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INSIDE:

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SHIPPING FINANCE

FUEL QUALITY

REGIONAL FOCUS

Close analysis

Albert Leyson of Drew Marine flags up some of the quality issues that can occur in the use of distillates

Strict regulations are planned for the near future by the International Maritime Organization (IMO) and other authorities that require alternative fuel systems or exhaust gas cleaning systems. The most highly promoted and anticipated alternative fuel by major Classification societies and specific marine segments is undoubtedly liquefied natural gas (LNG). Capable of meeting the most stringent exhaust emission limits for sulphur oxides (SOx) and nitrous oxides (NOx) alike, LNG has hit the mainstream as prominent ship operators have requested that some of their recent newbuild orders be delivered 'LNG-ready', meaning they can easily be retrofitted to use LNG in the future.

Even though the IMO will likely postpone the entry into force of the MARPOL 73/78 Annex VI Tier III NOx emissions limit for five years (originally effective in 2016, now extended to 2021), the US Environmental Protection Agency (EPA) still requires US-flagged vessels to be compliant from January 2016. In preparation, some engine manufacturers have recently launched dual-fuelled engines and LNG conversion packages in anticipation of the future demand for fuel flexibility. Finally, to manage fuel availability as a result of an ever-increasing fleet of LNG-powered vessels, more LNG bunkering ports will be coming online, including the one slated to open in February 2014 at Port Fourchon, Louisiana. Propelled by the growing US gas market, the new LNG bunker terminal will cater to LNG-equipped offshore workboats, and other vessels operating in the Gulf of Mexico region, within the North American Emission Control Area (ECA).

Regardless of the types of vessels and/or trades that eventually embrace LNG as their primary source of energy, ship operators utilising conventional diesel engines often overlook management of the other, more common fuel alternative – distillate fuel oil. Similarly, early adopters of dual-fuel LNG-ready engines must also effectively manage the pilot fuel, typically distillate fuel oil, required for LNG ignition, and for when natural gas or residual fuel oil is unable to be used.

For vessels that have opted not to equip their exhaust stack with an exhaust gas cleaning system (e.g. scrubber), fuel switchover to distillate fuel oil will be the default action for most ships when they are required to emit less emissions. Fuel switchover would be required prior to entering a reduced exhaust emission zone, whether it is required for vessels operating in port as required by the European Union (EU), or in specific regional areas as defined by the IMO's ECA zones and the California Air Resources Board (CARB), for example. Distillate fuel oil that is used mainly for this reason would likely be stored for extended periods of time; hence, the new distillate fuel oil requirement for oxidation stability is formed, as stipulated by the most recent edition of the ISO 8217:2012 marine fuel specification, limiting its value to 25 g/m^3 maximum.

Although ISO 8217:2012 defines a common quality standard in which marine fuel oil is commercially bought and sold, bunker purchasers often assume that distillate fuel oil grades, with the most common being DMA grade, are all *crème de la crème* in terms of overall fuel oil quality. As such, many ship operators typically obtain just one sample of distillate fuel oil bunkers, merely for MARPOL 73/78 Annex VI Regulation 18 compliance, and never consider the need to actually obtain and analyse a separate distillate fuel oil sample. In fact, laboratory statistics suggest that only 20%-30% of distillate fuel oil samples routinely get analysed. Even more alarming is that a majority of vessels that predominantly use distillate fuel oil actually have never tested for its quality parameters. So the question remains, how can you ensure that you got what you paid for? With an average price premium between 50%-60% of that of RMx 380 grade fuel oil, it is important to identify some of the quality-related problems pertaining to distillate fuel oil.

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Considering the importance of LNG ignition, and more importantly – given that it is the most viable alternative to burning high sulphur residual fuel oil – distillate fuel oil should meet the requirements as specified in ISO 8217:2012 – Table 1.

There are more critical parameters that revolve around sulphur content and its associated parameters, viscosity, and lubricity. First and foremost, the arbitrary maximum values given for sulphur bear no reflection of actual marine distillate fuel oil sulphur content. Since 2011, the percentage of distillate fuel oil samples analysed with sulphur content less than 0.10 mass % has been steadily increasing to over 80% in the year-to-date. One possible explanation for the dramatically increased percentage every year is the carryover of On-Highway or On-Road Ultra-Low Sulphur Diesel (ULSD) stock into the marine bunker market in order to meet the increased demand.

Sulphur	Percentage of Distillate Fuel Oil		
%m/m	2011	2012	2013(YTD)
≤ 0.10	52.7	69.0	83.0
> 0.10	47.3	31.0	17.0

Sulphur	Percentage of Distillate Fuel Oil		
%m/m	2011	2012	2013(YTD)
≤ 0.01	15.8	23.7	31.4
≤ 0.05	-	38.5	49.5

Courtesy: Oiltest Marine Services

Given the percentage of distillate fuel oil samples that have record high level sulphur values, it becomes essential to evaluate the oil's boundary layer lubrication properties and the associated risk concerning insufficient boundary layer lubrication. Evaluated separately, the distillate fuel oil's minimum viscosity and/or lubricity are typically specified by diesel engine and boiler manufacturers in order to assess the relative effectiveness of the oil's ability to prevent metal-to-metal wear in fuel injection and fuel pump internals.

The distillate fuel oil's minimum viscosity is an indicator of the fluid's ability to maintain adequate film thickness. In cases where the minimum viscosity is not met, there is a likelihood the oil film can fail and leak, resulting in equipment loss of pressure, cavitation, or worst-case scenario, seizure. To prevent this from occurring, diesel engine and boiler manufacturers routinely instruct a chiller or cooler be installed and used to adequately raise the oil viscosity to the minimum level.

Since the parameter's introduction in the ISO 8217:2010 revision, the boundary layer property of lubricity provides the distillate fuel oil's ability to prevent wear. The standard test method for lubricity is done with a High-Frequency Reciprocating Rig (HFRR) that evaluates the ability of a fluid to affect friction between, and wear to, surfaces in relative motion while under load. The test uses a vibrating arm that rubs a steel test ball, loaded with 200 g mass, against a test disk that is completely submerged in a heated 2 ml fuel sample, with a 1 mm stroke, and at a frequency of 50 Hz for 75 minutes. After this time-intensive test, the ball is cleaned, and the major and minor dimensions of the wear scar are measured under 100x magnification and averaged. The resulting average is given as the wear scar diameter at the tested temperature, in this case at 60°C. Note, while the distillate fuel oil's viscosity effects on lubricity are not totally eliminated, they are minimised with this test method.

According to the most current ISO 8217 revision, lubricity is required to be tested for distillate fuel oils with sulphur content below 0.05 mass % (500 mg/kg). Statistics clearly show that, at time of writing, nearly half of the distillate fuel oil samples would in fact require lubricity to be analysed. One major marine engine manufacturer goes further and states in its *Low Sulphur Guideline:* 'Documented experience about fuels with lower sulphur content than 0.01 mass % (100 mg/kg) is not available. However, in extreme cases a lubricity additive can be added to very low sulphur fuel…'

Gathering documented experience, such as fuel test reports, remains a challenge since distillate fuel oil samples are seldom submitted for analysis. Furthermore, the additional cost incurred for carrying out the time-intensive HFRR lubricity testing may sound unappealing. While Drew Marine offers these analytical services in partnership with Oiltest Marine Services in order to prevent the occurrence of extreme cases, it may prove more cost-effective to instead treat the fuel with a lubricity additive, since the percentage of distillate fuel oil with very low sulphur continues to increase.

Another fuel quality related problem associated with low sulphur fuel oil involves the inclusion of substances, such as fatty acid methyl ester (FAME), inorganic acid, used lubricating oil (ULO), or any added substance or chemical waste that would jeopardise the safety of the ship, or adversely affect the performance of machinery onboard. Most of these substances contain little or zero sulphur content and can be obtained at relative low cost. As such, in bunker ports where demand exceeds supply, unscrupulous marine fuel suppliers may create low sulphur fuel oil laden with bio-derived materials, inorganic acids, or used lubricating oils (ULO). Since all have little to no sulphur content, they make excellent oil cutter stock. The presence of certain acids or oil soluble metals from biodiesel components and used lube oil has been known to cause internal diesel injector deposits (IDID).

IDID disrupts the injection process and consequently affects the combustion process, thus potentially causing any number of negative consequences to injection equipment, engine internals, and exhaust system. The presence of these internal deposits can inhibit or completely prevent the motion of key internal fuel injection parts, which can disrupt the pressure, timing and/or amount of fuel delivered to each cylinder. This disruption causes combustion-related problems that reduce overall emission and available power, and increase fuel consumption. In extreme cases, complete engine failure can occur.

Drew Marine first offered its lubricity additive, AMERGY XLS, to the marine market more than a year prior to the entry into force of the Baltic Sea ECA in 2006, when fuel sulphur content was capped to 1.50 mass %. In addition to imparting lubricity, the active components in AMERGY XLS reduced the likelihood of incompatibility faced during fuel switchover, improved storage stability, and helped minimise the formation of carbonaceous deposits on injector tips. With a further reduction in fuel sulphur content due in 2015, limited to 0.10 mass %, Drew Marine's most recent fuel additive, AMERGY ULS-D, was designed specifically to address IDID problems, such as fouling of critical fuel slide valves. The additive can effectively remove any deposit that has formed and can prevent any new fouling from accumulating. With the potential to significantly extend the service life of fuel injection parts, AMERGY ULS-D ensures that the distillate fuel oil used in the next generation and duel-fuelled diesel engines remains trouble free.

Parameter	Unit	Limit	DMX	DMA	DMZ	DMB
Viscosity @40°C	mm²/s	Max	5.500	6.000	6.000	11.00
Viscosity @40°C	mm²/s	Min	1.400	2.000	3.000	2.000
Sulfur	% m/m	Max	1.00	1.50	1.50	2.00
Lubricity, wear scar diameter @60°C	µm	Max	520	520	520	520

Excerpt from ISO 8217:2012 - Table 1 - Distillate Marine Fuels

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