Action code: AT FIRST OPPORTUNITY

Cooling Water Treatment and Periodical Test of the Cooling Water

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Concerns
Owners and operators of
MAN four-stroke diesel engines.
Type: Propulsion and GenSet

Summary
The requirements to freshwater quality, treatment and periodical check of cooling water treated with nitrite based additives are summarised. Operational issues and damages related to insufficient freshwater quality/cooling water treatment are presented as well.

Reference is made to:
Engine - Instruction Manual:
010.000.023-13 Specification of engine coolant and 010.000.002-03 Coolants inspecting.

Attachments: A Quick Guide for checking engine cooling water (version 1.0)

Dear Sirs

Recently, a number of incidents related to internal corrosion, rust and limescale attacks on engine components have been reported to us. The consequence has been service difficulties such as premature requirement for component overhaul as well as component failure and in some extreme cases engine standstill and expensive major overhaul of the engine.

Root cause analysis points towards the cooling water quality and treatment. This service letter focuses on correct cooling water treatment with nitrite based additives, since nitrite is a widely accepted cooling water inhibitor (closed systems). Based on the analysis the difficulties can in many cases be related to:

1. Too high German hardness °dGH. The quality of the freshwater should be either distilled water or fully desalinated water.
2. Too low concentration of inhibitor. The concentration of chemical additives in the cooling water must under no circumstances be lower than specified by MAN Diesel & Turbo.
3. Failure to control inhibitor and chloride concentration and pH levels. The coolant must be checked at least once a week and once every 2 to 6 months a coolant sample should be sent to an independent laboratory or PrimeServ Lab.

If you have any questions or comments please forward your mail to: LEO7-HOL@mandieselturbo.com with reference to this service letter.

Yours faithfully

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Fig. 1: *Rust and limescale fill up the cooling space of the exhaust valve seat ring, and the O-ring has become hard and brittle*

Content

Background

Typically, the damage experienced due to insufficient cooling water quality and treatment include the following:

1. Leaking exhaust valve seats
2. Corroded fuel valve inserts
3. Blocking of cooling water flow in charge-air cooler
4. Blocking of cooling water flow in lube oil cooler
5. Blocking of cooling water bores in cylinder head.

The damages are often a result of corrosion, restrictions in or blocking of the cooling water flow, which are caused by deposits of limescale and/or rust.

In general corrosion may result in leakages and thereby reduce the lifetime and safety of the engine components. Limescale as well as rust deposits will reduce the heat transfer and may result in thermal overload of the components to be cooled by the engine cooling water. A thermal overload may, however, also result in cracks and leakages as seen in the exhaust valve seat ring.

Insufficient cooling water flow has widespread consequences, in many cases this will influence the combustion process as well and therefore the overall performance and safety of the engine. Besides, experience shows that the mentioned damages can occur on a short time-scale even for new engines if the cooling water quality and treatment is neglected.

Fig. 2: *Layers of rust and lime scale reduces the transfer of heat from the fuel injection nozzle*

The origin of restrictions in cooling water flow is in some cases that normal hard water has been used with limescale formation on the engine components as a consequence. In other cases the inhibitor concentration has been too low, which has caused formation of rust on the engine components.

This service letter focuses on the nitrite containing cooling water additives since nitrite is a widely accepted cooling water inhibitor (closed systems).

Our investigations have shown that the nitrite (NO_2) concentration is particularly important. If the nitrite concentration is too low the protective layer on the engine components will not form and moreover, the low concentration of nitrite causes the cooling water conductivity to increase, thus enhancing corrosion.

The MAN Diesel & Turbo recommendations for cooling water nitrite concentration, which in some cases are higher than those given by the manufacturer, are based on experience with service difficulties and breakdown directly related to a low nitrite concentration.

Another critical factor is bacteriological contamination of the cooling water. Such a contamination can cause a rapid reduction of the nitrite concentration. It is therefore important that the engine coolant treatment is monitored closely. It is only possible to have an indication of a bacteriological contamination of the engine cooling water with the test equipment available on board the ships through the reduction of the nitrite concentration. A reduction may, however, also stem from oxygen in the cooling water or from a leakage which required topping up with untreated water.

The MAN Diesel & Turbo recommendations are therefore once every 2 to 6 months to send a coolant sample to an independent laboratory, the engine manufacturer or PrimeServ Lab. How often the coolant samples should be sent to the laboratory depends on the test result received from the laboratory. If the test results vary a lot over time samples must be sent more frequently than if the test results are stable.

Requirements to freshwater quality

The MAN Diesel & Turbo engines are designed for treated fresh water only, seawater, brackish water, river water, brines, industrial waste water or rain water must under no circumstances be used. The distilled water from a freshwater generator is free of lime and salts and therefore limescale will not form on the engine components.

Fig. 3: *Rust and limescale blocks the cooling water bores (valve seat removed from cylinder head)*

The quality of the freshwater must be checked using the MAN Diesel & Turbo water testing kit or a similar test kit provided by the manufacturer. The requirements to freshwater quality are stated in Table 1.

Treatment and periodical checks of the cooling water

When distilled water (from a fresh water generator) is used as the engine coolant (as recommended, see Table I), it is highly important to focus on the cooling water treatment to avoid corrosion. The reason is the aggressive nature of the distilled water. If it is not treated correctly, rust will quickly occur and once the process is started it will happen fast in the high temperature cooling water.

1) °dGH German hardness
1 °dGH = 10 mg/l CaO
= 17.9 mg/l CaCO3
= 0.179 mmol/l

2) 1mg/l = 1 ppm

Table 1: *Quality specifications for coolants*

Typical value/property	Water for filling and refilling (without additive)	Circulating water (with additive)
Water type	Fresh water, free of foreign matter	Treated cooling
Total hardness	≤10°dGH [1)]	≤10°dGH [1)]
pH value	6.5 - 8 at 20 °C	≥7.5 at 20 °C
Chloride ion content	≤50 mg/l	≤50 mg/l [2)]

Table 2: *Nitrite containing chemical additives*

Manufacturer	Product designation	Initial dosing for 1,000 litres	Minimum concentration/ppm		
			Product	Nitrite (NO_2)	Na-Nitrite ($NaNO_2$)
Drew Marine	Liquidewt Maxigard	15 l 40 l	15,000 40,000	700 1,330	1,050 2,000
Wilhelmsen (Unitor)	Rocor NB Liquid Dieselguard	21.5 l 4.8 kg	21,500 4,800	2,400	3,600
Nalfleet Marine	Nalfleet EWT Liq (9-108) Nalfleet EWT 9-111 Nalcool 2000	3 l 10 l 30 l	3,000 10,000 30,000	1,000	1,500
Nalco	Nalcool 2000 TRAC 102 TRAC 118	30 l 30 l 3 l	30,000 30,000 3.000	1,000	1,500
Maritech AB	Marisol CW	12 l	12,000	2,000	3,000
Uniservice, Italy	N.C.L.T. Colorcooling	12 l 24 l	12,000 24,000	2,000	3,000
Marichem – Marigases	D.C.W.T. - Non-Chromate	48 l	48,000	2,400	-
Marine Care	Caretreat 2	16 l	16,000	4,000	6,000
Vecom	Cool Treat NCLT	16 l	16,000	4,000	6,000

The importance of adding the correct inhibitor as well as the correct amount of inhibitor is therefore crucial to ensure a safe operation of the engine without service difficulties and breakdown of engine components. The inhibitors are added to the engine cooling water to produce the protective film on the engine components in contact with the cooling water. It is important for the function of these inhibitors that the cooling water quality is as described in table 1.

The focus is here treatment of cooling water with nitrite based cooling water additives. Only the additives approved by MAN Diesel & Turbo may be used, these are listed in table 2 together with the requirements to the minimum additive concentration.

The additive concentration must be checked once a week using the test kit provided by the additive manufacturer or by MAN Diesel & Turbo.

Check description 010.000.023-13: Specification of engine coolant, for further information on freshwater quality and treatment.

Check description 010.000.002-03: Coolants inspecting, for information on check of the cooling water.

In conclusion it should be noted that alternative and approved products that are not based on nitrite are also available and approved by MAN Diesel & Turbo for cooling water treatment.

Operation guidelines

Engines in stand-by mode and engines operating on HFO must be preheated; the correct standby temperature of the high temperature cooling water is at least 60°C at the cylinder head. It is also recommended to pre-heat engines operating on MDO to ensure the longest service life of the engines wear parts. The pre-heat temperature must be maintained under all circumstances to ensure an optimal engine performance and to minimize the risk of cold corrosion.

We enclose a quick guide for treatment and maintenance of cooling water.