

for MITSUI—MAN B&W engines, Precautions for operation of fuels with maximum 0.50% sulphur		No. 202	
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ENGINE TYPE	All engine types	DATE	2019.7.17

Rev.1: Choice of cylinder oil (2020.07.22)

On 1 January 2020, the global sulphur limit on marine fuels will be reduced from 3.50% to 0.50% sulphur.

Consequently, all ships are restricted to use fuel with a sulphur content complying with regulation, i.e. maximum 0.50% sulphur, (compliant fuels) or utilize an approved equivalent mean to reduce the sulphur oxides (SOx) emitted, e.g. a SOx scrubber.

It is expected that many new types of maximum 0.50% sulphur compliant fuel oil (VLSFO: Very Low Sulphur Fuel Oil) will be placed on the market.

Basically, VLSFO can be used on Mitsui-MAN B&W two stroke diesel engines. However, since the properties of VLSFOs will vary from fuel batch to fuel batch, it is necessary to pay more attentions to handle the fuels on board based on parameters of the actual fuel than before.

The general recommendation and guidance for operation on VLSFO are informed in this Service Note.

PRIORITY

IMMEDIATELY <input type="checkbox"/>	AT FIRST OPPORTUNITY <input checked="" type="checkbox"/>	WHEN CONVENIENT <input type="checkbox"/>	OTHERS <input type="checkbox"/>
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Precaution for operation on VLSFO

Properties of VLSFOs might become more variety than that of distillate (DM) and residual (RM) type fuels specified in ISO 8217, as various new refinery streams will be used to produce VLSFO.

Characteristics that will vary within VLSFOs are viscosity, density, pour point and cat fines (Al+Si) content. These parameters are important, as they affect many of the fuel systems on board.

0.50% VLSFO	Kin. Viscosity at 50°C, cSt	Density at 15°C, kg/m ³	Pour point, °C	Cat fines Al+Si, ppm	Comments
Fuel 1	45	990	27	<15	Low viscosity and high density, High pour point
Fuel 2	360	969	<24	55	High cat fine content
Fuel 3	7.4	885	-24	28	Very low viscosity and density High cat fine content
Fuel 4	215	942	30	45	High cat fine content, high pour point
Fuel 5	60	985	<-3	33	High cat fine content, low viscosity and high density

Table 1: example of 0.5% S VLSFO (Quote; MAN Energy Solutions, Service Letter SL2019-670)

➤ **Incompatibility between different fuel batches**

Mixture of a fuel with another fuel may form sludge and deposits by asphaltenes dropping and this may result in blocking of fuel oil filters. Incompatibility issue have always been present. However, problem caused by incompatibility might become more frequent, as VLSFO will be produced on the basis of widely refinery streams.

1. To avoid mixing of different fuel batches, empty tank as much as possible before bunkering a new fuel batch.
2. In case if mixing cannot be avoided, reduce the amount of fuel in the tank as much as possible before bunkering new fuel, and check the compatibility of the fuel in the tank and the bunkering new fuel before mixing by means of on-board method for indication of compatibility; ASTM D4740 (spot-test) or laboratory method if the fuels are available.
3. During normal operation, a small amount of fuel oil continuously leaks through the main engine fuel pumps as clean drain, and this clean drain is led to the overflow tank. When the clean drain in the overflow tank is led back to the fuel settling tank, check if clean drain in the overflow tank and another fuel in settling tank is the same fuel batch. If not, take the same actions as above item 2.

➤ **Viscosity**

If the viscosity is lower than 2 mm²/s, the fuel injection may be compromised.

1. The recommended fuel oil viscosity at engine inlet is 2~20 mm²/s. It is recommended to keep a fuel oil viscosity at minimum 2 mm²/s at engine inlet.
2. It is recommended to check the clearance of barrel and plunger of fuel pumps, and to replace them in case if excessive wear is measured.
3. It is recommended to make an engine start test on very low viscosity fuel oil before entering high-risk areas, e.g., ports and other congested areas. It is recommended to make such start test at least every 6 months

➤ **Density**

The density of fuel oil is important for the fuel cleaning. If the gravity disc in separator is not suitable for the fuel in use, the fuel will not be cleaned. As the cat fines (Al+Si) may be found in VLSFO, the correct size gravity disc should be used for optimal fuel cleaning.

➤ **Cold flow properties**

The cold flow properties of fuel oil are frequently defined by the pour point (PP).

The fuel oil should be heated sufficiently to be able to flow freely and be homogenous, in order to avoid filter blocking, so the temperature in the fuel system, e.g. tanks and pipes, should be minimum 10 °C higher than the pour point of the fuel oil.

➤ **Cat fines (Al+Si)**

The cat fines (Al+Si) may be found in VLSFO as in High Sulphur HFO. Cat fines are small and very hard particles originating from the refining process. In case of insufficient cleaning on board, cat fines may enter the engines with fuel oil and cause wear, so the fuel oil must be cleaned on board the ship before it reaches the engine.

1. Remove the cat fines from the fuel oil by setting a high temperature and a low flow in the fuel oil separator.
2. 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 period.
3. It is recommended to install a 10 um fine filter before engine. This filter will act as an indicator for insufficient operation of the separator.

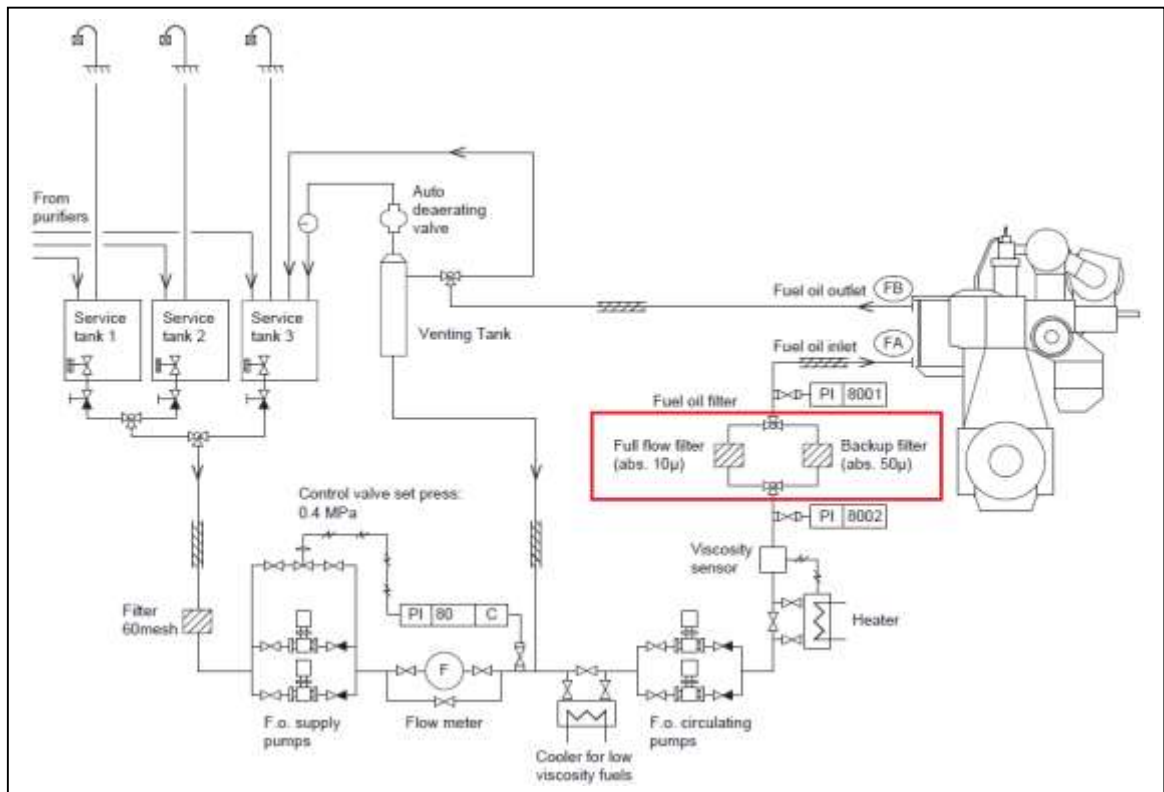


Fig 1: Schematic of fuel circulating system with 10 um fine filter in front of the engine

Cylinder lubrication for 0 to 0.50% sulphur fuel

➤ Choice of cylinder oil

When operating on low sulphur fuel, only small amount of sulphuric acid are formed in the combustion chamber and condenses on the liner wall. The cylinder lube oil additives are then not used for the designed purpose and they tend to build up as calcium deposit in the combustion chamber.

It is recommended to use low-BN (BN40) cylinder oil when operating on low sulphur fuel.

➤ ULSFO : Ultra Low Sulphur Fuel Oil	BN15 ~ BN40
➤ MGO : Marine Gas Oil (maximum 0.10% sulphur)	

➤ VLSFO : Very Low Sulphur Fuel Oil (0.10~0.50% sulphur)	BN40 ~ BN70 ^{※1}
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※1: Start by using a BN40 cylinder oil.

On the other hand, generally, detergency of the low-BN cylinder oils (to keep the engine clean and remove the deposit formed on piston ring lands and in ring grooves) is relatively lower as compared with the high-BN cylinder oils. Therefore, if heavy deposits have built up on the piston ring lands and in the ring grooves when operating on low-sulphur fuel with low-BN cylinder oil, depending on condition, up to BN 100 cylinder oil can be used. However, in this case, it is recommend to use alternately between high-BN cylinder oil and Low-BN cylinder oil. Please follow the deposit control guideline stated in page 6 if heavy deposits are observed.

Fig 2 and Fig 3 show overview of the recommended BN levels on Mk8 and new engines (including S60ME-C7.1) and on Mk7 and older engine types respectively.

For cylinder oil brands, please refer to Service Note No.194.

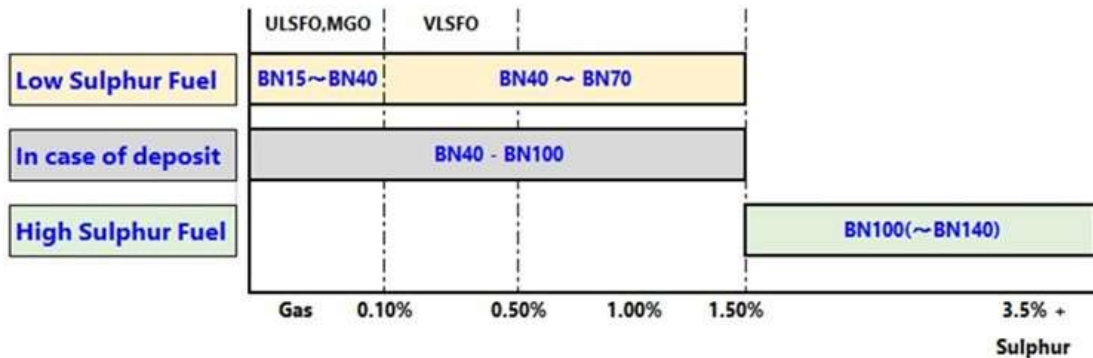


Fig 2: Recommended BN levels on Mk8 and newer engines (including S60ME-C7.1)

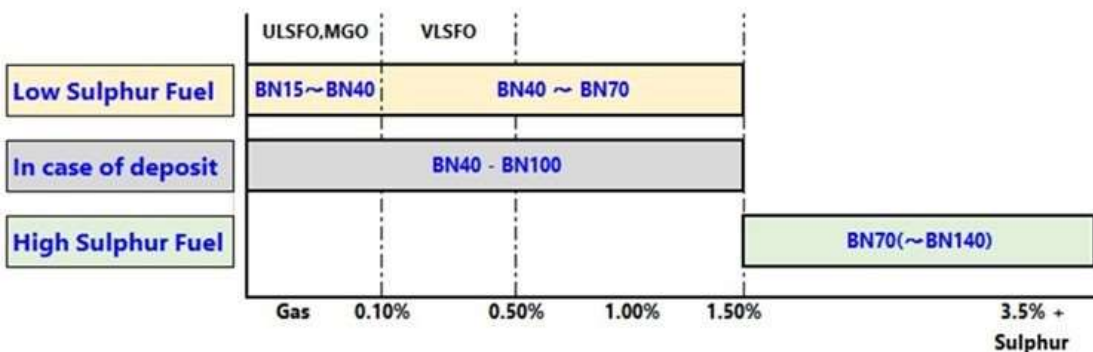


Fig 3: Recommended BN levels on Mk7 and older engines (except S60ME-C7.1)

➤ Feed rate

It is important to adjust the feed rate to the "optimal feed rate" by avoiding over-lubrication. The "optimal feed rate", which is the minimum feed rate yet maintaining acceptable cleanliness, acceptable wear and avoiding hard contact such as micro-seizures on the piston rings and cylinder liner, must be assessed based on the actual cylinder condition on each vessel.

- New ships entering service and after reconditioning or renewal of cylinder liner must follow the guidance given in the Instruction Book (Fig.4) during initial running-in of the components. Cylinder condition must be checked by scavenge port inspection before reducing the feed rate to the next step. Feed rate can be reduced to the next step if good condition is confirmed. Deposit formation must be monitored when reaching 1.0 g/kWh and further feed rate reduction requires acceptable cylinder condition based on inspections.
- Vessels in service, which have not yet optimized the feed rate for VLSFO operation, should start at the existing feed rate or 1.0g/kWh and then reduce the feed rate in steps of 0.10g/kWh based on inspections until the minimum feed rate is reached. Cylinder condition must be checked by scavenge port inspection before reducing the feed rate to the next step. Feed rate can be reduced to the next step if good condition is confirmed.

If heavy deposits have built up on piston ring lands and in the ring grooves before the minimum feed rate is reached, the feed rate should be increased back to the previous step, and no further reduction is recommended.

If sign of hard contact such as micro-seizures is observed on the piston rings, the feed rate should be increased to 1.20 g/kWh or more and the cylinder condition should be carefully monitored. If sufficient improvement is found with increased feed rate applied, the feed rate can be reduced in steps of 0.10g/kWh based on inspections until the minimum feed rate is reached.

As the specific minimum feed rate is set at 0.60g/kWh to keep the necessary oil film on running surface between the cylinder liner and the piston rings, the feed rate cannot be reduced below 0.60g/kWh.



Photo 1 Clean condition



Photo 2 Medium amount of deposits on 1st ring land
(Quote: MAN Energy Solutions, Service Letter SL2019-671)

➤ Inspection of cylinder condition

It is recommended to check the cylinder condition by scavenge port inspection according to the instruction book (monthly), and to measure the cylinder liner wear at least once a year.

Drain oil analysis is a good way to evaluate the cylinder condition, it is recommended to take drain oil samples and analyze at regular intervals. The iron (Fe) content and the BN value should be analyzed. For analysis methods, please refer to Service Note No.190

Fe content in drain oil will be the measurement of wear of cylinder. The maximum Fe content in drain oil must be adjusted to the individual engine based on actual wear measurements.

The values shown in table 2 are only as guidance.

Cylinder bore	Max. total Fe content
26cm~50cm	100ppm
60cm~70cm	150ppm
80cm~98cm	200ppm

Table 2: Guiding drain oil levels

Residual BN level in drain oil can be used as a guide to the depletion of cylinder oil. For guidance, the residual BN should be around 25% of the original BN value of the cylinder oil in use.

➤ **Deposit control when operating on maximum 0.50% sulphur fuel.**

If heavy deposits have built up on the ring lands and in the ring grooves using maximum 0.50% sulphur fuel, it is recommended to follow the deposit control guideline stated in below.

Deposit control guideline

1. Start by increasing the feed rate of the low-BN oil up to 1.0g/kWh.
2. If no or insufficient improvement is found with only increased feed rate applied, or heavy ring land deposits are observed at 1.0g/kWh and higher:
 - Change to cylinder oil with higher BN cylinder oil.
 - Alternating the use of high-BN oil and low-BN oil is recommended to reduce the formation of calcium deposits as low as possible. Use the high-BN oil for one week and then the low-BN oil for one week. Switch back to the high-BN for one week and so forth. Depending on performance, the intervals can be adjusted to secure clean pistons, but avoid using high-BN oil for longer than necessary.
3. If improvement is found with higher BN oil:
 - Reduce the feed rate in steps of 0.10g/kWh. Cylinder condition must be checked by scavenge port inspection before reducing the feed rate to the next step. Deposit formation must be monitored and if deposits are observed, feed rate must not be reduced to the next step.
4. If the engine suffers from heavy ring lands and ring groove deposits, a prolonged period using only high-BN oil has shown to be able to clean the engine. In such cases, it is recommended to carry out scavenge port inspections every two weeks.

Specification of Main engine

➤ **Jacket cooling water temperature**

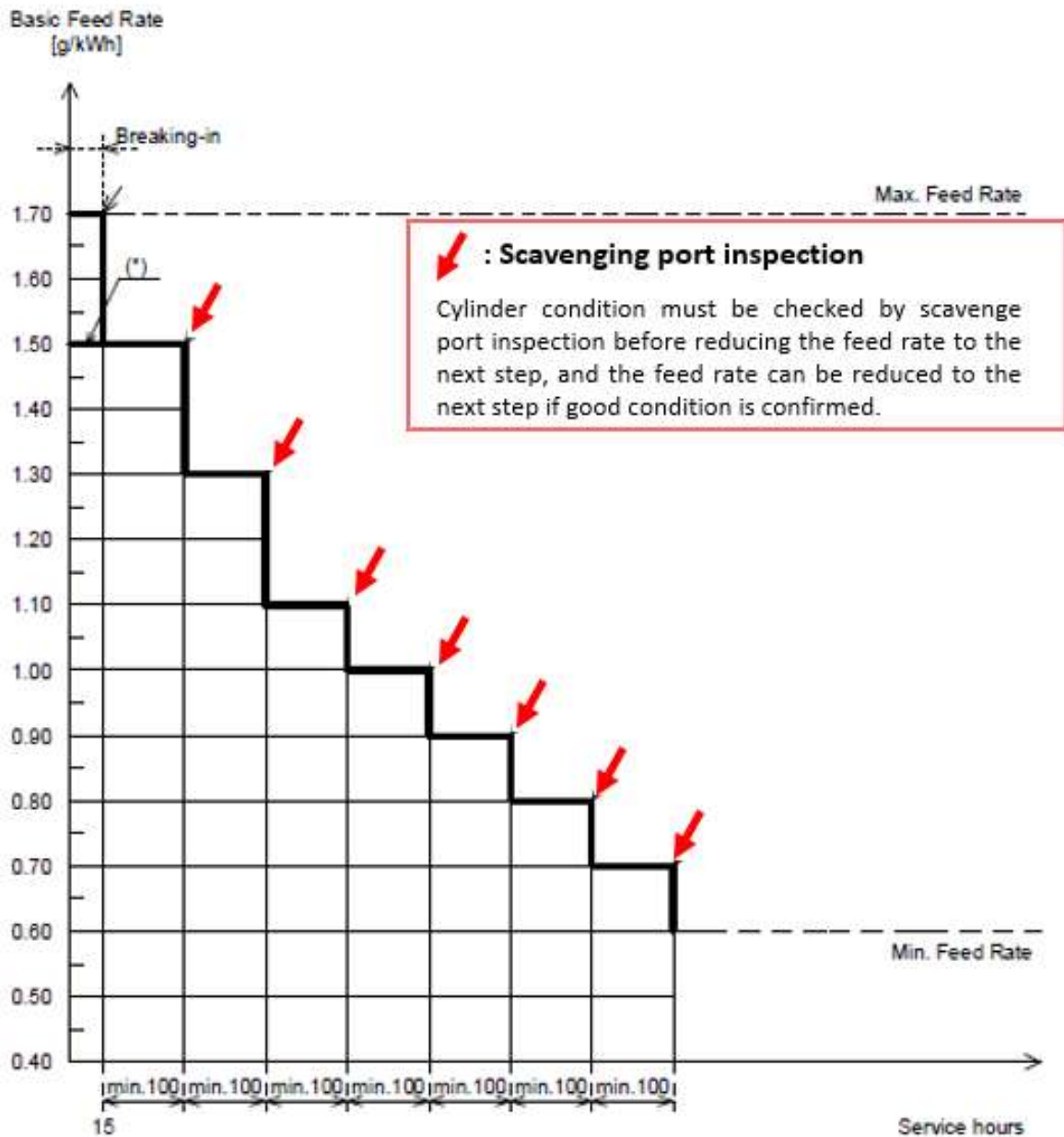
As the risk of cold corrosion is reduced, the jacket cooling water outlet temperature can be reduced to 80 °C. However, the cooling water set point must be aligned with other components in the cooling water system, such the fresh water generator.

On main engine equipped with LDCL (Load Depended Cylinder liner) system, it is recommended closing down the LDCL system when running on maximum 0.50% sulphur fuel.

LDCL system can be stopped from MOP by changing LDCL state from [Auto] to [Stop] mode. During normal operation if LDCL state is changed to [Stop] mode, LDCL pump will be stopped and the 3-way valve will be set to the 100% position, then though an alarm "LDCL manual stopped from MOP" will occur, this alarm can be cut-out manually from the Alarm List on MOP. Regarding the methods of LDCL system closing down and an alarm manual cut-out, please refer to the Instruction Book, Chapter 703 "MOP Description"

➤ **Piston ring**

It is recommended to apply the hard cermet coating on running surface of all the piston rings to improve anti-scuffing performance at the next overhaul if the cermet coating piston ring is currently not applied on your vessels. For details, please refer to Techno News No.101.



*) for Mark9 type with cylinder bore 50 cm and smaller engines

Fig.4: Guidance schedule of the cylinder oil feed rate at MCO for fuel with sulphur content up to 0.5wt %