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BUNKERSPOT

TAKING THE PLUNGE

IS SHIPPING READY FOR THE 2020 GLOBAL SULPHUR CAP?

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LNG

Flow chart

With reference to the recently published revised edition of the ISO 8217 marine fuel specification, **Albert Leyson** of Drew Marine looks at cloud point and cold filter plugging point testing requirements to determine the cold flow characteristics of distillate fuel

According to the 6th edition of ISO 8217, which was released in March 2017, marine fuel specifications have been transitioned from traditional bunker fuels made from crude oil to the inclusion of fuels derived from renewable and/or alternative sources. This transition was mainly attributed to the demands of marine environmental legislation that called for the increased use of low sulphur fuel as a primary means to lower sulphur oxide (SOx) emissions. The renewable fuel source in focus is fatty acid methyl ester(s) (FAME), which is also referred to as biodiesel.

Generally, biodiesel has been considered environmentally friendly because it is made from renewable resources such as animal fats or vegetable oils. When compared to petroleum-based diesel fuel, biodiesel offers the following key advantages: non-toxicity,

Figure 1: Solid wax deposits visible in a fuel storage tank as viewed from an open manhole

biodegradability, and improved emissions profile with regard to the formation of soot/ particulate matter (PM) and SOx. It has been these main environmental advantages that had attracted various countries from around the world, which included Germany and Brazil as frontrunners, to include FAME in their conventional on-road diesel fuel as early as the 1990s. Now, FAME has come into the marine bunker market by successfully making its way as part of the latest marine fuel specifications.

The inclusion of biodiesel in marine fuel is spearheaded by the addition of three new grades that contain a certain amount of FAME into *ISO 8217:2017 – Distillate Marine Fuels – Table 1*. The three new grades, designated as DFA, DFZ, and DFB, are collectively referred to as DF grades. The DF grades are essentially identical to the marine distillate or DM grades, designated as DMA, DMZ, and DMB, respectively, except that the DF grades allow a maximum FAME content of 7.0% by volume.

The underlying reason for the introduction of the new fuel specifications (DF grades) is the anticipation of the inevitable increase in demand for marine fuels with limited sulphur content. Perhaps considered as the single, most influential driver for the future demand for low sulphur fuel is when the maximum global sulphur content of all marine fuels used onboard ships becomes limited to a maximum of 0.5 mass % from an existing level of 3.5 mass %. This far reaching, global regulatory requirement per IMO Resolution MEPC.280(70) will become effective on 1 January 2020. This updated resolution to MARPOL Annex VI will apply to all ships, except those ships that are equipped with an exhaust gas cleaning system for SOx emissions removal.

In the June/July 2016 issue of *Bunkerspot*, the challenges surrounding the inclusion of biodiesel in marine fuels were highlighted ('FAME Academy', p43-46). Moreover, the specific risks for poor fuel stability and the increased probability for wax deposition were covered in the article. The concern regarding the deposition of paraffin or wax, and the need to identify this concern by amending ISO 8217 was highlighted previously in the April/May 2014 issue of *Bunkerspot* ('Climate change', p64-66). The amendment proposed was to include new test parameters, such as cloud point and cold filter plugging point, as part of the marine distillate fuel specification.

Three years later, the proposed amendment has come to fruition! The cloud point and cold filter plugging point are now required to be tested and reported for winter grades of DMA, DFA, DMZ, and DFZ per ISO 8217:2017.

The testing of cloud point and cold filter plugging point determines the cold flow characteristics of distillate fuel, regardless of whether it contains biodiesel. Cloud point is defined as the temperature at which clear fuels become cloudy or hazy. When the fuel specimen is observed to be cloudy or hazy, this signifies the beginning of wax crystal precipitation. As the wax crystals in the fuel continue to precipitate and form, the paraffins in the fuel will form larger, solid wax deposits.

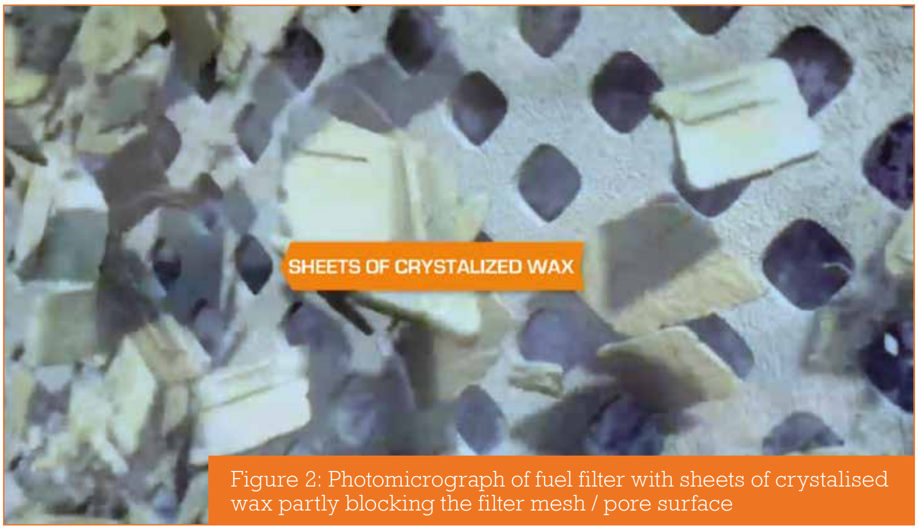

Figure 2: Photomicrograph of fuel filter with sheets of crystalised wax partly blocking the filter mesh / pore surface

'While the cloud point of distillate fuel grades DMA, DFA, DMZ, and DFZ per ISO 8217:2017 have a requirement to test and report the cloud point, there have been no specific maximum values set at this time. However, it is recommended that the cloud point should be between 4°C to 6°C below the lowest ambient temperature where the vessel intends to operate'

An example of a distillate fuel with high cloud point that has formed solid wax deposits can clearly be seen in Figure 1. Although heating coils are included in residual fuel oil tanks to lower fuel viscosity for pumpability, heating coils are rarely, if ever, incorporated into distillate fuel oil tanks. This particular vessel was no exception.

With its distillate fuel mostly solidified, the vessel no longer had the opportunity to treat the fuel in the tank with a cold flow improver. Cold flow improver additives, such as Drew Marine's AMERGY PPD, must typically be dosed into the fuel before the fuel temperature drops below the cloud point. In this case, the vessel could not use the fuel until the following spring, when the surrounding sea temperature rose sufficiently and thus allowed the fuel to 'melt' back into liquid form.

While the cloud point of distillate fuel grades DMA, DFA, DMZ, and DFZ per ISO 8217:2017 have a requirement to test and report the cloud point, there have been no specific maximum values set at this time. However, it is recommended that the cloud point should be between 4°C and 6°C below the lowest ambient temperature where the vessel intends to operate. If this recommended temperature differential is not reached, then there would be a higher chance of experiencing operational difficulties with regard to fuel flow and/or pumpability.

Since there are no given cloud point specification limits for grades DMA, DFA, DMZ, and DFZ, Drew Marine recommends to proactively test for the cloud point of such fuel grades with an onboard cloud point test kit. The onboard test kit can be used for immediate cloud point testing of any distillate fuel samples which may be provided by the bunker tanker prior to bunkering.

After bunkering commences, a spot sample should also be obtained and sub-

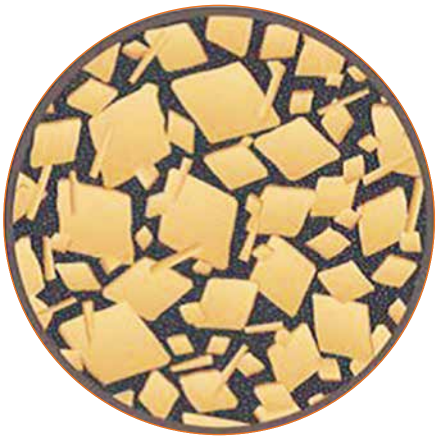

Figure 3: Broad microcrystalline wax formation of untreated fuel

Figure 4: Narrow microcrystalline wax formation of fuel treated with cold flow improver

sequently tested for cloud point in order to confirm the cloud point test result of the fuel sample originally provided by the bunker tanker. By determining the fuel's cloud point, ship operators can decide whether the bunkers would need to be additised with a cold flow improver. If the bunkers need to be treated, the cold flow improver additive can be dosed to the nominated tanks accordingly.

Depending on the severity of the cloud point deficiency, the amount of cold flow improver treatment would vary. Typically the higher the cloud point, the more cold flow improver additive that would be necessary to treat the fuel. As mentioned earlier, should cold flow improver treatment be required, the additive would need to be dosed before the wax deposits begin to crystallise. By following this proactive fuel additive treatment approach, ship operators can ensure that their distillate fuel, whether laden with or without biodiesel, does not solidify nor gel up in storage tanks.

To protect the operator from cold flow related issues downstream of the fuel storage tanks, the current ISO 8217 edition also introduced a cold filter plugging point requirement. Unlike cloud point, which was previously only required for DMX grade specifications, the cold filter plugging point is relatively a new test parameter to the marine industry. Note, DMX grade is typically reserved as the fuel that is used for lifeboat diesel engines and emergency diesel generators.

The cold filter plugging point test parameter originated from ASTM D975 – Standard Specification for Diesel Fuel Oils as one of three cold flow test parameters that may be used to estimate the cold operating temperature limits of a given fuel. The other two cold flow test parameters included cloud point and low temperature flow test. Low temperature flow test is similar to cold filter plugging point, but it takes a much larger sample size and it takes longer to complete. By 2009, the cold filter plugging point test parameter was incorporated into EN 590 – Automotive fuels – Diesel – Requirements and test methods, which interestingly allowed a maximum FAME content of 7.0% by volume.

The cold filter plugging point is the lowest temperature at which a given volume of fuel still passes through a standardised filtration device in a specified time when cooled under certain conditions. The cold filter plugging point temperature is usually between the cloud point and pour point. The cold filter plugging point test simulates the flow of cold fuel through a diesel engine's fuel system.

So in addition to cloud point, the cold filter plugging point for grades DMA, DFA, DMZ, and DFZ must also be tested and reported. Unlike the cloud point requirement, which can help to prevent the solidification of fuel in storage, the cold filter plugging point aims to mainly prevent the agglomeration of wax deposits on the fuel filters. A photomicrograph of the filter mesh of a fuel filter, which has sheets of crystallised wax accumulated on filter pore surfaces, is shown in Figure 2.

These sheets of wax deposits initially appear as broad microcrystalline structures, as depicted in Figure 3. As the wax build-up continues to form, the deposits agglomerate and begin to restrict fuel flow through fuel pipes and fuel filter surfaces. Over time, further restriction occurs which can subsequently lead to inadequate fuel flow to the engine. In the worst-case scenario, whereby full blockage of the filter has ensued, the

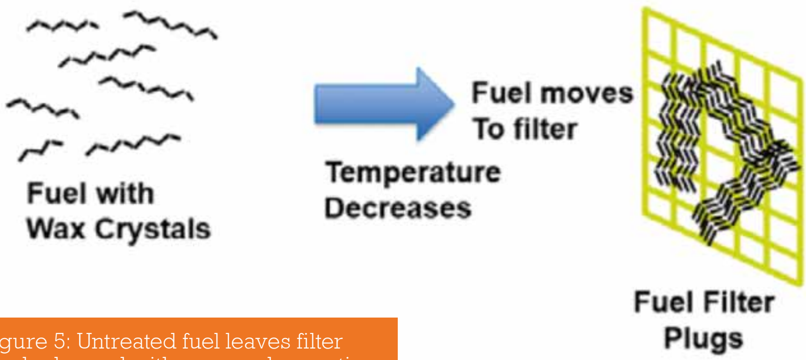

Figure 5: Untreated fuel leaves filter mesh plugged with wax agglomeration

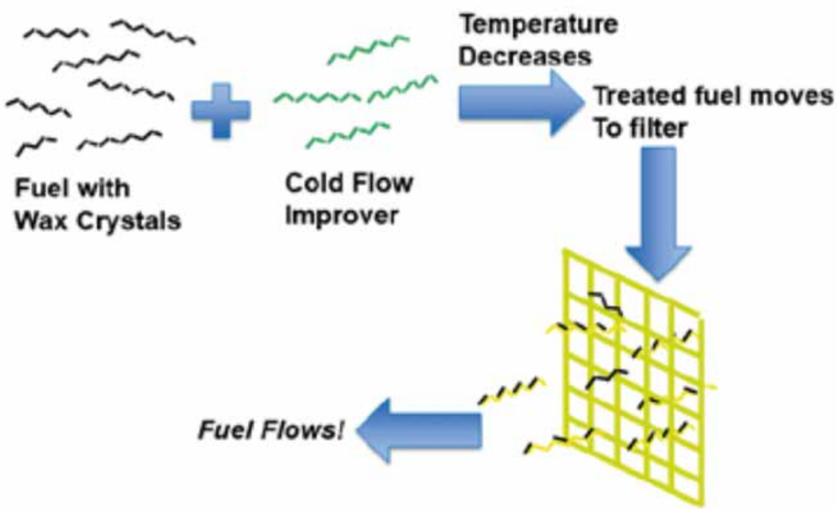

Figure 6: After being properly treated with cold flow improver, fuel flows without agglomerating on filter mesh

> ‘Unlike the cloud point requirement, which can help to prevent the solidification of fuel in storage, the cold filter plugging point aims to mainly prevent the agglomeration of wax deposits on the fuel filters’

engine would become starved of fuel.

To prevent these types of situations from ever arising, testing of cold filter plugging point provides an estimation of the lowest temperature at which fuel gives trouble-free flow. Typically, cold filter plugging point testing can only be run by analytical laboratories. When combined with cloud point and pour point, cold filter plugging point helps to determine the fuel’s suitability for storage and filtering for the ship’s intended voyage, including those passages into colder climates. When the cloud point and/or cold filter plugging point temperature results are found to be inadequate for the ship’s intended voyage, the contingency measure of treating the potentially problematic fuel with a cold flow improver, such as AMERGY PPD, should be seriously considered.

AMERGY PPD modifies the crystallisation of the wax or paraffin normally found in distillate fuel, including biodiesel. Instead of crystalising into broad sheets of wax deposits, the paraffin in the distillate fuel forms narrower wax deposits when AMERGY PPD is used, which is shown in Figure 4. AMERGY PPD also disrupts the normal agglomeration process of waxy deposits on filter surfaces, as depicted in Figure 6. With the combination of being able to modify the wax deposit into narrow particles and to prevent their agglomeration on filter surfaces, AMERGY PPD is able to ensure fuel flow.

Since the amount of wax can vary in marine distillate fuel, AMERGY PPD treatment ranges from 50 parts per million (ppm) to 2,000 ppm (1 litre per 20 metric tonnes (mt) to 1 litre per 0.5 mt), based on the cloud point result. Drew Marine recommends testing the cloud point of new distillate fuels with an onboard test kit. Ideally, bunker buyers should adopt the latest edition of ISO 8217 when procuring distillate fuel and request that cloud point be included on the certificate of analysis. With the cloud point on hand, ship operators can treat their distillate fuel accordingly with a product such as AMERGY PPD cold flow improver and prevent the fuel from solidifying in storage tanks and blocking up fuel filters.

Drew Marine provides technical solutions and services to the marine industry with a range of advanced marine chemicals, and equipment.

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