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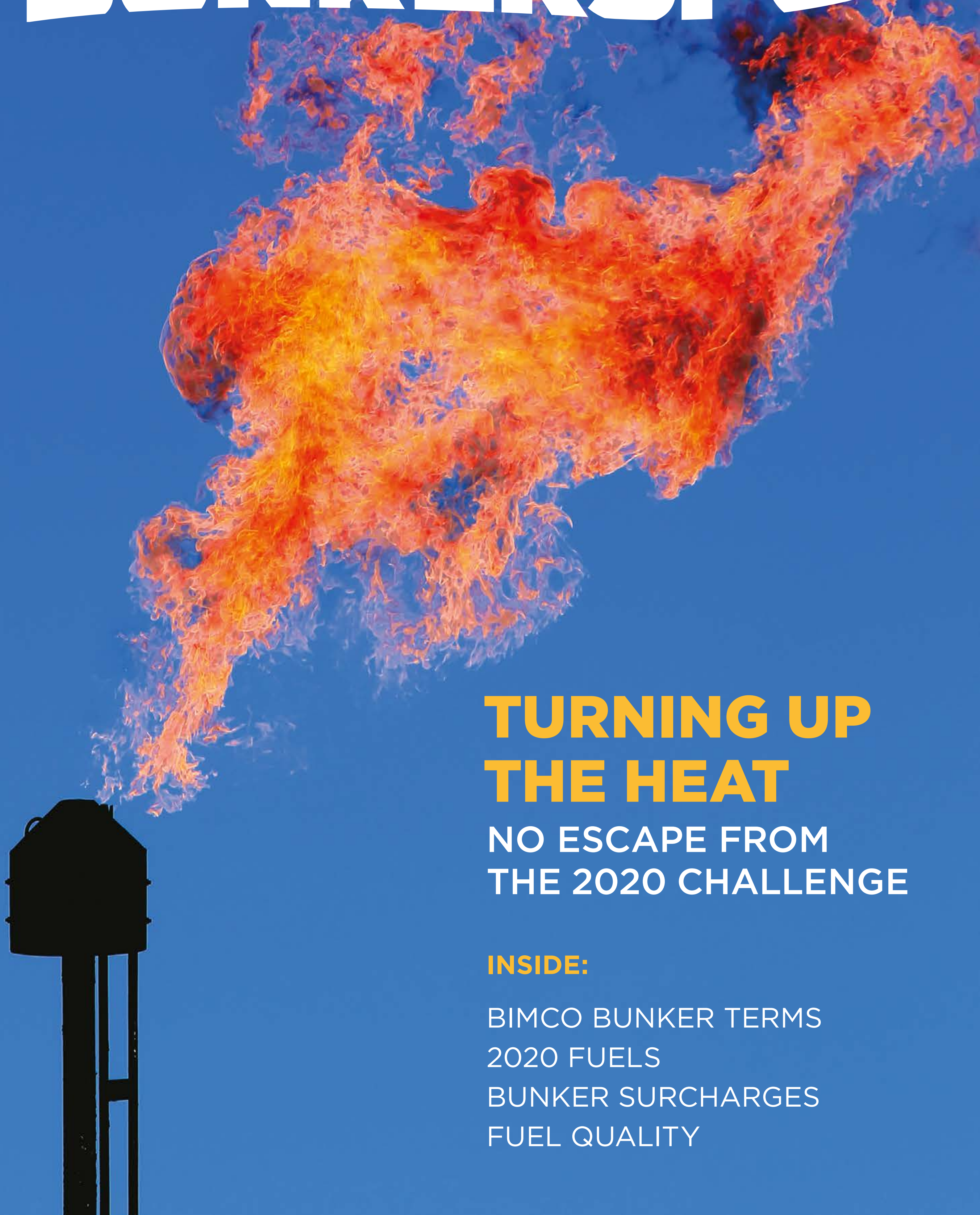

TURNING UP THE HEAT

NO ESCAPE FROM THE 2020 CHALLENGE

INSIDE:

BIMCO BUNKER TERMS
2020 FUELS
BUNKER SURCHARGES
FUEL QUALITY

Number-crunching

Albert Leyson of Drew Marine points to a likely shortfall in compliant distillate fuel availability in 2020. Is it time to look at on-road diesel as a possible solution – and revisit the difficult issue of fuel flashpoint?

By now, we should all be aware that the reduction of the global fuel sulphur cap from 3.50% to 0.50% is inevitable and that there are few, if any, means of preventing or delaying this game-changing event. With 1 January 2020 just over a year away, one critical decision – to the tune of a few multi-million dollars – still looms large for many operators. That decision is to whether to invest in the installation of an exhaust gas scrubber for the removal of sulphur oxides (SOx). Without the installation of a SOx scrubber, operators may be faced with a bigger fuel bill or could potentially be fined for the use of non-compliant fuel.

Certain operators have already decided to avoid the higher premiums which are anticipated for the price of compliant low sulphur fuel oil (LSFO), and to pursue the use of exhaust gas scrubbers instead. A SOx scrubber would allow the continued use of high sulphur fuel oil (HSFO), enabling the vessel to still meet the equivalent SOx emission limit as if 0.50% LSFO were being used. In fact, some operators have gone as far as securing a financial stake of 20% or more in their respective scrubber manufacturers. On the other hand, some operators have opted to prepare their vessels for the switchover to 0.50% LSFO.

Viewed as a much simpler route, switching to 0.50% LSFO would allow operators to merely clean out their residual fuel oil tanks prior to their first LSFO bunkering. Cleaning of the residual fuel tanks would help avoid the possible formation of sludge deposits as a result of incompatibility between the new LSFO and any residual fuel remaining on board (ROB).

However, operators could be faced with a bunker supply shortage, which has been anticipated in certain geographies, and could be fined by relying solely on fuel switching for compliance.

Let us keep in mind that these anticipated LSFO supply shortages are the very reasons that would artificially raise bunker prices, at least initially or until the suppliers meet the LSFO demand. One certain way to ensure that the LSFO supply would meet demand is to consider sourcing compliant fuel from a much larger supply-pool, especially for those areas that have already predicted a shortage of compliant fuel.

I can recall such a proposal from a presentation which was made at an annual green shipping event in 2012. The proposal was suggested because at the time there had been some uncertainty about the availability of enough compliant fuel for meeting the 2015 fuel sulphur limit of 0.10% for emission control areas (ECAs). The presentation was called, *The Case for Harmonizing Marine and Auto-Diesel Flashpoint Limits*[1]. (A detailed study on the flash point limits for both vertical markets will be covered later in this article.)

The presentation claimed the refinery investment that would have been required to meet the rising global energy demand at the time, which had included the 0.10% LSFO demand for ECAs, had been falling behind. It was further suggested that the marine industry would be able to meet the increasing demand for distillate fuels by utilising a much wider supply of LSFO sources from the automotive or on-road diesel market.

If we review the macroeconomic consequences of the reduction of the ECA fuel sulphur cap from 1.0% to 0.10% in 2015[2], there was a 3.1% reduction of residual fuel oil output versus a gain of 2.1% in gas/diesel oil output. This was according to the data published by the International Energy Agency (IEA) in 2015, excerpts of which are shown in Table 1.

Interestingly enough, most of the increase in diesel demand, which showed a gain of 4.3% for gas/diesel oil, appeared to have stemmed from Europe, where the two European ECAs were established.

With all things remaining the same in terms of the number of refineries and their capacities, if we were to take the difference between the refinery gross output of gas/diesel oil in 2015 and compare it to last year, it should be possible to certainly produce another 10,485,000 metric tonnes (mt), or 1.6% increase in output, from 2017[3]. (see Table 2 for details on the IEA 2017 refinery gross output in OECD regions).

However, if we take into consideration several industry estimates, including the IEA's, that suggest approximately 75% of the current demand for HSFO would shift to LSFO come IMO 2020, could we be faced with a significant shortfall of compliant fuel? In order to answer this question, we would need to determine the amount of LSFO that would be required.

Working with a commonly estimated bunker market of about 230 million mt per year, this would translate to 630,137 mt

Region	Product, thousand MTs	2014	2015	% Change
OECD Americas	Gas/diesel oil	289 915	291 625	0.6
	Residual fuel oil	45 997	42 248	-8.2
OECD Asia Oceania	Gas/diesel oil	104 872	105 527	0.6
	Residual fuel oil	31 216	29 304	-6.1
OECD Europe	Gas/diesel oil	256 955	268 096	4.3
	Residual fuel oil	70 835	71 869	1.5
Total OECD	Gas/diesel oil	651 742	665 248	2.1
	Residual fuel oil	148 048	143 421	-3.1

Table 1: 2015 Refinery gross output in OECD regions

Region	Product, thousand MTs	2016	2017	% Change
OECD Americas	Gas/diesel oil	284 045	284 665	0.2
	Residual fuel oil	41 288	42 127	2.0
OECD Asia Oceania	Gas/diesel oil	105 205	106 367	1.1
	Residual fuel oil	32 369	29 022	-10.3
OECD Europe	Gas/diesel oil	260 328	263 731	1.3
	Residual fuel oil	75 240	77 838	3.5
Total OECD	Gas/diesel oil	649 578	654 763	0.8
	Residual fuel oil	148 897	148 987	0.1

Table 2: 2017 Refinery gross output in OECD regions

per day. Taking 75% of this daily amount would yield 472,603 mt per day. To convert this daily LSFO demand by weight into energy, we take an average energy content for residual fuel of 40.5 MJ/kg to calculate a LSFO energy demand of 19,140 TJ/day.

In order to determine the amount of LSFO that would be needed in the form of marine gas oil (MGO), we would need to use a typical MGO energy content of 43.0 MJ/kg. This would result in an MGO demand of 445,126 mt per day or 162,470,930 mt per year. Subsequently, since 0.10% LSFO is comprised of mostly MGO, let us equate the required amount of LSFO 0.10% to the above-mentioned MGO demand.

Next, in order to determine the amount of LSFO that would be needed in the form of 0.50% LSFO, we would need to use the calculated energy content of 42.7 MJ/kg for 0.50% LSFO. The calculated energy content was obtained using 87% MGO blended with residual fuel. This would translate to 448,253 mt per day or 163,612,412 mt per year of 0.50% LSFO demand.

From either route, 0.50% LSFO or 0.10% LSFO, there would be an apparent shortage of compliant distillate fuel by a factor of fifteen. The factor of fifteen is derived from dividing the average LSFO demand of 163 million mt by the readily available increase in annual output of 10,485,000 mt, which was calculated earlier.

Again, all things remaining the same in terms of refinery gross output for gas/diesel oil, then overcoming this apparent shortage of compliant LSFO may become a very big challenge!

Enter the solution of potentially sourcing an unlimited amount of compliant fuel from the on-road diesel market. After all, most of the world's refineries have been designed for maximum distillate production as distillate streams are often the highest in demand and the most profitable product stream. Unfortunately, this is easier said than done.

One of the main challenges of utilising on-road diesel as a marine fuel has been the low flash point of automotive gas oil or diesel oil. With the average flash point of on-road diesel at 55°C, it is too low to meet the minimum flash point of 60°C, which originated from SOLAS in 1974 for passenger ships with more than 36 passengers.

While available globally, the different flash point requirements of the largest on-road diesel markets from around the world vary greatly.

We have a minimum flash point requirement of 52°C in the United States and in Brazil, > 40°C in Canada, > 55°C in the European Union (EU) and Middle East, a minimum of 50°C in Japan, and a minimum of 35°C in India.

As a result of the disparity of flash point requirements from the various geographies, on-road diesel would be hard-pressed to use as a cure-all unless, of course, the minimum flash point of 60°C for marine fuels was lowered accordingly.

As an aside, SOLAS had originally required in 1960 that new passenger ships use fuel with a flashpoint of not less than 110°F (43°C). By 1981, SOLAS was amended to subject all fuels, except as otherwise permitted, to 60°C minimum. From then onwards, the first official marine specification from British Standard per BSMA 100:1982 established the flash point of marine fuel grades, with the exception of one grade, as 60°C minimum.

The only exception has been the grade reserved for emergency purposes such as emergency diesel generators and diesel lifeboat engines. From BSMA Class M1 grade to the current ISO 8217 DMX grade, the flash point of fuel reserved for emergency purposes has been set at 43.0°C minimum. Likewise, SOLAS stipulates that for emergency generators, fuels with a flash point of not less than 43°C may be used.

While the exception may have more to do with the increased reliability of using a higher quality distillate which just happens to have low flash point, I find it somewhat diverting that lifeboats, which are specifically designed to carry passengers, are still permitted to use such low flash point fuels.

Back to the aforementioned proposal for the expanded use of on-road diesel – it was noted that the predominant on-road diesel fuel specification was *EN 590 Automotive fuels – Diesel – Requirements and test methods*, which was very similar to the US version *ASTM D 975 Standard Specification for Diesel Fuel Oils*. Generally, both standards required additional test parameters to be analysed when compared with ISO 8217 Petroleum products – Specifications of marine fuels. In order to make a point, some of the notable similarities and differences between these two on-road diesel fuel standards versus our marine standard should be addressed.

EN 590 has had a lubricity specification of 460µm; whereas ASTM D 975 has had a higher and relatively more tolerable 520µm wear scar diameter requirement. The difference in the lubricity limits could be attributed to engine tolerances between the types of on-road diesel vehicles in the EU versus the United States. Nevertheless, on-road diesel engines are usually high-speed engines; whereas, marine engines are generally medium-speed and slow-speed diesel engines.

Yet, due to similarities in the advanced injection technology used across all diesel engine types, ISO 8217 eventually added a lubricity requirement of 520µm in 2010, which was likely a precaution over the increasing use of ever lower sulphur fuels in marine. In fact, other parameters, along with their limits, including hydrogen sulphide (H_2S) (2.00 mg/kg), acid number (0.5 mg KOH/g), and oxidation stability (25 g/m^3) were also added to ISO 8217:2010.

To elaborate, the ISO 8217 oxidation stability limit was made the same as the upper limit of 25 g/m^3 per EN 590. Interestingly, in lieu of the acid number as required by ISO 8217, both EN 590 and ASTM D 975 have required different copper strip corrosion ratings of Class 1 and Class 3, respectively.

In contrast to ISO 8217, neither on-road diesel standard has ever had an H_2S requirement. The absence of H_2S testing could simply be due to the fact that the hazards posed to drivers as compared to onboard crew have been non-existent in the relatively smaller diesel tanks found in on-road diesel vehicles. This just goes to show that the range of specification requirements by parameter and by their respective limits can vary within the same market as well as across different vertical markets.

Using a more recent example and to serve as a final case in point, EN 590 has allowed up to 7% fatty acid methyl ester(s) (FAME) content since the early 2000s, although the practice of commingling FAME with diesel has been known to have occurred as early as the ►

1990s. To give emphasis to the time gap or delay of when our marine fuel standard eventually comes to adopt facets of on-road diesel standards, ISO 8217 did not allow the inclusion of FAME until the 2017 edition. Last but not least, to recognise the growing inclusion of FAME in marine fuels from the on-road diesel supply chain, the *de minimis* level has been raised from the 0.10% FAME from the 2010 edition to 0.50% FAME in the current 2017 edition.

In my opinion, we cannot continue to turn a blind eye to the ever-increasing manifestation of on-road diesel in marine bunkers nor of the apparent need for an update of the bunker regulations. While IMO has adopted Resolution MSC.391(95) *Adoption of the International Code of Safety for Ships Using Gases or Other Low-flashpoint fuels (IGF Code)* in 2015, this regulation has really addressed more of the requirements for ships using LNG. The IGF Code has more or less relegated low flash point fuels to comply with existing SOLAS regulations.

Therefore, without a specific regulation in effect, we should consider the possible measures that would be required in order to avoid a flashpoint problem from the potential distillate shortfall come IMO 2020, all the while mitigating the risks to personnel, the ship, and the environment.

First, we should ask ourselves whether reducing the minimum flash point requirement by 5, 10 or 17 degrees or even 22 degrees Kelvin would truly produce any additional hazards other than those already known, which can be suitably mitigated by current firefighting standards and by the incorporation of additional physical measures, such as through improved ship board engineering and design.

As examples, could the compulsory use of an alcohol resistant firefighting foam concentrate, which is similar to that which is required by the Fire Safety Systems Code for chemical tankers, sufficiently reduce the risks of fighting a fuel oil-based fire? Could fuel tanks be designed to be situated further away from the boundaries of machinery spaces to allow the storage of fuel oils with a flashpoint of less than 60°C and still be in compliance with existing regulations? Could the expanded use of double-walled piping prevent oil from spraying from a burst fuel pipe and minimise its chances of ever becoming ignited? How about the collection of volatile fuel vapors that could form in the tank headspace – what are their chances of becoming sources of a fire or an explosion?

It is commonly known that marine distillate fuels typically do not require heating due to their low viscosity. Similarly, the viscosity of 0.50% LSFO is estimated to be between 4 to 6 mm^2/s @40°C. Since neither distillates nor LSFOs require heating, the tendency for volatiles to accumulate and to be released into the machinery space as a source of fire or explosion would be minimal.

On the other hand, residual fuels, which must be heated due to their high viscosity, have a relatively larger potential to produce a flammable atmosphere in a tank headspace, even when stored at a temperature below the measured flash point.

Remember, the flash point of a given material is intended to be used as guide only and not to serve as a clear distinction between hazardous and non-hazardous materials or dangerous and non-dangerous goods. Generally speaking, flammable liquids will ignite and burn easily at normal working temperatures; whereas combustible liquids have the ability to burn at temperatures that are usually above working temperatures. For clarification, the Workplace Hazardous Materials Information System (WHMIS) 1988 defines flammable liquids as having a flashpoint below 37.8°C (100°F); whereas combustible liquids have a flashpoint at or above 37.8°C (100°F) and below 93.3°C (200°F).

Considering that SOLAS focuses on minimising the probability of ignition through the division of the ship into main vertical and horizontal zones by thermal and structural boundaries as well as the arrangements for fuel oil, lube oil and other flammable oils, would that further justify lowering of the flash point of marine distillates which are defined as combustible liquids to a minimum of 37.8°C (100°F)? Furthermore, would it be more suitable, perhaps, to introduce another, more useful parameter, such as fire point or auto-ignition point, as a better indicator of identifying potential ignition hazards?

If we were to look to CIMAC for further direction, we should at the very least consider their *Guideline on the Relevance of Lubricant Flash Point in Connection with Crankcase Explosions*. This CIMAC guideline, which was released in July 2013, states that flash point testing of lubricating oils as an accurate or early indicator of the potential risk of a crankcase explosion has not been proven and so it is no longer recommended.

Instead CIMAC recommends the use of a combination of oil mist sensors, gas detection sensors, and bearing temperature monitors as an early warning system for the risk of a crankcase explosion.

In the end, the criticality of flash point will need to be further scrutinised as to whether or not it remains the most useful indicator for potential ignition hazards. As one of the major suppliers of onboard test kits for analysing essential fuel oil and lube oil parameters, I can attest that flash point test kits, such as the one shown in Figure 1, which have been available since the 1990s, have never been as ubiquitous as say an onboard density meter, which helps to determine bunker quantity as measured by volume in cubic metres into weight in metric tonnes. Could this be attributed to the fact that flash point will almost always certainly meet the 60°C specification?

Figure 1: Drew Marine Flash Point Test Kit

Yet, how is it that in the first half of 2018, I have been alerted by a major testing laboratory over a dozen times concerning off-spec, low flash point distillate fuels received from different ports from all over the world! Alas, it would seem that a wind of change in the carryover of on-road diesel into marine bunkers is well underway – with or without a proper discussion of onboard safety.

1 - A. Mikkelsen & A. Wright, *Flashpoint of Marine Distillate Oil Fuels: The Case for Harmonizing Marine and Auto-Diesel Flashpoint Limits* (2012)

2 - International Energy Agency, Monthly Oil Statistics, www.iea.org/statistics/monthlystatistics/monthlyoilstatistics/, (2015)

3 - Ibid (2017)

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