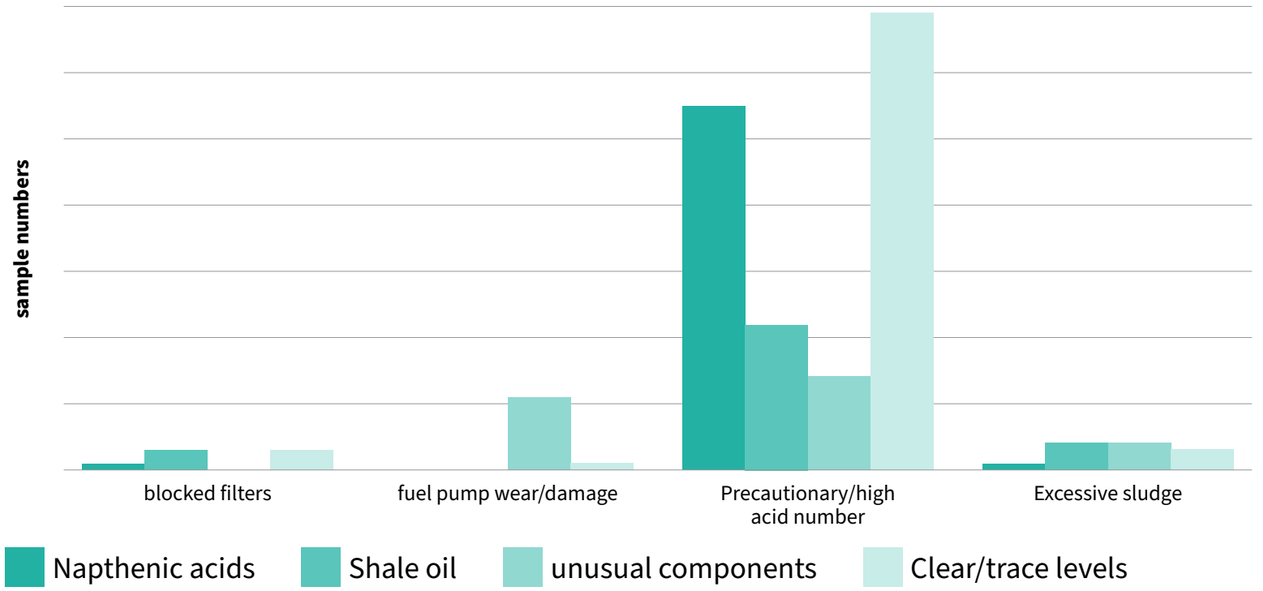
- The SOLAS Flash point limit of 60 Deg C does not state any allowable margin of error below the limit
- Flash point test results are reported to the nearest 0.5 Deg C

Forensic Testing/fuel chemistry

Along with the routine testing carried out on bunker samples there are many cases where more detailed investigative chemical analysis is requested or required to understand the compositional nature of the fuel. This can be prompted by a higher than expected acid number result, a recent problem reported from a particular port or some operational problem experience by the vessel in question. Testing methods selected may vary depending on what the intended parameter being investigated is and so approached on a case-by-case basis. We need to be careful when reviewing the analysis data and drawing conclusions more broadly but we can at least look at some of the findings and some results are shared below.

The majority of fuels investigated with full FTIR and GC-MS testing are clear from any significant levels of chemical compounds being present and a high proportion of high acid number fuels (>2.00mgKOH/g) are found to have naphthenic acids. Naphthenic acids occur naturally in crude oil and depending on the crude oil source will be at higher or lower levels in the eventual marine fuel product, however there is no evidence for any damage or problems caused by naphthenic acids, at least at the levels we generally see in marine fuels.

Figure 11: Forensic testing (FTIR + GCMS methods)



- Fourier Transform Infrared (FTIR)
- Solid Phase Extraction(SPE referred to as acid extract)
- Gas Chromatography Mass Spectrometry (GCMS)

Another point we can pick up on, as mentioned previously, is that fuels with acid number in the 0.50 – 1.00mgKOH/g range are at a level where the fuel is not completely free from organic acids, however not at a high enough acid number to most likely be naphthenic acids and we can see, as an example, that often we find low levels of other compounds such as the indications of the presence of Shale oil, and in some cases a range of other unusual material.

It can be difficult when looking at the forensic test results to determine the exact source of certain compounds and the possible operational impact and the levels detected that they will have, however by comparing the GC-MS finger print of various fuels from different vessels and then receiving an operational feedback from the use of the fuels we can build up a better picture. For example we can compare against samples of pure Estonian Shale oil for example or pure CNSL(Cashew Nut Shell Liquid) which we have tested previously and thus can make some clear assessments about what is in the fuel, in some cases where it has come from and what operational precautions to possibly take.

It should be understood that GC-MS, whilst a useful extended investigative tool, used to understand better the chemical make-up of the fuel, and in some cases identifying any unusual chemical compounds, such as Organic Chlorides , it is still very limited due to its limited search library in its analytical library set up , less than 1%, of the tens of thousands of chemical compounds that might be present. Then the question arises as to what has not been detected as well as what has.

Therefore using the chemical analysis can be very difficult in respect to coming to some agreement with the supplier in way of it, on its own identifying the ‘cause’ of the ‘effects’ being reported by the ship. In these cases ISO 8217 Clause 5 should be referred to as detailed to the right.

- ISO8217 2017 General requirements 5.2: The fuel shall be free from any material at a concentration that causes the fuel to be unacceptable for use in accordance with Clause 1 (i.e. **material not at a concentration that is harmful to personnel, jeopardizes the safety of the ship, or adversely affects the performance of the machinery).**
- ISO8217 2017 Annex B: “…a refinery, fuel terminal or any other supply facility, including supply barges and truck deliveries, should have in place adequate quality assurance and management of change procedures to ensure that the resultant fuel is compliant with the requirements of Clause 5.”

Major incidents

Although there are a number of cases of off-spec fuels and fuel related operational problems throughout the year, we occasionally see a number of fuels from the same area causing common problems across a number of ships, indicating a potential supply chain quality integrity breakdown. Looking back to last year we had one such issue in Houston which is worth discussing as there are still concerns with fuel quality in this area.

CASE 1:
Houston and New Orleans – Fuel pump problems, unusual chemicals in fuels

Around April/May 2024 we received reports from a number of vessels stating problems using recently bunkered fuels, mainly from Houston and to a lesser extent New Orleans and a small number of other nearby ports in the US Gulf coast area. The problems were mainly centred on fuel pump wear or damage (example in figure 12), resulting engine operational problems loss of power leading to total engine failure in some cases.

Some of these problem fuels were investigated with detailed forensic FTIR and GC-MS analysis. The results of which showed a number of unusual chemical compounds, although no clear single chemical compound between every problem fuel and some fuels with unusual chemicals detected seemingly used without problems.

While the exact chemistry involved in the fuel pump damage remains unclear it is apparent these fuels contained a mixture of chemicals, potentially some form of waste products from bio-fuel production or other refinery processes and it could be argued they failed to meet the general requirements of an ISO8217 compliant fuel as mentioned above.

These incidents mainly occurred with fuels bunkered from March through to July so would appear to have been something eventually addressed by the supply chain however a clear indication of the risks to fuel quality particularly in ports and regions where there is a large refining and chemicals industry and opportunity for various products to enter the marine fuel supply chain.

Figure 12:

- **Fuel pump after using fuel bunkered in Mobile, USA, April 2023**

  Despite the range of unusual chemicals detected it was not possible to determine the exact cause of the damage , however what was clear is that the continued reported problems from fuels of similar finger print chemical markers, pointed to one or more other undetectable elements of a blend feedstock which is unsuitable for use in marine bunkers - we have since been advised that a study

Bio-fuel – FAME

In 2024 we have continued to see an increase in the number of ship operators starting to use biofuels onboard on regular basis or at least trialling to gain necessary experience.

There are a number of different products that could be described as biofuel so we have to be careful to be sure of exactly what is being referred to. This is particularly important for any ship operator purchasing fuel where they must be clear what they are actually agreeing to load when offered a bio-fuel.

Selection of established “bio-fuels” against standardised specifications

- **FAME – Fatty Acid Methyl Ester** (most common product when referring to biodiesel) – quality standards EN 14214 and ASTM D6751
- **HVO – Hydrotreated vegetable oils** (paraffinic diesel known as renewable or green diesel) quality standard EN 15940

Figure 13: Bio-fuels tested

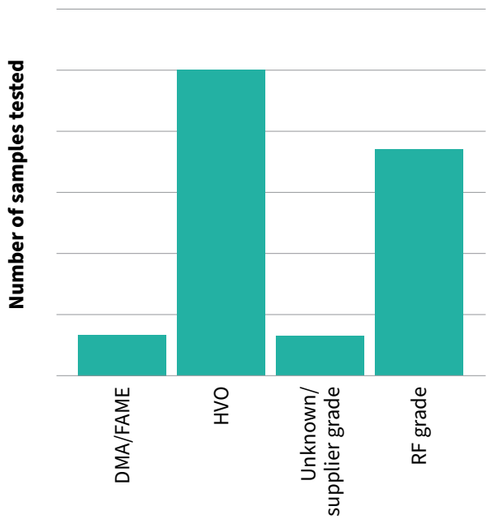
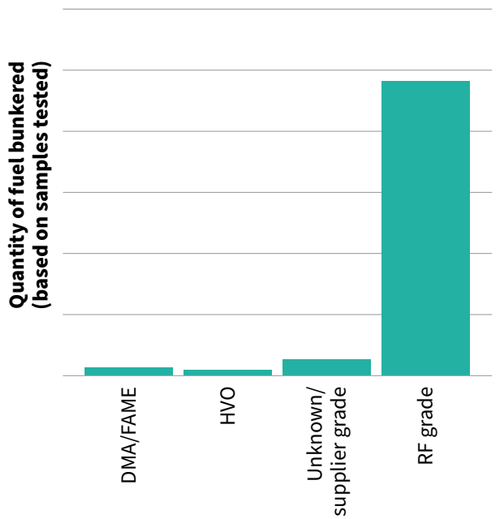


Figure 14 : Bio-fuels tested



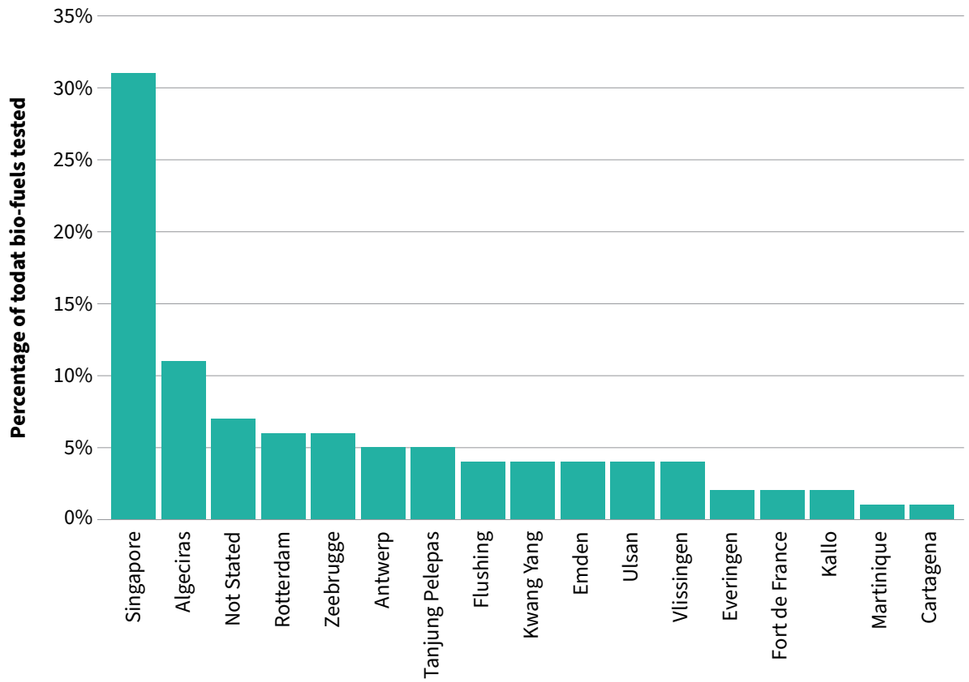
- High number of HVO samples, many of these are bunkered by small vessels such as tugs
- Certain vessels on regular routes such as car-carriers are able to have a contract with one particular supplier
- Most large trading vessels are trialling VLSFO/FAME blends

What we see most often over the last year are blends of regular VLSFO with 20 – 30% FAME, most commonly referred to as B20 or B30, RMG380 B30, VLSFO B30 or some similar. This range of VLSFO to FAME seems to be common for a number of reasons, firstly it leaves the product still with properties generally in line with a standard VLSFO. The % of FAME is also limited in some ports by regulations relating to what the supply barges can and cannot carry depending on their class i.e. whether an IBC Annex 1 tanker, which bunker barges are very often, or a chemical product tanker IBC Annex II rated. From our experience, B30 FAME based fuels have been used now by a number of vessels without any reported problems. It is important to realise that with 70% VLSFO the majority of issues reported relate to this part of the blend rather than the 30% FAME, whether relating to high Sulphur, cat-fines, Sediments etc, all of which are not an issue with FAME. Where there may be problems if when the FAME itself does not meet the required quality standard, such as EN14214. So far this does not seem to have been a big issue but looking ahead as the supply of FAME may struggle to match increased demand there may be a risk of the lowering of the quality, which will need to be monitored.

We also see some vessels using FAME based blends that are marketed as a brand name and the supplier gives their own quality spec limits, however lacking in the necessary transparency of what product exactly has been blended, also needed for the clarity in the carbon calculations. It can be a concern where no exact definition is given for the products used in the blend however our experience with some of the more popular blends seems so far to be generally positive.

Singapore is where we have seen the most VLSFO/FAME based bio-fuel bunkering, however recently more fuels from Algeciras also seems to be popular along with ports in the ARA region (figure 15).

Figure 15: VLSFO/FAME bio-fuels tested



One of the major quality incidents from 2022 involved a high number of vessels experiencing problems after bunkering fuels in the ARA region and subsequently discovering that Cashew Nut Shell Liquid (CNSL) had been used as a blend component at up to 20% and from an unknown resource. These cases were clear off-spec fuels as they had not been sold as bio-fuels and not declared as such to the ship using this fuel. We have not seen anything of the same extent in 2023 however have still seen CNSL detected in a small number of fuels with some resulting in operational problems. CNSL along with other biofuel types and renewable fuels of non bio origins are currently being tested and in some cases sea trialled. Very much driven by the industry recognising the need to find other low carbon fuel sources to meet the demand for non fossil sustainable fuels. With this in mind a lot of work will be required to understand what products can and cannot be safely used in a marine environment/ ship engine/fuel system and transparency will be needed to be clear what products are actually being bunkered.

Year ahead

ISO 8217

The international marine fuel quality standard, ISO 8217:2024 7th edition has just been released replacing the previous 6th edition of 2017. As many will be aware there have been a number of editions of the standard since its first publication in 1982, specifically 1996, 2005, 2010/2012 and 2017, which are all still used and quoted in bunker contracts. The test methods added, parameter limits and general requirements have evolved over time, however the new 2024 version sees considerable changes, with updates focussing on aligning more with the shift to predominantly VLSFOs since 2020 and a greater focus on bio-fuels moving from 7% in the distillate fuel to allowing up to 100% for FAME and in residual fuel oils as well. With this in mind it is important to clearly understand the changes and potential implications for purchasing fuel.

EU ETS, FuelEU, IMO CII, etc

Along with the new ISO8217 standard there is also the inclusion of the marine industry in the EU ETS (emissions trading system) and along with other IMO, EU and wider industry pressures there will likely be more incentive to start switching to bio-fuels for many vessels and with this a continually growing bio-fuel supply market. This will bring challenges in terms of availability and cost, as well as clearly understanding the relevant regulatory requirements, and will also introduce challenges from a fuel quality point of view. As mentioned previously we have already seen some problems where untested bio oils are sold without proper understanding of the performance on a marine engine and fuel system. This malpractice is likely to continue as the industry looks to meet demand and reduce costs.

Alternative fuels

There of course is also continuing development and progress on alternative fuels, such as methanol, hydrogen, ammonia. These new fuels introduce a number of issues to consider but will be important parts of the overall fuel mix going forwards and for the foreseeable future alongside traditional marine residual and distillate fuels and drop-in fuels.

To find out more about Alternative fuels for shipping, please refer to LR's industry leading report series – **Fuel for thought**

Summary

To conclude, the general picture of fuel quality in 2024 is one similar to the past few years, at least since the shift to predominantly VLSFO in 2020. The same historical quality concerns such as cat-fines and stability, sulphur and flash point remain, and isolated incidents of chemical contamination are still occurring. Looking forward, the application of the newly established ISO 8217:2024 standard, which includes all current fuel types, is anticipated to be adopted swiftly. We can also expect an increase in the demand and use of different biofuel and RFNBO types, not just of FAME. This adds significant challenges to the maritime industry to maintain the control of the quality and composition transparency of the fuel supplied.

For more information visit www.lr.org/FOBAS

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