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VDR German Shipowners' Association

Industry Guidance on Compliance with the Sulphur ECA Requirements

Assistance to ship owners, operators and crew

This Industry Guidance shall give assistance to ship owners, operators and crew to prepare for the changes in fuel characteristics and compliance with the new sulphur limits for ships fuel used in in Sulphur Emission Control Areas (SECA) as of January 1, 2015. The main emphasis of this paper lies on the process of switch over from HFO to LSF.

Introduction

As of January 1, 2015, 0:00h, the sulphur content of fuel oil used on board ships within SECAs shall not exceed 0.10% m/m. This is required both by the European Directive n°2012/33/EU of 21st November 2012 as well as Annex VI of the international MARPOL Convention. In most cases, compliance will require the use of Low Sulphur Fuel, LSF (MDO or MGO) by the ship or of the recently offered compliant fuels such as HDME50 with higher pour points and viscosities that require heating. Prior to entry into a SECA, it is therefore required to have fully switched over from any high sulphur fuel in use to the SECA compliant marine fuel. Alternative compliance can be achieved by using fuels with higher sulphur content if exhaust gas cleaning systems are used, the so-called scrubbers.

Current SECAs are the designated areas within 200 nautical miles offshore the coast-line of the USA and Canada, the US Caribbean ECA (waters around Puerto Rico and the U.S. Virgin Islands), as well as the Baltic Sea and North Sea/English Channel in Europe. This paper mainly concentrates on implications of the European SECAs.

Generally speaking, the western boundary of the North Sea SECA is the longitude extending from Brest (France) to Falmouth (U.K.) and further northwards from Strathy Point east of the Orkney Islands (U.K). The northern boundary of the North Sea SECA is the latitude extending from Vågsøy (Norway) to Thorshavn (Faroes). Further, the area is bound by the latitude extending from Skaw to Gothenborg (i.e. entry to the Baltic SECA).

Legal Background

With regard to sulphur oxide emissions the relevant regulation (MARPOL ANNEX VI, Regulation 14.4.3) states:

> *While ships are operating within an Emission Control Area, the sulphur content of fuel oil used on board ships shall not exceed [...] 0.10% m/m on and after 1 January 2015.*

The international MARPOL Regulations is transferred to European law by Directive 2012/33/EU regarding sulphur content of marine fuels. It regulates inter alia the sulphur content of fuels used by maritime transport in the Baltic Sea, North Sea and English Channel. It states in the relevant regulations:

- Member States shall take all necessary measures to ensure that marine fuels are not used [...] within SOx Emission Control Areas if the sulphur content of those fuels by mass exceeds [...] 0,10 % as from 1 January 2015.
  If a ship is found by a Member State not to be in compliance [...] with this Directive, the competent authority of the Member State is entitled to require the ship to:
  - present a record of the actions taken to attempt to achieve compliance; and
  - provide evidence that it attempted to purchase marine fuel which complies with this Directive in accordance with its voyage plan [...] and [...] no such marine fuel was made available for purchase.
- The ship shall not be required to deviate from its intended voyage or to delay unduly the voyage in order to achieve compliance.

Properties and compatibilities of fuels

Energy content per Volume

Between High Sulphur Fuel Oil (HFO) and distillates lies a difference in density of approximately 8%. As the fuel pumps deliver a defined volume of fuel to the engine, this may result in a reduction of available energy for combustion and a potential reduction of maximum power that is not compensated by the higher net calorific value of distillates (~ + 2%). In normal operation of a vessel this will usually not be a problem, but might have a negative impact in extreme circumstances.

Compatibility

Reports further show that modifications in the refinery processes have led to considerable changes in fuel properties. In a report by Chevron (Chevron, July 2007) it is evidenced that the

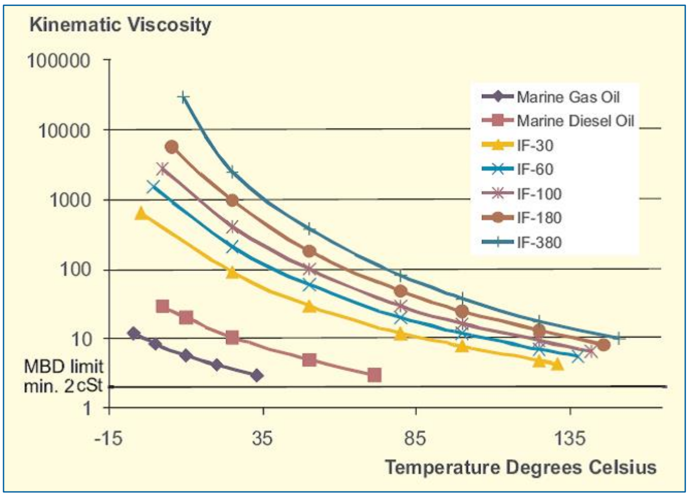

Fig.1: Viscosity of marine fuels as function of temperature (Source: MAN)

stability of asphaltenes is deteriorated by the visbreaking process. They can form sediment (coagulation is influenced by time and temperature) when the aromaticity of the fuel matrix is changed by blending of HFO and MDO. The change-over procedure from HFO to MGO usually takes a longer period of time, during which there will be a mix of the two very different fuels. As a result of this mixing, the asphaltenes of the heavy fuel are likely to precipitate as heavy sludge, with filter clogging as a possible result (MAN, Primeserve, 2010).

The most obvious way to avoid this result is to check the compatibility between the fuels before bunkering, which can be done either manually with a test-kit on board, or via an independent laboratory. The latter often being too slow a process, as the ship will already have left the harbor before the laboratory returns with the test result.

The risk of an incompatibility of marine fuels is also acknowledged by the ships engine manufacturers. Amongst many, MAN verifies in a report on the operation of MAN B&W Two-stroke Engines on low-sulphur fuels that when switching from heavy fuel to a distillate fuel with low aromatic hydrocarbon content, there is a risk of incompatibility between the two products.

HDME50 is compatible with Gas Oil, however, is sensitive to mixture with low sulphur residual fuels. Above 2% of residual fuel precipitation of asphaltenes may occur. Temperature control of the fuel may be required to prevent paraffines to fall out.

Viscosity

For optimum combustion the fuel has to be distributed very evenly in the engine, which requires a certain viscosity at the injection nozzle. Fuels with high viscosities are heated up to temperatures above 100°C. At this temperature the viscosity of MDO will be below the limit of 2cSt (see Fig.1). That means when switching from HFO to MDO the temperature in the relevant fuel system has to be reduced to and kept at values not exceeding 50°C. The use of fuels like HDME50 offer the advantage to reduce the temperature control requirements.

Preparing considerations for fuel switchover

Fuel requirements

Depending on the operational profile the required amounts of HFO and LSF from January 1, 2015 onwards and the resulting tank capacities should be estimated. The considerations should include the requirements of the charterer, if applicable. If the ship operates solely within a SECA and only LSF will be used, the decision should include how to proceed with any remaining High Sulfur Fuel (HSF) on board. Depending on the decision, a disposal should be organized.

In cooperation with the charterer contact fuel suppliers, negotiate and decide on sulphur content and date of bunkering. (Remember that nearly all ships in the SECA or entering will require LSF).

If a fuel switchover before entering into the SECA is necessary a sulphur content below 0,10% is advantageous because the time for switchover and the use of LSF outside the SECA can be reduced with a low sulphur content of LSF. If a switchover will take place often, sulphur contents near 0,10% should therefore be avoided.

Storage tank arrangement

LSF should not be heated in the storage tanks to prevent unwanted reduction of viscosity (cf. Fig.1); however, for ships operating in winter in the Baltic Sea the pourpoint of LSF should be checked. To prevent unwanted heating, HFO tanks and temperature sensitive LSF tanks should be separated.

After longer use sediments will build up in fuel tanks that could go into solution when the tank is used for LSF, resulting in contamination and potential non-compliance. Therefore tank cleaning might be necessary and should be arranged in time.

Fuel system

Separated bunkering lines could prevent unwanted contamination during bunkering operations. HFO and LSF should use separate pipes as much as possible.

The differences in temperature and viscosity could lead to leakages in the system. It is advised to timely plan countermeasures. If necessary, sealings etc. should be replaced to prevent fire risks.

To prevent contamination of LSF during switchover a special fuel pipe should transfer the fuel backflow from the machinery to the HFO tank. When switchover is completed the backflow should be returned as usual.

It is advised to clearly study the fuel circuit, including tank return of the pipes, in order to quantify the possible tank contamination (matter of volume and frequency, special care to be considered at low consumption/high return volume). Depend-

Fig. 2: Damaged plunger of injection pump

ing on result, risk of filter-clogging etc. should be analysed and corrective action/procedure implemented.

Most fuel pumps currently in use are displacement-type pumps, such as screw or gear pumps. According to manufacturers, these pumps are designed to operate with a minimum fluid viscosity of 4 cSt. An assessment should be made of all fuel pumps on board to determine whether they are able to operate with the lower viscosity and lubricating properties associated with the low sulphur marine distillate fuel and to consider the need for modification or replacement.

Considerations for ships with repeated switchover

The design and arrangement of the fuel system has an influence on the LSF used during the switchover process that hat to take place outside the SECA to comply with the requirement that the switchover has to be completed when the ship enters the SECA. For ships with only one service tank this can be an important amount of fuel. A separate service tank for LSF would reduce time and effort for switchover.

Above that the calculation of the LSF consumption outside the SECA and the required time for switchover as well as an analysis of possible improvements of the fuel system are recommended. Depending on the number of switchovers the additional operating costs could pay back the investment for an improvement of the fuel system within the restrictions existing ships inevitably have.

Proposed installations for inspection purposes

Port State Authorities may require samples of the fuel currently used for combustion. This will require taking a sample form the feed or returning line of the engines. Because of the lower fuel pressure it is recommended to install a permanent and safe sampling valve in the return line combined with temperature measurement. If a data logger permanently stores this temperature in reasonable time intervals because of the different temperature of HFO and LSF, this may serve as evidence that switchover was completed correctly and compliant fuel is used for combustion.

Diesel engines

Contact your engine manufacturer with regard to the special requirements when operating on LSF, e.g. minimum viscosity at engine inlet, lubrication oil requirements, recommendations for changes in the fuel system etc. In the following some general findings are given.

As stated above the fuel viscosity at the injection nozzle should not be below 2cSt that means the temperature should not be above 45 to 50°C. This is especially important at low loads and idling. Excess fuel not required for combustion is returned to the service tank. The material temperatures of the engines are kept around 80°C by cooling. If a high amount of fuel is recirculated a gradual temperature increase may follow with a reduction of viscosity below 2cSt and resulting combustion and starting problems. A fuel cooler in the return line could prevent this.

During switchover the temperature in all components of the fuel supply system to the engine has to be reduced from a temperature above 100°C to a value corresponding to the required viscosity. The allowable maximum temperature transient is about 2°C/min for switch-over to prevent seizure at the injection pumps (Bartmann, 2014). Due to the increase of pressure at the injection pump from 600 bar (1960ies) to 1600 bar (today) with common rail injection in the course of engine development, the wall thicknesses were increased making the pumps more vulnerable to fast temperature changes (Fig. 2).

Therefore time should be allowed to maintain the temperature gradient recommended by the engine manufacturer, e.g. 2˚C/minute, in a controlled manner while switching fuel. This will in many cases be necessary in order to avoid a thermal shock to the system, e.g. seizure of fuel injection pumps, and/or other operational problems that may occur due to low viscosity and/or rapid temperature changes.

Injection pumps are designed with quite small tolerances and benefit from sulphur content in fuel to ensure lubrication. By running on MGO, these elements may seize due to lack of lubrication, with the result of potential loss of power. Worn injection pumps may have increased leakages leading to alarms and disturbances in operation. Consequently reduced maintenance intervals may be necessary.

MAN for example acknowledges these risks and underlines that low viscosity of the marine fuel used may cause seizures, starting difficulties and problems operating at low load. Statistical data shows that the majority of the supplied fuels have viscosities in the range of 2.5 – 4 cSt (at 40 degC). As parameters requiring increased focus operating on distillate fuels, MAN describes:

- Viscosity (> 2 cSt, preferably >3 cSt);
- Change-over between HFO and MDO / MGO;
- (Compatibility, thermal shocks, gassing of hot gas oil);
- And vice-versa (MDO/MGO to HFO);

- Lubricity (max. 460 mm according to ISO12156 (HFRR test));
- Correlation between low sulphur and cylinder oil BN.

MAN recommends to test the engines low viscosity limit, to install ”tools” in the fuel system where possible (cooling/change over) and to focus on cylinder condition (lub oil consumption/BN).

Boilers

Boilers already operate on LSF in European Ports, so no special considerations are expected.

Recommended operating instructions

Detailed operating instructions including precise documentation of performance will prevent mistakes and failures during bunkering and switchover as well as disputes with Port State Authorities.

Bunkering

Operating instructions for bunkering should include:

- Clear identification of bunker lines for HFO and LSF
- Acceptable sulphur content (No value on Bunker Delivery Note above 0,10 is acceptable, inaccuracy of measurement is no argument!)
- Test of compatibility (if applicable)
- Place and procedure to take MARPOL sample
- Documentation of bunkering procedure
- Storage of samples
- Procedures and notifications if LSF is not available or available fuel exceed required limits

Switchover

Conduct initial and periodic crew training along operating instructions. Detailed operating instructions for switchover should include:

- Planning of switchover including calculation of time and location of start of switchover depending on:
  - Volumes in the fuel system to be flushed (tanks, pipes etc.);
  - Sulphur contents of HFO and LSF as stated on BDNs;
  - Fuel consumption at current engine power.
- Exact & detailed definition of switchover process: Sequence and time intervals of opening and closing of defined valves, starting of pumps etc.;
- Checks for possible leakages in system seals, gaskets, flanges, fittings, brackets and supports;
- Check of system pressure and temperature alarms, flow indicators, filter differential pressure transmitters;
- Fuel system inspection and maintenance schedule;
- Test of main propulsion machinery, ahead and astern, while on marine distillates.
- Ensure start air supply is sufficient and fully charged prior to maneuvering;
- How to proceed in case of bad weather and sea state conditions in the sea area for switchover that prevent switchover for safety reasons.

Documentation

Please note that Section H of Oil Record Book-Part I requires each ship to record details of every bunkering. The information to be recorded is

- Place of bunkering;
- Time of bunkering;
- Type and quantity of fuel oil and identification of the tanks were the fuel was stored.

The documentation of switchover should clearly state:

- Exact time of start and end of switchover;
- Corresponding positions of ship;
- Power of main engine(s);
- Inventories of all tanks especially at times of tank switchover.
- Interdiction of the use of LSF in a vessel without approved modifications
- Charterers must provide the vessel with fuels of the necessary sulphur content to allow the vessel to trade within the emission control zones ordered by the charterers. The charterers are also required to use bunker suppliers that operate in accordance with Regulations 14 and 18 of MARPOL Annex VI.
- The responsibility for the storage, management and use of the fuels supplied rests with the owners as does the emission control requirements of MARPOL Regulations 14 and 18.

Navigational Rights and Freedoms under UNCLOS

The sulphur content limits set out under Regulation 14.4.3 MARPOL ANNEX VI and under Art. 4a para. 1 b) EU Directive 2012/33 apply to vessels of all flags within ECAs. According to some European Member States, some EU maritime administrations are planning measurements of sulphur emissions with remote sensing technology to check compliance that a maximum sulphur content of 0.10% m/m is being emitted as from 1 January 2015. Some Member States have announced to install remote “sniffer technology”, e.g. under the Great Belt Bridge.

From a legal perspective, the use of such systems is allowed. In accordance with the United Nations Convention on the Law of the Sea (UNCLOS) States can check and enforce against foreign flagged vessels in their ports for non-compliance with marine environmental regulations (esp. Art. 212, 222 UNCLOS).

Only as regards vessels under flags of MARPOL ANNEX VI States, a port State may also enforce against vessels in their ports in respect of violations of the sulphur emission limits, which occurred beyond the internal waters, territorial waters or exclusive economic zone (EEZ), where the evidence so warrants (esp. Art. 211, 218 UNCLOS).

Under UNCLOS, coastal States only have restricted at-sea enforcement powers as to foreign vessels navigating in its territorial sea or its EEZ. Foreign vessels enjoy the right of innocent passage in the territorial sea (Art. 17 pp. UNCLOS) and the freedom of the high seas in the EEZ (Art. 58 para. 1, 87 para. 1 a) UNCLOS).

The coastal State may only undertake physical inspections "on the spot" of foreign vessels navigating in its territorial sea, where there are clear grounds for believing the vessel has, during its passage in the territorial sea, violated its laws and regulations adopted in accordance with UNCLOS or applicable rules and standards for the prevention, reduction and control of pollution from vessels, such as the sulphur limits under MARPOL ANNEX VI.

Inspections of foreign vessels under flags of MARPOL ANNEX VI States navigating in its EEZ or territorial sea may only be undertaken, where there are clear grounds for believing the vessel has, in its EEZ, committed a violation of the sulphur limits under MARPOL ANNEX VI, resulting in a substantial discharge causing or threatening significant pollution of the marine environment (Art. 211, 220 UNCLOS).

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