Action code: WHEN CONVENIENT

Heavy Fuel Oil Cleaning

Removal of abrasive particles

SL2017-640/LNW
February 2017

Concerns

Owners and operators of
MAN four-stroke diesel engines.
Types:
Marine: L16/24, L21/31, L23/30H, L27/38, L28/32H
Stationary: L16/24S, L21/31S, L23/30S, L27/38S, L28/32S, V28/32S
Propulsion: L21/31, L27/38, L23/30A, L28/32A

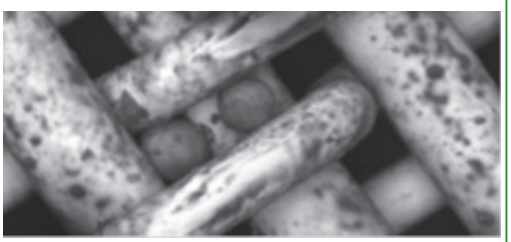
Summary

Service experience and recommendations are provided in this service letter to enable efficient cleaning of fuel oil and removal of abrasive particles.

Reference is made to:

SL13-577/KEL, SL14-595/CLAN, SL2016-615/JFH and the Instruction Manual, description 010.000.023-05, Heavy fuel oil (HFO) specification.

Attachments:
Quick Guide on fuel oil cleaning – removal of abrasive particles (version 2.0)



Dear Sirs

MAN small bore four-stroke medium speed engines have been designed for- and successfully operated on HFO for decades. Service experience is excellent, provided the fuel oil supplied to the engine is according to specifications. Therefore, the importance of fuel oil quality is addressed in this service letter in order to obtain or maintain the intended service reliability and performance.

On-board fuel oil cleaning, including removal of abrasive particles, is of great importance since damage as a result of abrasive wear is a major reason for severe operational difficulties.

Chemical properties of the fuel oil, such as ignition qualities, are not within the scope of this service letter.

To ensure proper fuel oil cleaning and removal of abrasive particles, the following elements must be present in the fuel oil cleaning system and must be given special attention:

- Separator - correct temperature and flow rate
- Filters – installation (fineness and position) and operation
- Settling and service tanks – correct operation including cleaning flow in service tank.

Yours faithfully

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Content

Fuel oil cleaning system

MAN engines are designed to operate on all commercially available fuels within the ISO 8217-2012 and CIMAC-2003 fuel specifications (HFO), however, only when sufficiently treated on-board. For this purpose, a well-designed and maintained fuel oil cleaning system is a must. Separators in combination with a settling tank and filters are the generally accepted standard. Abrasive particles are potentially damaging to the engine and these are the main focus of this service letter. To ensure safe operation of the engine, the HFO must be cleaned by an on-board fuel oil cleaning system.

Abrasive particles

Catalytic fines (cat fines) are the most damaging of the abrasive particles normally found in fuel oil. Cat fines are small particles of spent catalyst remaining in the fuel oil after the catalytic cracking process. The cat fines are very hard, consisting mainly of aluminium and silicon oxides, varying in size down to tenths of microns, see Fig. 1.

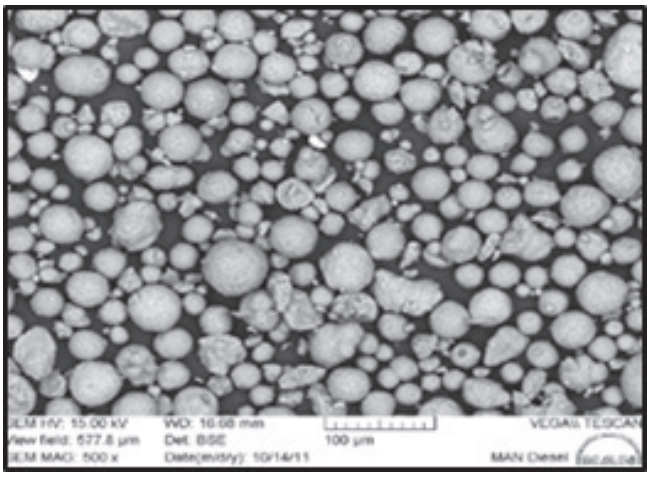


Fig. 1: *SEM photo of catalytic fines*

Catalytic fines remaining in the fuel oil after separation and filtration have the potential to cause abrasive wear and damage to the engine. With a high content of cat fines in the fuel oil, the engine will require maintenance more often and the risk of damage and unsafe operating conditions is larger. By reducing the amount of cat fines in the fuel oil cleaning system to below the specified limits, the engine will have a predictable and low wear rate, calling for overhaul at the specified mean time between overhaul (TBO) only. Less cat fines means less wear, so the amount of cat fines should be keept as low as possible at all times. Cat fine levels even lower than the maximum allowed are therefore desirable.

Settling and service tanks

The heavy particles in fuel oil, such as large cat fines, will eventually settle at the tank bottom due to gravitation. The result is a higher concentration of particles in the bottom of the tanks that may be hurled up in rough sea conditions. Therefore settling and service tanks must be drained regularly. Service experience has shown that even the service tank, containing fuel already cleaned by a separator, shows a considerable degree of settling.

Cleaning flow

To ensure removal of the particles settled in the service tank, a cleaning flow must be established. The correct service tank design has an overflow pipe from the bottom of the service tank. If not installed by the yard, a retrofit solution with a small pump providing a flow from the drain point on the service tank and back to the settling tank should be fitted.

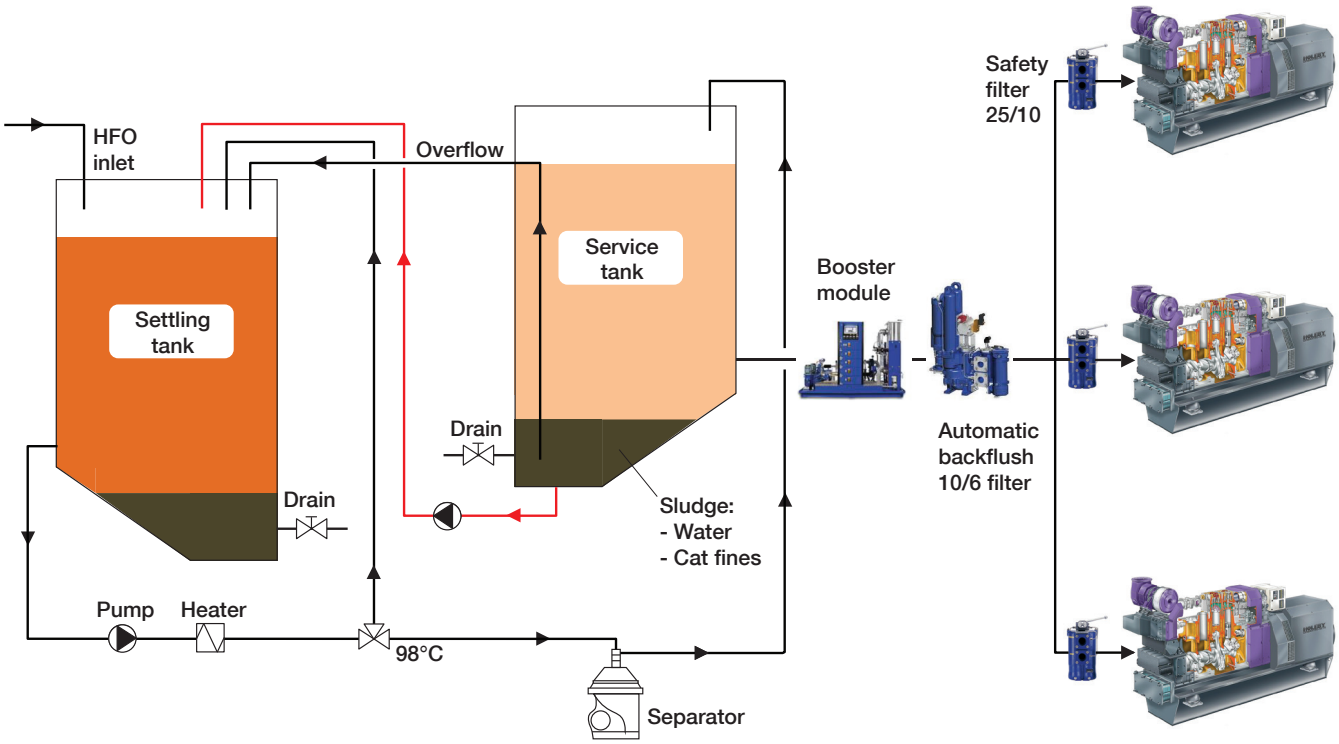


Fig. 2: *Cleaning flow established as retrofit*

Pre-heaters

Pre-heaters raise the fuel oil temperature to the correct separator inlet temperature. Service experience has shown that there are both design and operational reasons causing a too low separator inlet temperature.

One of the design-related reasons is installation of pre-heaters with too small heating capacity and/or a too limited steam supply.

Another reason is that a proportional–integral–differential controller (PID controller) must be installed to keep the temperature correct and stable. If only a P-function controller is installed, it will most likely cause too large temperature variations and, as a result, too low/too high fuel oil inlet temperature. If the fuel oil separator inlet temperature is too high, it may cause boiling of the control water in the separator. Therefore, an upgrade to a PID-type controller is highly recommended.

Among the operational reasons is a too low set point or that the heater surface is clogged by deposits, thus limiting the heating capability.

The above factors will lead to a reduced separator inlet temperature and, eventually, poor separation and failing separators.

Separators

Separators are good at separating material with a higher specific density, such as water, foreign matter and sludge, from the fuel oil. For practical reasons, the separators must be of the self-cleaning type, installed, operated and maintained according to manufacturers' current recommendations. If properly maintained and operated, a separator can remove particles down to approximately 5 µm. Smaller particles are difficult to remove, and good maintenance and operating procedures are a must.

The efficiency is important and should be checked every third month as a minimum. Check the efficiency by drawing samples before and after the separators and send these to an MAN PrimeServ Lab or similar for analysis. Samples should be taken more often when operating on fuel oil bunkered with more than 25 ppm cat fines.

Definition	Particle size	Quantity
Inorganic foreign matter including catalyst particles	< 5 µm	< 20 mg/kg
Al+Si content	--	< 15 mg/kg
Water content	--	< 0.2 vol. %

Table 1: *MAN Diesel & Turbo requirements with respect to the maximum content of particles and water after separation.*

The two most important operational parameters for obtaining good separation are temperature and flow. A high temperature and low flow removes a high amount of particles – good efficiency, while a low temperature combined with a high flow barely removes any particles at all – poor efficiency.

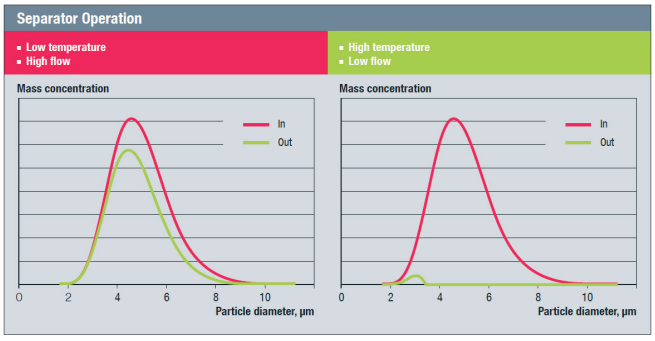


Fig. 3: *Separator efficiency shown for two cases:*
1. low temperature/high flow and
2. high temperature/low flow

Another issue to address is that good maintenance is important, often overlooked, and difficult to quantify. However, if the bowl is not cleaned in time, deposits will form on the bowl discs, the flow velocity will increase, and the separation efficiency will drop.

The design flow rate is often much higher than required for today's trade. Consequently, the fuel flow rate to the separators could and should be lowered as much as possible to ensure the best possible separation. Some manufacturers design the fuel oil supply system with automatic adjustment of the flow rate according to the actual consumption. If this type of equipment is not available, MAN Diesel & Turbo recommends reducing the flow to the known daily consumption. This is normally done by a bypass valve, but alternatively a smaller feed pump can be installed.

Thus to ensure good separation:

- Operate and maintain separators according to suppliers' specifications
- Keep the fuel oil temperature at 98 C or higher at the separator inlet
- Keep a correct (low) flow of fuel oil through the separators.

Homogenisers

If a homogeniser is installed, it should only be used if installed after the separators. A homogeniser in front of the separator will destroy the separation process and should not be used.

Filters

To protect the engines from particles that have either passed the separators or been generated inside the fuel system, a 10 µm abs. automatic filter must be installed in the circulation loop (SL2016-615/JFH). All new engines are fitted with a 25 µm abs. safety filter, which serves as a short term final protection. Service experience is excellent with the latest filter layout consisting of a 10 µm abs. auto filter and a 25 µm abs. safety filter. Long overhaul intervals of fuel nozzles, fuel pumps and combustion chamber components have been recorded, even for plants with problematic separation. An update to the latest system design standard should be considered a must for engines in service.

Engine wear and damage

Abrasive wear happens when the fuel oil cleaning system is not removing the cat fines from the fuel oil. Rust, sand and dust are other components which must also be removed; however, they are normally less harmful and are found in the fuel in much smaller quantities in normal service. New vessels risk heavy contamination with rust and sand if the piping has not been cleaned and flushed properly, with fuel pump seizures as a result.

Fuel injection system

The fuel nozzles are normally the first part to be damaged from abrasive particles. Abrasive particles change the size and shape of the injector holes. Any change of the holes alters the injection spray pattern of the fuel oil, which will cause poor combustion, fouling and consequential damage such as sticking and broken valves, damaged turbochargers, etc. In the fuel pump, abrasive particles will be trapped between the plunger and barrel and may cause wear or even seizures. Excessive wear of the plunger and barrel affects the injection pressure and timing and, thereby, causing poor engine performance, limiting the power output.

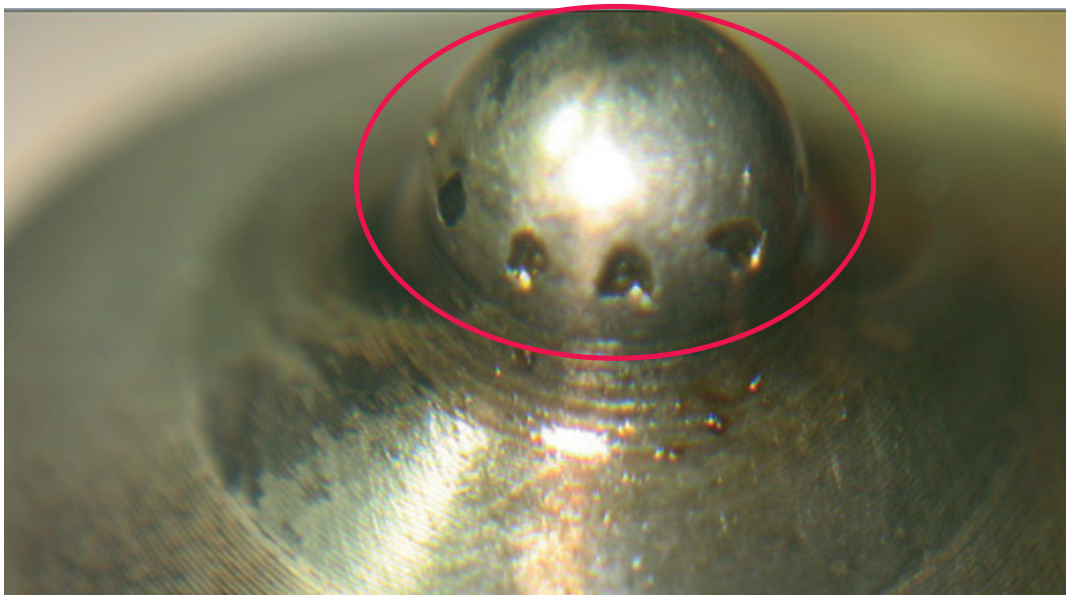


Fig. 4: *Abrasive wear has changed the shape and size of the injector holes*

Combustion chamber

When the engine is running, the cat fines from the fuel will be trapped between the piston ring and groove or between the piston ring and liner causing wear to develop quickly on these components. In severe cases the piston and liner will wear out in a very short period of time, even down to a few hundred hours of operation. The symptoms are low compression pressure and high lube oil consumption.

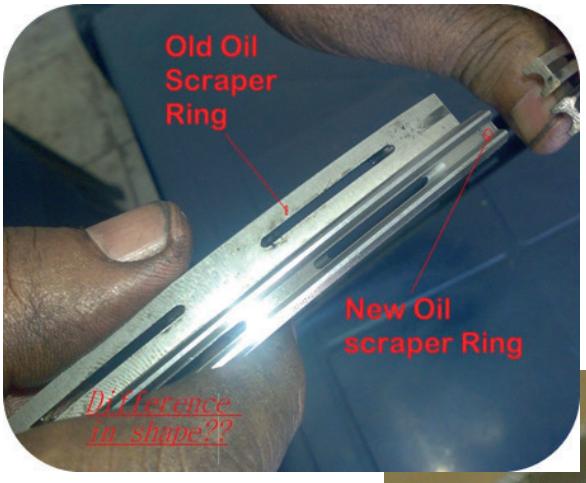
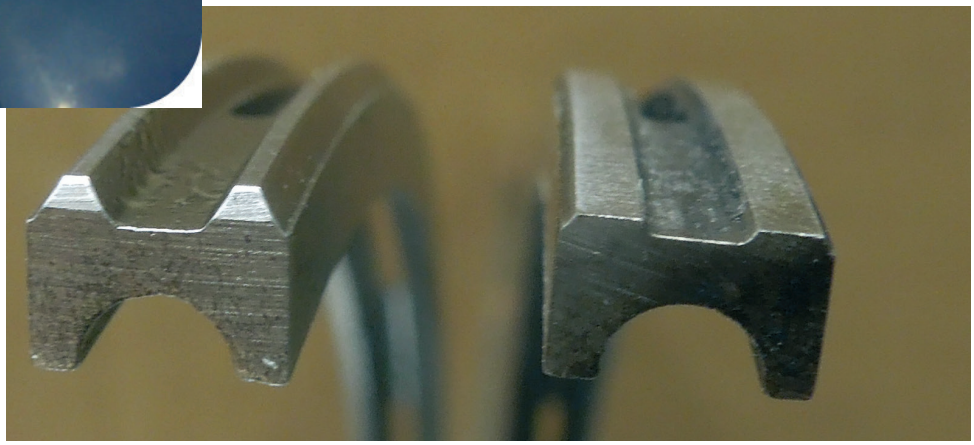


Fig. 5: *Abrasive wear of an oil scraper ring*



Turbocharger

Abrasive particles that pass the fuel equipment and the combustion chamber will reach the turbine section of the turbocharger. Here, the main reason for wear on (primarily) the nozzle ring is abrasive particles, leading to a short lifetime and therefore early replacement.

Fig. 6: *Worn nozzle ring caused by abrasive particles*

Conclusion

Bunkered HFO should be cleaned and abrasive particles removed before it is used in our engines. Strictly following the procedures for separators, filters and tanks will ensure low levels of abrasive particles, with long lifetimes of components and trouble-free operation of the engine as a result. Poor fuel oil cleaning may result in severe damage and expensive repairs and downtime.

It is the obligation of the engine operators to ensure the correct fuel quality to the engine.

Please address questions or comments regarding this service letter to: LEO7-HOL@mandieselturbo.com