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STATUTORY TOPIC

Issues related to the use of low (0.10% m/m max.) sulphur marine fuel oils

INFORMATION

What is a 'low sulphur' marine fuel oil?

Within this context 'low sulphur' refers to fuel oils with a sulphur content limited to 0.10% m/m maximum. This is the limit value given in the revised MARPOL Annex VI for fuel oils to be used from 1 January 2015 inside Emission Control Areas established to restrict sulphur oxide (SO_x) and particulate matter emissions (ECA-SO_x). Additionally, the EU Sulphur Directive (2005/33/EC) introduces a 0.1% m/m sulphur limit for most ships 'at berth' in EU ports from 1 January 2010. Also in the CARB Regulated California Waters regulations, mandating the use of ISO8217:2005 DMA or DMB grade fuels in main and auxiliary engines and auxiliary boilers, the allowable sulphur limit reduces to 0.1% m/m from 1 January 2012.

The majority of marine fuel oils meeting this 0.10% m/m limit would be expected to be categorised as ISO8217:2005 DMA grade with the remainder generally categorised as DMB grade. Residual fuel oils would not be expected to meet this limit other than isolated instances of straight run products produced from extremely low sulphur crude stocks.

Supply of 0.10% limited sulphur fuel oils

It could not be assumed that DMA (or DMB) grade fuel oils as manufactured would normally meet a 0.10% m/m sulphur limit, hence where required this value – to the required precision – would need to be clearly specified in fuel purchase contracts, bunker clauses and in charter party agreements.

The production of such fuel oils would require the selection of specific blend stocks. Consequently, these fuels will not usually be supplied with any significant margin between the actual value and the limit value. The significance of this is that 0.10% m/m limited fuels will have very limited tolerance to mixing with other gas oils or diesel oils and still being compliant, noting that in all controls the limit is in respect of the fuel oil as used – the fuel oil as loaded is simply the first step in the process. Consequently, it would be necessary to ensure that loading, storage, transfer and service system arrangements are such that all fuels loaded as compliant will not be subject to any significant degree of mixing with other fuels prior to the point of use.

Where it is required to change over to use low sulphur fuel oils – for example under the EU Sulphur Directive while 'at berth' – it will be necessary to ensure that the fuel used by isolated items of machinery, such as incinerators or bow thruster engines, is also compliant.

Attention would be necessary to ensuring that unsuitable blend stock materials have not been used in the production of these low sulphur fuel oils.

Unsuitable material would include, for example, acidic cutter stocks, kerosene – due to the risk of resulting flash point being below 60°C – or biodiesel. In the latter case, while biodiesels have been used to varying degrees of success in a number of land based applications, either as fuels or as blend components with petroleum fuels (gas oils), there is no general experience of using biodiesel or biodiesel blends in marine applications. The concern with using such fuels in unprepared systems, as may be the case for a ship on global operations, is that there may be materials present which would promote corrosion or accelerate oxidation stability problems. Furthermore certain seal / gasket materials may be adversely affected. Even with prepared systems, there are the concerns as to storage stability within marine systems and the affinity to water and hence propensity to microbial contamination.

While typically the concern will be with not exceeding the given limit value, attention is also necessary to the possibility of automotive type fuels with extremely low sulphur contents being supplied instead. Currently the EU road diesel sulphur limit is 10 mg/kg (0.001% m/m) while in the US the limit is 15 mg/kg (0.0015% m/m). Due either to supply convenience (for example when delivery is to be made by road tanker) or through such fuels not meeting the full automotive specification requirements these fuels could be supplied to marine users. In addition to the various performance issues noted below, the key point is that these road fuels may not meet the minimum marine fuel oil flash point limit of 60°C thus raising statutory (SOLAS) and class compliance issues.

Technical issues

Although historically marine gas oil fuels around or below 0.1% m/m sulphur have been used without problems these were fuels which, due to their manufacturing route, were naturally of that level of sulphur content. With the expansion of demand for fuels meeting a 0.10% m/m sulphur limit such fuels will increasingly need to be specifically produced.

The manufacturing processes which result in the production of low sulphur distillates can result in fuels with low viscosity or poor lubricity or oxidation stability characteristics. Additionally such fuels can be more susceptible to microbial contamination. Since low sulphur products tend to have reduced aromaticity these fuels would not be readily compatible with residual fuel oils as they would tend to promote asphaltene instability.

Low Viscosity:
It would need to be established what the viscosity limitations are for the machinery in which the fuel is to be used together with the likely temperatures which would be experienced in service. On that basis it would then be possible to determine what action to take – this could involve including a minimum fuel oil viscosity limit in bunker clauses, controlling the minimum viscosity encountered (which may require the fitting of fuel oil coolers or chillers) or modifications / replacement of sensitive machinery components such as the gear type fuel supply pumps (typically fitted in the service systems to engines, boilers and other combustion devices) and fuel injection system components.

Low Temperature Performance:
In addition to limiting fuel temperatures, so that adequate viscosity is retained, attention must also be given to the implications of the fuel's low temperature characteristics such as pour point, cold filter plugging point and cloud point. The manufacturing processes which result in low sulphur distillates would normally have so broken down the waxy structures which

result in low temperature performance problems that these should not be encountered in practice. However, there can be naturally occurring low sulphur distillates, which may well have substantial wax content, hence due regard must still be applied to ensuring that the temperature of these fuels, at any point in the system, is not so reduced that solidification or other wax deposition problems occur.

Lubricity and Lubrication:
Lubricity as a characteristic relates to boundary lubrication performance which is distinct from the viscosity related concerns which affects the ability to generate a hydrodynamic lubricant film. Equipment manufacturers' recommendations regarding minimum lubricity requirements (usually expressed in terms of wear scar diameter from a High Frequency Reciprocating Rig (HFRR) – i.e. IP 450) must be followed.

The draft of the 4th edition of the International Marine Fuel Standard ISO8217, as currently being reviewed by the various national committees, is due to enter into effect in July 2010. This revision introduces limits for all distillate grades in respect of oxidation stability and, for fuels with sulphur content below 0.05% m/m, lubricity which is controlled to a maximum of 520 micron although it should be noted that the EU road diesel specification, EN 590, has a tighter limit of 460 micron.

Where a low sulphur fuel is to be used in either two-stroke or four-stroke engines the engine builder's recommendations should be followed in respect of lubricant controls, both in terms of grade (TBN rating) and quantities, since it is necessary to avoid an accumulation of unspent additives while still maintaining adequate lubrication of moving parts.

Density:
Due to the typical density of low sulphur fuel oils the actual quantity of fuel, in terms of tonnes, contained within a given tank will be reduced as compared to residual fuel oils. This would similarly be reflected in the amount of fuel injected per pump stroke resulting in a higher fuel rack setting for a given load despite the higher calorific value of the low sulphur fuel oils.

Power Shortfall:
Since virtually all engines are shop tested on gas oil they should be still be capable of achieving the rated power values when operating on low sulphur distillates – problems of power shortfall will tend to occur in those instances where fuel injection system components have been subject to wear. The level of wear may be such that injection performance will still be satisfactory when operating with a fuel of 10-15 cSt at the injectors but, when operating with the much lower viscosity low sulphur fuel oils, the ability to generate the required pressures (both in terms of sharpness of pressure rise as well as the overall pressure) will be compromised with a corresponding detrimental effect on combustion – in extreme cases the pumps will be totally unable to generate the necessary injection pressure resulting in engine failure or an inability to restart.

Pre-heating Control:
Since these low sulphur fuel oils will be gas oil / diesel oil type products heating would not be required prior to injection. It would need to be ensured that the injection temperature control systems function correctly and so avoids heating of these fuels prior to use.

Trace heating systems would similarly need to be shut down while using these fuels but, of course, reapplied when transferring back to use residual fuel oils.

Solvent Characteristics:
Low sulphur fuel oils will generally have a cleaning action when used in systems normally operating on residual fuel oils, this will have the effect of potentially mobilising accumulated sludge materials with consequent increased loading on the fuel treatment equipment or sticking of fuel injection components.

Additionally, due to the 'searching' nature of these fuels, seals and joints may exhibit a tendency to leakage, an effect which would be compounded by component temperature variations resulting from switching between fuel types. There would also be an increased tendency to dribble from fuel injectors.

Auxiliary Boilers:
All the above points equally apply to auxiliary (and main) boilers and their associated fuel supply systems, including the need to ensure that fuel oil supply pumps are capable of operating with the lower viscosities which may be encountered with low sulphur distillates and that trace heating is not applied.

In addition there are a number of specific points related to boiler safety and operations; manufactures recommendations must be followed, particularly those relating to the combustion control system, furnace purge duration and the number and settings of the flame scanners. Air/fuel ratios may need be to be increased, as compared to those for residual fuel oil, to avoid smoke formation. In the case of rotary cup burners modifications may be necessary to avoiding coke formation in the cup. With steam atomising burners it may be possible to convert these to air atomising or alternatively change to a type where heating of the fuel oil in the burner by the steam supply is minimised.

Approval of Modifications

Where there is to be a change, in order to comply with low sulphur requirements, in the fuel grade used from that for which combustion systems were designed for due regard to all safety implications is essential. These implications may be examined by means of a HAZOP workshop or other suitable risk assessment undertaken by the key parties and stakeholders.

Where modifications are to be made to combustion machinery, control systems, fuel oil supply systems or fuel oil storage arrangements in order to operate with low sulphur fuel oils these must be approved by the ship's classification society prior to application.

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Further information

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