Action code: WHEN CONVENIENT

Operation on fuels with maximum 0.50% sulphur

SL2019-670/DOJA
February 2019

Concerns
All MAN B&W ME/ME-C/ME-B/MC/ MC-C, ME-GI and ME-LGI engines.

Summary
For operation on max. 0.50% S fuel:
- The 0.50% S fuel family will show diverse characteristics, also within the same fuel grade.
- Avoid mixing different fuel batches.
- Pay attention to the actual fuel parameters and act accordingly.
- Adjust the fuel temperature to ensure correct viscosity.

Relevant Service Letters:
SL2018-659, SL2014-593, SL2017-638, SL2018-663 as well as the most recent SL on cylinder lubrication (currently SL2014-587).

Dear Sir or Madam

On 1 January 2020, the global sulphur (S) limit on marine fuels will be reduced from 3.50% to 0.50% S. Consequently, all ships are restricted to use fuel with maximum 0.50% sulphur or utilise an approved equivalent mean to reduce the sulphur oxides (SO_x) emitted, e.g. a SO_x scrubber. A 0.50% sulphur limit is already in force in Chinese territorial waters. The current 0.10% sulphur emission control areas (SECAs) will remain unchanged. Note that other local emission areas may exist.

This Service Letter gives information and guidance on operation on 0.50% S fuel, and how to prepare for the change from operation on high-S fuel to 0.50% S fuel. Recommendations are given for the potential challenges with 0.50% S fuels, e.g.:
- Increased variation in the viscosity, density and cold flow properties from fuel batch to fuel batch – also within the same fuel grade.
- Incompatibility between fuel batches.

More information can be found in the paper “Detailed information on Preparation and Operation on fuels with maximum 0.50% sulphur” [1]. Always refer to the most recent guideline available for your specific engine type, e.g. service letters, for recommendations for lubrication, piston rings and cylinder condition, etc.

For questions and inquiries regarding the content in this letter, contact our Operation department at: Leo@man-es.com

Yours faithfully

Mikael C. Jensen
Vice President
Engineering

Stig B. Jakobsen
Senior Manager
Operation

Head office (& po. address)
MAN Energy Solutions
Teglholmsgade 41
2450 Copenhagen SV
Denmark
Phone: +45 33 85 11 00
Fax: +45 33 85 10 30
info-cph@man-es.com
www.man-es.com

PrimeServ
Teglholmsgade 41
2450 Copenhagen SV
Denmark
Phone: +45 33 85 11 00
Fax: +45 33 85 10 49
PrimeServ-cph@man-es.com

Production
Teglholmsgade 35
2450 Copenhagen SV
Denmark
Phone: +45 33 85 11 00
Fax: +45 33 85 10 17
manufacturing-dk@man-es.com

Forwarding & Receiving
Teglholmsgade 35
2450 Copenhagen SV
Denmark
Phone: +45 33 85 11 00
Fax: +45 33 85 10 16
shipping-cph@man-es.com

MAN Energy Solutions
Branch of MAN Energy Solutions SE, Germany
CVR No.: 31611792
Head office: Teglholmsgade 41
2450 Copenhagen SV, Denmark
German Reg.No.: HRB 22056
Amtsgericht Augsburg

Introduction

From 1 January 2020, a global limit of 0.50% sulphur in the fuel, set by IMO enters into force. This Service Letter describes the operational challenges for operation on fuels with max. 0.50% S fuels.

Many new types of 0.50% S very low sulphur fuel oil (VLSFO) will be placed on the market and this will challenge the handling of the fuel on board. The main fuel challenges for operation on 0.50% S VLSFOs are:

1. Fuel quality will vary from batch to batch more frequently than before.
2. Different fuel types may be incompatible. This requires that different fuel batches are kept segregated.
3. Important fuel parameters will vary:
   a. Viscosity could vary between low, as distillate type, and high as residual type. This affects the temperature settings of the fuel system.
   b. Density is important for fuel cleaning.
   c. Cold flow properties - the fuel temperature must be sufficiently high to keep the fuel flowing freely.

Table 1 summarises the content in the Service Letter.

Summary

Fuel recommendations
Properties of the 0.50% S VLSFO may vary from batch to batch, e.g. high to low viscosity, density and pour point.
Ensure that the fuel characteristics and the ship's technical capabilities match each other.
Check the parameters of the actual fuel and act upon the results, e.g. fuel temperature adjustments.

Operation recommendations
Ensure that the viscometer/viscosity sensor before the engine is installed and is working properly.
Ensure that heating and cooling equipment is installed and is working properly.
Ensure that fuel pumps are in adequate condition to be able to handle high and low viscosity fuels.
Avoid compatibility issues and do not mix different fuel batches. If mixing cannot be avoided, check compatibility (ASTM D4740, "coffee filter test", "spot-test") of the different fuel batches.
Clean the fuel and use the highest suitable temperature and lowest possible flow in the separators to ensure efficient cleaning and maximum removal of cat fines.
Switching between fuels: follow the procedures and monitor temperature and viscosity (max. 2°C/min).
Fuel viscosity at engine inlet: 2-20 cSt

Table 1: Summary

Information on 0.50% S VLSFOs

The max. 0.50% S VLSFO family will be a range of distillate (DM) and residual (RM) types of fuels. Examples of fuel characteristics that will vary within the 0.50% S VLSFO family are viscosity, density, pour point, and cat fines (Al+Si) content. These parameters are all important to consider since they affect many of the systems on board.

It is assumed that the 0.50% S VLSFO types will be fully capable of being categorised within the existing ISO 8217 standard [2]. MAN Energy Solutions expects that fuels with characteristics within the ISO 8217 standard are well-suited for MAN B&W two-stroke engines. It is always important to read and act on the fuel suppliers' recommendations, manuals and best practice sheets to ensure safe and efficient use of the fuels.

The fuel characteristics within a certain ISO 8217 grade may differ more in the future, since more variation is expected in used refinery streams. The ISO 8217 working group is preparing a Publicly Available Specification (PAS) [3]. It will provide guidance to the application of the current ISO 8217 standard to 0.50% S VLSFO fuels. It is expected that the ISO/PAS 23263 will be published in mid-2019.

It is important to ensure that the fuel characteristics and the ship's technical capabilities match each other, for example the fuel system and engine. Some fuel suppliers can supply a certificate of quality (COQ) which is a fuel analysis of the fuel in the shore storage tank. The COQ can be received before bunkering if agreed between the parties. The information in the COQ makes it easier to plan and act accordingly.

MAN Energy Solutions has received specifications and analyses of 0.50% S fuels. Table 2 shows some characteristics from a few of these samples. The fuels show very different parameters, so attention should be paid to the actual fuel and how it should be treated.

0.50% S VLSFO	Kin. Viscosity at 50°C, cSt	Density at 15°C, kg/m³	Pour point, °C	Cat fines, Al+Si, ppm	MAN Energy Solutions comments
Fuel 1	45	990	27	< 15	Unusual viscosity (low) to density (high) relationship. Note: high pour point.
Fuel 2	360	969	<24	55	Al+Si: above average. Pour point may be high.
Fuel 3	7.4	885	-24	28	Very low viscosity and density. High Al+Si.
Fuel 4	215	942	30	45	Al+Si: above average. Note: high pour point.
Fuel 5	60	985	< -3	33	Al+Si: above average. Unusual viscosity (low) to density (high) relationship

Table 2: Examples of various 0.50% S VLSFO fuel types

Operational recommendations

This is an overview of some of MAN Energy Solutions' recommendations and advice for operation on 0.50% S VLSFO.

Stability of a fuel

The stability of a residual fuel is defined by its resistance to breakdown and to create asphaltenic sludge even if it is subjected to forces such as heating and long storage time while being handled under normal operating conditions. In ISO 8217:2017 [2], the fuel stability is measured by means of the total sediments method. The higher the amount of sediment measured, the more sediment is expected to drop out of the fuel, thereby causing sludge.

Incompatibility between different fuel batches

Fuel compatibility is a measure of how stable a fuel is when mixed with another fuel, and the tendency of the mixture to form sludge and deposits by asphaltenes dropping out. This process can occur immediately after mixing or later depending on the fuel's stability reserve, and the process is non-reversible. The resulting issues are problems in the fuel cleaning system with sludge in the tanks and in the fuel system, which may result in blocked filters and separators. Incompatibility issues have always been present. Problems caused by incompatibility might become more frequent, as new refinery streams will be used to produce 0.50% S VLSFO.

Recommendations for fuel commingling (mixing two different fuel batches in the tank):

1. Avoid mixing different fuel batches.
   a. Empty tanks as much as possible before bunkering a new fuel batch
2. If mixing cannot be avoided:
   a. Reduce the amount of fuel in the tank as much as possible before bunkering new fuel.
   b. Fuels with similar viscosity, density and pour point often show acceptable compatibility, as they are likely to be of similar fuel type.
   c. Check the compatibility of the fuel in the tank and the new fuel.
      i. use on-board method for indication of compatibility: ASTM D4740 (aka spot-testing or coffee filter testing) [4]
      ii. use lab methods, if the fuels are available
      iii. if the fuels indicate compatibility, mixing may be possible.

Note: ASTM D4740 [4] is developed for aromatic fuels containing asphaltenes. Very paraffinic fuels and distillate blends may show false negative results, indicating fuels to be incompatible when they are actually compatible. The false negative result is due to pigment/wax separation. Care should therefore be taken when evaluating the results.

Fuel pump drain overflow tank

During normal operation, a small amount of fuel continuously drains through the main engine fuel pumps. Traditionally, this fuel is led back to the heavy fuel settling tank. As the different fuel types may be incompatible, it is important to keep the different fuel streams separated. To ease operation, the drain system could be updated to separate the streams [1].

Fuel tanks

Depending on the design of the actual fuel system, different handling procedures have to be made in order to manage possible incompatibility between different fuels. Examples are given below to two different types of fuel systems [1]:

1. Flexible fuel system with separate fuel lines (Fig. 1). This system makes it easier to handle and change between different fuel types that might be incompatible, as each fuel tank can be emptied before a new batch is introduced.
2. Simple fuel system with shared fuel lines (Fig. 2). Attention has to be paid to the fuel handling when changing fuels, because of the risk of mixing fuels in the tanks. The settling and service tanks should be emptied as much as possible before new fuel is added.

Viscosity

The recommended fuel viscosity range for MAN B&W two-stroke engines at engine inlet is shown in Table 3. It is very important to check the viscometer, and for those ships not equipped with a viscometer or viscosity sensor, it is highly recommended to install one.

Range	Fuel viscosity at engine inlet
	MAN B&W engines
Minimum	2 cSt
Normal (DM grades)	3 cSt or higher
Normal (RM grades)	3 – 18 cSt
Maximum	20 cSt

Table 3: Fuel viscosity at engine inlet

If the viscosity is lower than 2 cSt, the fuel injection may be compromised. We recommend making an engine start test on very low viscosity fuel to verify whether the pumps are sufficiently unworn to be able to build up sufficiently high pressure. It is especially important for MC engines. The test should be performed before entering high-risk areas (e.g. ports and other congested areas). By such action, the individual low-viscosity limit can be found for each engine with correspondingly worn pumps. It is recommended to make such start check at least every 6 months.

Flexible fuel system

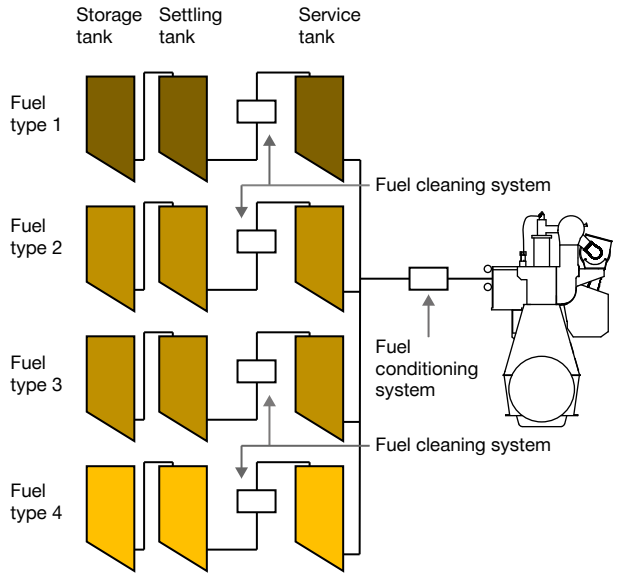

Figure 1: Schematic of a flexible fuel system

Simple fuel system

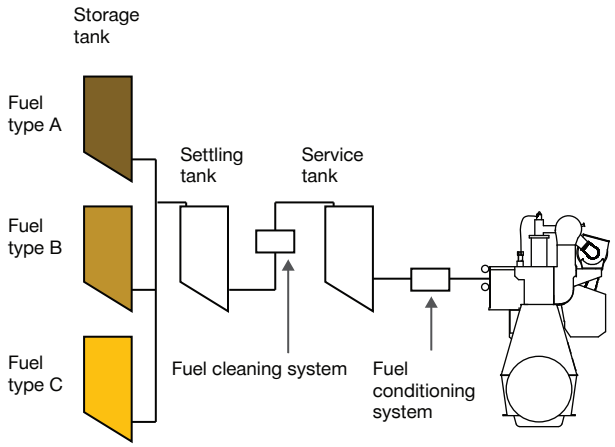

Figure 2: Schematic of a simple fuel system

If the viscosity of the fuel gets too high, it will lower the effective injection pressure for the ME engines, which may lead to slower injection and a lower degree of atomisation of the fuel. In extreme cases, it may compromise the combustion. On MC engines, the mechanically driven fuel pumps, cams and camshaft may experience difficulties in handling the thick fuel.

It is important to check the heating and the cooling capabilities of the fuel system to ensure that it can handle both high and low viscosity fuels, because viscositiy, pour point, and other cold flow properties may vary between fuel batches. To build in a margin for safe and reliable operation and maintaining the required viscosity at engine inlet, installation of cooler(s) may be necessary [1].

Density

The density of the fuel is important for the fuel cleaning. Correctly sized gravity discs should be used in classic separators. The gravity disc in a classic separator must be changed when the density of the fuel changes. If the gravity disc is not suitable for the fuel in use, the oil-water interface in the separator will not be correct, and the fuel will not be cleaned. Water may be led with the fuel to the engine or the fuel will be led to the drain with the water.

The most commonly used type of separators, in newer ships, automatically adjusts the oil-water interface without the need of gravity discs. To support optimal fuel cleaning, automatic separators are recommended by MAN Energy Solutions.

Cold flow properties

The cold flow properties of a fuel are frequently defined by the pour point (PP), but others exist as well. PP can be measured for distillate (DM) and residual (RM) grades. The fuel should be heated sufficiently to be able to flow freely and be homogenous, in order to avoid filter blocking, etc. In the distillate marine fuels system, it is recommended to keep the temperature between 30-40°C to minimise the risk of wax crystallization, and to decrease the risk of too low viscosities. For residual-type fuels, the temperature in the fuel system, e.g. tanks and pipes, should be minimum 10°C higher than the pour point of the fuel.

Cat fines (Al+Si)

As in high-sulphur HSHFO and 0.10% S ultra low sulphur fuel oil-RM (ULSFO-RM), cat fines may also be found in 0.50% S VLSFO. Cat fines are small, very hard particles which can wear the engine fast. They should be removed by cleaning of the fuel. Fuel cleaning should be carried out at the highest possible temperature, and at the lowest possible flow [SL2017-638].

The level of cat fines must always be kept as low as possible, and the recommended maximum acceptable level is 15 ppm Al+Si at engine inlet for short periods.

Change-over from high-sulphur HSHFO to 0.50% S VLSFO

From 1 January 2020. the ship must comply with the 2020 regulation. This means that the engine must burn max. 0.50% S fuel, and that the fuel delivered must contain

max. 0.50% S. The ship must ensure that the fuel to the engine will be max. 0.50% S without being contaminated with the previous HSHFO causing the sulphur content to increase above 0.50% S at engine inlet.

The tanks and systems could be cleaned, or the tanks could be emptied, and the HSHFO remaining in the system could be purged through the system in order to reach a compliant level. Some additives claim to be able to clean the tanks and fuel system. MAN Energy Solutions does not have any experience with such additives.

All the fuel tanks and the fuel system may be covered inside with remains of the HSHFO which has been used for many years. These remains may be high in sulphur and cat fines, and the new fuels may be able to dissolve the remains and cause sludge and sulphur and cat fines contamination of the new fuel batch. It is important to make sure that the sludge and the cat fines do not reach the engine. The remains of the HSHFO may be removed by purging, diluting, and dissolving with low-S fuel. Experience has shown that this may have to be repeated several times with different fuel batches, as each fuel batch can only dilute and dissolve limited amounts of the remaining HSHFO.

Change-over process

When changing between fuel batches with different viscosity, it is important to keep the temperature change rate below 2°C/min. If the temperature changes faster, the fuel pumps may stick.

In case the previous fuel and the new fuel are very incompatible and cause excessive sludging and blocking of the auto-filters, consider switching the engine to a distillate (e.g. DMA) in between the two fuel batches to prevent engine blackout due to lack of fuel.

Combustion

In rare cases, fuels may show unfavourable combustion characteristics. Several engine tests made over the years have shown that such fuels do not have major influence on the MAN B&W two-stroke engines. The fuels ignite and burn as for other fuels.

Familiar fuel on board?

New 0.50% S VLSFOs will be introduced on the market, and this may challenge ship installations and the handling of the fuel on board. Failures sometimes occur, as in 2018 when a number of ships experienced operating problems using residual fuels bunkered in the Houston area. When these problems occurred, it proved to be beneficial to have another fuel on board, so that the crew could switch to an alternative fuel.

More information

More detailed information on the challenges and solutions for operation on 0.50% S VLSFO and the change-over process from HSHFO to 0.50% S VLSFO is available in the separate MAN Energy Solutions paper: “Detailed information on Preparation and Operation on fuels with maximum 0.50% sulphur”. It also includes information on: 0.50% S VLSFO characteristics, Purchasing Fuel – Responsibilities and actions, Test procedure of new types 0.50% S VLSFO, Biofuel and Fuels not fit for purpose.

Papers can be found on: https://marine.man-es.com/two-stroke/technical-papers

References

1. Detailed information on Preparation and Operation on fuels with maximum 0.50% sulphur.
2. ISO 8217:2017 Sixth edition. “Petroleum products – Fuels (class F) – Specifications of marine fuels”.
3. ISO/PAS 23263: “Considerations for fuel suppliers and users regarding marine fuel quality considering the implementation of maximum 0.50% S in 2020”.
4. ASTM D4740. Standard test method for fuel cleanliness and compatibility of residual fuels by spot test.

Notwithstanding the foregoing, it remains the responsibility of the owner/operator of an engine to ensure that suitable fuel is conditioned and used, in order to prevent damage to the engine and other equipment on board.