Wärtsilä 2-stroke
Technical Services

RT-138
Issue 5, 25 January 2016

Lubricating oils

Information to all Owners and Operators of Wärtsilä 2-stroke engines.

Next opportunity

Preventive action
To ensure trouble-free operation of Wärtsilä 2-stroke engines, it is important to follow the recommendations about lubricating oils stated in this bulletin.

Validity
This Technical Bulletin remains valid from the date of issue until further notice.

Note
This Data & Specifications bulletin Issue 5 supersedes Data & Specifications bulletin RT-138, Issue 4, dated 22.02.2014.
Reasons:

- Appendix 1 to RT-138 is updated.
- The particle size and count for RT-flex and W-X engines has been updated.
- The Figure 1: Piston Under Side (PUS) drain oil analysis interpretation has been updated.
- The Figure 2: Relationship between fuel sulphur content and cylinder oil BN has been updated.

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Contents

1 Introduction

NOTE:
This Data & Specifications bulletin Issue 5 supersedes Data & Specifications bulletin RT-138, Issue 4, dated 22 December 2014. Reasons:

- Appendix 1 to RT-138 is updated.
- The particle size and count for RT-flex and W-X engines have been updated.
- Figure 1 and Figure 2 have been updated.

2 System oil

The system oil provides lubrication for the bearings, the running parts of the engine and the crosshead assembly. In addition, system oil is used as hydraulic fluid in the servo oil system of the engine and also cools the pistons.

System oil requirements:

- An additive-type crankcase oil of the SAE 30 viscosity grade must be used as system oil.
- It must have a minimum BN of 5.0 mgKOH/g and detergent properties.
- It must meet load carrying performance in the FZG[1] gear machine test method A/8, 3/90 according to ISO 14635-1, Failure Load Stage (FLS) 11 as a minimum.
- Good thermal stability, anti-corrosion and anti-foam properties and good demulsifying performance are further requirements.

NOTE:
Validated lubricating oils for Wärtsilä two-stroke engines are given in:

- Appendix 1 “Validated cylinder and system oils”.

For other or new lubricants contact Wärtsilä. The contact details are given in Chapter 9 “Contacts”.

[1] *The FZG gear machines located at the FZG Institute, Munich/Germany, shall be the reference test apparatus and will be used in the event of any uncertainty about test repeatability and reproducibility*

2.1 Oil care

2.1.1 System oil

To keep the lubricating oil in good condition for a long period, effective oil treatment is necessary. This is achieved by using a self-cleaning, centrifugal separator working as purifier in by-pass, by circulating the oil from the oil tank through the separator. The purifier throughput shall be set according to the recommendation of the separator manufacturer. However it is recommended to maintain the oil temperature at 95 °C for this treatment unless it is advised otherwise by the separator supplier.
Solid contaminants (dirt) and water must be removed from the oil as completely as possible. There is always the risk that water can enter the system and cause corrosive attack on engine parts, particularly with sea water. Water contamination can also lead to bacterial contamination of the oil resulting in loss of lubrication capability and heavy corrosion of the system. Good maintenance is the most effective precaution to keep water out of the oil. The water content of the lubricating oil must not exceed 0.2% by mass over an extended period of time. If higher water contamination is observed, special measures such as intensified treatment in the separator or in a renovating tank must be considered.

2.1.2 Servo oil system of RT-flex, W-X82 and W-X92 engines

In order to prolong the lifetime of the sliding parts, fine filtered oil is used in this system. Fine filtered oil is branched off from the system oil and flows through an additional automatic filter, which flushes back to the system oil, which flushes back to the system oil. The filter mesh size is according to the particular engine specifications.
The function of the flushing process and the low differential pressure shall be monitored during operation of the automatic filter; see documentation of the automatic filter manufacturer.
The bypass filter element can be used temporarily for inspecting and cleaning the regular elements, or if these elements have to be removed for any reason.

2.2 Attention limits for selected system oil parameters

The condition of the lubricating system oil charge can be assessed by analysing selected parameters. With regular checks deterioration can be detected at an early stage and remedial procedures must be taken.

The following guide limits must not be exceeded for a long period in service; these are the oil alert limits:

Table 1: Alert limits of system oil parameters for RT-flex and W-X engines

Parameter	Unit	Limit	Test method
Viscosity at 40 °C	mm^2/s [cSt]	max. 140	ASTM D 445
Flash point (PMCC)	°C	min. 200	ASTM D 92
Total insolubles	% m/m	max. 0.70	ASTM D 893b
Base Number (BN)	mgKOH/g	max. 12	ASTM D 2896
Water content	% m/m	max. 0.20	ASTM D 95 or ASTM D 1744
FZG gear machine test	Failure load stage	min. 9	ISO 14635-1 A8, 3/90

Table 2: Alert limits of system oil parameters for RTA engines

Parameter	Unit	Limit	Test method
Viscosity at 40 °C	mm^2/s [cSt]	max. 140	ASTM D 445
Flash point (PMCC)	°C	min. 200	ASTM D 92
Total insolubles	% m/m	max. 0.70	ASTM D 893b
Base Number (BN)	mgKOH/g	max. 12	ASTM D 2896
Water content	% m/m	max. 0.50	ASTM D 95 or ASTM D 1744
FZG gear machine test	Failure load stage	min. 8	ISO 14635-1 A8, 3/90

If one of the limits is reached, appropriate remedial action must be considered to correct the situation. Such action may be intensified purification (decreased flow rate, adjustment of temperatures), treating in a renovating tank (settling tank) or partial exchange of the oil charge. It is advisable to consult the oil supplier in such a case.

The oil condemnation limits are given in Table 3 and Table 4. If the oil condition has deteriorated so far that it cannot be improved by the purifier and filters, a part of the oil charge must be replaced to return the oil charge to an acceptable performance level.

Table 3: Oil condemnation limits for RT-flex and W-X engines

Parameter	Unit	Limit	Test method
Viscosity at 40 °C	mm^2/s [cSt]	max. 150	ASTM D 445
Flash point (PMCC)	°C	min. 180	ASTM D 92
Total insolubles	% m/m	max. 1.0	ASTM D 893b
Base Number (BN)	mgKOH/g	max. 15	ASTM D 2896
Water content	% m/m	max. 0.30	ASTM D 95
SAN[2]	mgKOH/g	nil	ASTM D664
Calcium	mg/kg [ppm]	max. 6000	ICP
Zinc	mg/kg [ppm]	min. 100	ICP
Phosphorus	mg/kg [ppm]	min. 100	ICP
FZG gear machine test	Failure load stage	min. 8	ISO 14635-1 A8, 3/90

[2] *SAN: Strong acid number expressed in mg of KOH needed for neutralization*

Table 4: Oil condemnation limits for RTA and older 2-stroke engines

Parameter	Unit	Limit	Test method
Viscosity at 40 °C	mm^2/s [cSt]	max. 160	ASTM D 445
Flash point (PMCC)	°C	min. 190	ASTM D 92
Total insolubles	% m/m	max. 2.0	ASTM D 893b
Base Number (BN)	mgKOH/g	max. 30	ASTM D 2896
Water content	% m/m	max. 0.50	ASTM D 95
SAN	mgKOH/g	nil	ASTM D664
Calcium	mg/kg [ppm]	max. 6000	ICP
Zinc	mg/kg [ppm]	min. 100	ICP
Phosphorus	mg/kg [ppm]	min. 100	ICP
FZG gear machine test	Failure load stage	min. 7	ISO 14635-1 A8, 3/90

These limits are set out as guidance. The quality condition of the oil in circulation, however, cannot be fully assessed by a single parameter. Other oil parameters must be used in context to be able to find the cause of the problem and the appropriate remedy for correction.

If the Base Number (BN) of the system oil rises sharply, do a check of the condition of the piston rod gland box and the piston rod.

A certain consumption and replenishment of system oil is required to keep the system oil in good condition.
If there is a significant decrease of the flash point below the recommended values given above, you must replenish the oil charge.

The replenishment prevents an increase in system oil BN. A small increase in BN is often an indication that the system oil consumption is low.

The open cup type of flash point determination (e.g. COC) should be used to decide if a partial or complete change of oil charge is necessary.
The closed cup flash point determination (e.g. PMCC) can be used to monitor the system oil condition, but not for oil change.

The FZ gear machine performance test (method A/8, 3/90, ISO 14635-1 of the oil charge) is very important if a new gear wheel, camshaft or fuel pump follower is polished or replaced. This gives protection against scuffing during the running-in of these components. If the system oil was used for more than a year, measure the FZG performance of the oil. This will show if the performance of the oil is satisfactory for new or polished gear wheels, camshaft or fuel pump follower.

Regular on board checks of BN and water content must be done in order to obtain an early indication of oil degradation.

2.3 Particle size and count for RT-flex and W-X engines

Particle size analysis can give useful data about the wear in an engine. Abrasive particles in the oil can cause wear, thus the requirements must be closely followed. The requirements for particle size refer only to the oil in RT-flex and W-X hydraulic oil systems. These systems operate the exhaust valves, fuel systems and cylinder lubrication systems.

The NAS 1638 and SAE AS 4059 particle count requirements were previously specified as per Table 5, Table 6 and Table 7, NAS 1638 method has been superseded by the ISO 4406 method (see Table 8). However, SAE AS 4059 should still be consulted for particles larger than 21 µm. NAS data is only provided for reference purposes.

Table 5: Recommended limits in NAS classes for RT-flex, W-X82 and W-X92 engines (Engines with Servo Oil filter)

	Particle size (µm or microns)				
	5–15	15–25	25–50	50–100	100–150
Cleanliness system oil	12	11	10	8	5
	Lubricating oil separator				
Cleanliness servo oil	12	11	8	5	0
			Servo oil filter		

Table 6: Recommended limits in NAS classes for W-X35, W-X40, W-X62 and W-X72 engines (Engines without Servo Oil filter)

	Particle size (µm or microns)				
	5–15	15–25	25–50	50–100	100–150
Lubricating oil	12	11	9	7	5
	Lubricating oil separator				

Table 7: NAS 1638 and SAE AS 4059 cleanliness classes

Contamination (particles/100 ml)		Particle size (µm or microns)				
		5–15	**15–25**	**25–50**	**50–100**	**100–150**
Classes: Up to class maximum	**(14)**	4,096,000	729,600	129,600	23,040	4096
	(13)	2,048,000	364,800	64,800	11,520	2048
	12	1,024,000	182,400	32,400	5760	1024
	11	512,000	91,200	16,200	2880	512
	10	256,000	45,600	8100	1440	256
	9	128,000	22,800	4050	720	128
	8	64,000	11,400	2025	360	64
	7	32,000	5700	1012	180	32
	6	16,000	2850	506	90	16
	5	8000	1425	253	45	8
	4	4000	712	126	22	4
	3	2000	356	63	11	2
	2	1000	178	32	6	1
	1	500	89	16	3	1
	0	250	44	8	2	0
	00	125	22	4	1	0

NOTES:

- Particle counting has poor repeatability and reproducibility.
- The method does not determine the nature, hardness or shape of the particle.
- Check the used oil analysis and particle count data to form a full picture.

Table 8: ISO 4406 particle count and size classes

	Number of particles per 100 ml		
	More than	**Up to and including**	**Class**
	250,000,000	—	<28
	130,000,000	250,000,000	28
	64,000,000	130,000,000	27
	32,000,000	64,000,000	26
	16,000,000	32,000,000	25
	8,000,000	16,000,000	24
	4,000,000	8,000,000	23
	2,000,000	4,000,000	22
	1,000,000	2,000,000	21
> 6 µm max.	500,000	1,000,000	20
	250,000	500,000	19
	130,000	250,000	18
> 14 µm max.	64,000	130,000	17
	32,000	64,000	16
	16,000	32,000	15
	8000	16,000	14
	4000	8000	13
	2000	4000	12
	1000	2000	11
	500	1000	10
	250	500	9
	130	250	8
	64	130	7
	32	64	6
	16	32	5
	8	16	4
	4	8	3
	2	4	2
	1	2	1
	0	1	0

The ISO 4406 particle count system operates with 3 size classes based on a 100 ml oil sample, which are:

- R4 = Number of particles equal to or larger than 4 µm
- R6 = Number of particles equal to or larger than 6 µm
- R14 = Number of particles equal to or larger than 14 µm

2.3.1 Recommended limits for ISO 4406 particle count

The requirement for 100 ml of oil sample is therefore:

ISO 4406 --/20/17 maximum

- in the servo oil system after the automatic fine filter of RT-flex, W-X82 and W-X92 engines
- in the lube oil system of W-X35, W-X40, WX62 and W-X72 engines after the main lube oil filter on plant side

Which means:

- **No requirement to count particles equal or larger than > 4 µm**
- **A maximum of 1,000,000 particles equal or larger than > 6 µm**
- **A maximum of 130,000 particles equal or larger than > 14 µm**

ATTENTION:
ISO 4406 is valid only for particles up to 21 µm. For particles with sizes above 21 µm, SAE particle count requirements must be followed.

2.3.2 Particle counts in the servo oil of RT-flex and W-X engines

If the particle count is higher than specified, do a check of the coarse and fine filters. This will make sure that all filter elements, gaskets and seals are serviceable. If the high particle count continues and the filters are in serviceable condition, there is probably an area of the engine that is worn too much. This will cause too many particles. Too many particles can go into the system oil if the piston rod gland boxes do not seal correctly. This causes used cylinder oil to go into the system oil. The purifier also removes particles. You must make sure that the purifier operates at the correct temperature in accordance with the manufacturer's instructions. Also, make sure that the flow rate is adjusted to get the best performance.

2.4 System oil samples

At regular intervals (e.g. approximately every 300 operation hours), it is recommended that a sample of the system oil shall be taken and sent to a laboratory for analysis. The analysis must include ISO 4406 particle counting for samples taken after the filter, before the oil goes into the engine main oil gallery or the servo system.

With the oil pump running and the engine oil at operating temperature, drain a small quantity of oil from a cock in the lubricating system to flush out any dirt accumulated in this cock and rinse the clean sample container with some oil.

Subsequently take an oil sample in the sample bottle marked with the following information for the laboratory:

- Ship's name or name of plant
- Engine type
- Engine serial number
- Date of sampling
- Operating hours of oil and of engine
- Sampling point location
- Oil brand and type

3 Cylinder lubricating oil

A high-alkaline cylinder lubricating oil of the SAE 50 viscosity grade with a minimum kinematic viscosity of 18.5 cSt at 100°C is recommended. However, cylinder oils of the viscosity grades SAE 40 and SAE 60 can be used under certain circumstances. The alkalinity of the oil is indicated by its Base Number (BN) measured in mgKOH/g according to method ASTM D 2896. The base number of cylinder lubricants is not an index for detergency, but a direct measure of alkalinity.

To choose the appropriate alkalinity of the cylinder lubrication oil, monitor regularly the piston underside drain oil. In particular, the residual BN of the drain oil should be measured as an indicator of correct cylinder lubrication. The residual BN of the drain oil is such a meaningful parameter, because it is influenced by the sulphur content of the fuel, cylinder lubrication feed rate, engine tuning and operating conditions. Within the safe operating range (shown in Figure 1) the lubrication oil feed rate and alkalinity can be optimized. During operation, the feed rate must not exceed the upper limit of 1.2 g/kWh. Fuels with a sulphur content in the range of 0.1% m/m to 0.5 % m/m using cylinder oils with BN15 and BN25 are excluded. For fuels with a sulphur content in the given range, see Figure 2. If a feed rate of 1.2 g/kWh is not sufficient to keep within the safe operating range, the BN of the cylinder oil must be increased. For more details about the procedure, see Technical Bulletin RT-161, "Cylinder Lubrication".

For the cylinder lubricating oil selection and feed rate optimization process, Figure 2 provides starting points of cylinder lubrication oils at a given sulphur content fuel.

3.1 Oil analysis of the piston underside drain oil samples (PUDOS)

Wärtsilä strongly recommends that piston underside drain oil samples, (also known as PUDOS or scrape down or drip oil), are taken regularly from each cylinder and analysed on board to monitor the engine condition. These analyses are done to assess the wear rates of the piston rings and cylinder liner. This helps to get the best choice of cylinder oil alkalinity and feed rate. The recommendation of some BN lubrication oils for given sulphur content during modern operation patterns is not feasible for all engines.

Residual BN, wear metals, viscosity, fuel components and water can be measured in the piston underside drain oil. The cylinder oil feed rate can be optimized according to the results from the drain oil monitoring. However, the upper limit for the feed rate at 1.2 g/kWh must not be exceeded at any operation point, except fuels with a sulphur content in the range of 0.1% < S < 0.5% m/m using cylinder oils with BN15 and BN25. For fuels with a sulphur content in the given range, see Figure 2. If the results from residual BN are below the safe operating limits (BN < 25), a higher BN cylinder lubrication oil must be chosen. The Technical Bulletin RT-161 explains in detail the procedure to determine the best feed rate.

Additional benefits are that the condition of the piston rod gland box can be monitored by considering the amount of system oil additive metals in the sample. It is important to monitor trends and not absolute values, and to consider the quantity of oil that is being drained in relation to the analysis results.
The corrosion of the liners and steel parts are calculated by measuring the total iron content of the piston underside or scrape down oil. There can be a significant amount of system oil which is mixed with the old cylinder oil in the piston underside space.
To get an accurate view of the used cylinder oil, a correction needs to be made to remove the impact of the system oil on results. This is done by correcting the iron and residual BN values by taking account of the system oil contributing phosphorous and/or zinc to the used oil. Care must be taken in performing this correction analysis as some cylinder oils also contain phosphorous and/or zinc.

Long-term experience (and the analysis of hundreds of piston underside samples) from a wide range of engines operating on fuel with sulphur content in the range of 0.5 to 3.5% m/m and cylinder lubrication oil with a range of BN 40 to BN100 shows that:

1. The **safe** corrected piston underside residual BN to avoid piston ring and liner corrosion is greater than **25 mgKOH/g** but below **50 mg KOH/g** (see the attention comment in Chapter 3.4)
2. The **alert** corrected limit for piston underside residual BN to avoid excessive corrosion is between 10mgKOH/g and **25 mgKOH/g.**
3. The **danger** corrected limit is less than **10 mgKOH/g** piston underside residual BN and is likely to lead to excessive corrosion and rapid piston ring and liner wear if not corrected. It also often causes scuffing and the rapid failure of piston rings and very rapid corrosive liner wear.

You must monitor the PU samples and do regular checks of the pistons, piston rings and cylinder liners for excessive particles corrosion and wear. This helps you find the safe value for continuous operation on low sulphur fuel (0.0% to 0.5%) and cylinder oil with a low BN (BN15 to BN25).

Fuel sulphur in the range 0.5 < Sulphur % < 3.5 m/m and cylinder oil with 40 < BN < 100

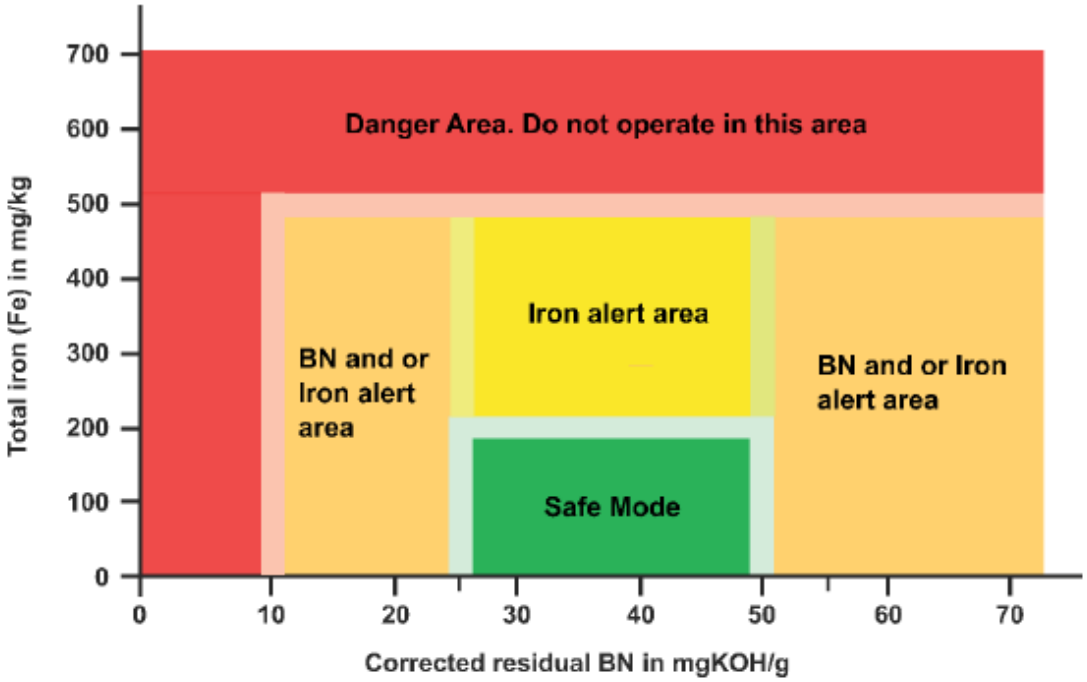


Figure 1: Piston Underside (PUS) drain oil analysis interpretation

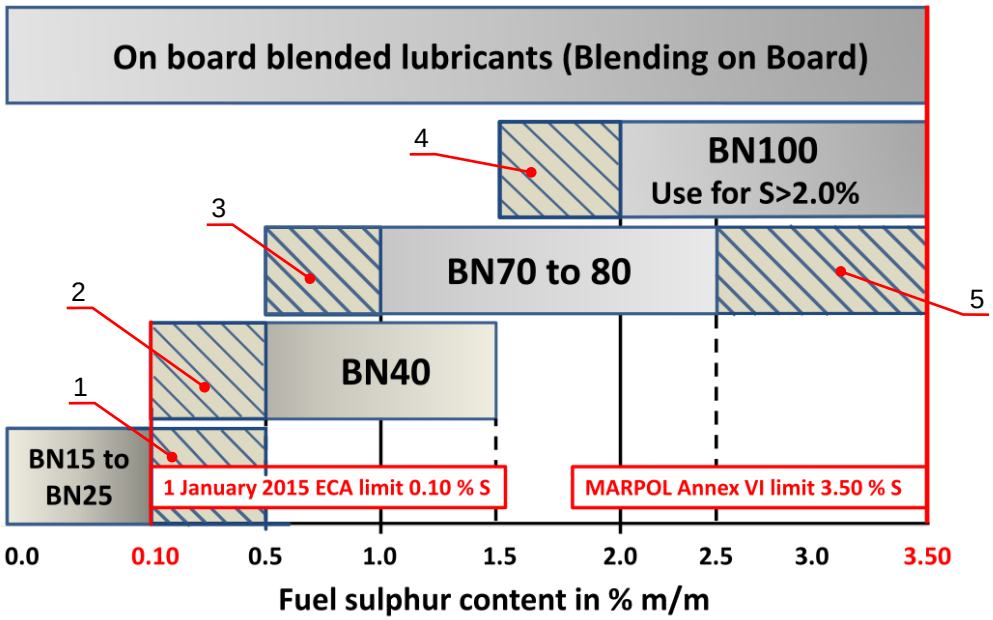
NOTE:
There are smooth transitions between the various areas as shown in Figure 1.

Figure 1 shows where engines fitted with chrome ceramic piston rings and fully honed liners must be operated in regard to piston underside total oil iron content and residual BN. The cylinder oil BN and/or lubricant feed rate must be changed to ensure that there is no excessive corrosive or magnetic iron in the piston underside oil.
The chromium content of the PUS oil is also an important indicator of corrosion or wear in the engine, when chrome ceramic piston rings are fitted. Chromium values of less than 25 mg/kg show that there is little corrosion and wear in the engine. Values above approximately 25 mg/kg indicate that corrosion and/or wear are occurring, which may reduce piston ring and liner life. The chrome content of the piston underside oil must not exceed 25 mg/kg for long periods of time.

ATTENTION:
Engines fitted with cast iron or non-chrome ceramic rings usually have significantly higher total iron levels than those stated above under normal operating conditions.

3.2 Fuel sulphur content and cylinder oil BN

As described in the introduction of Chapter 3, “Cylinder lubricating oil”, the selection of the correct BN of the cylinder lubrication oil must be driven by the results from piston underside drain oil analysis. However, as a general guidance for suitable combinations, Figure 2 shows starting points for the optimization process and recommendations if piston underside drain oil monitoring is not done.



1. ***0.1% < Sulphur < 0.5% m/m:*** *On board piston underside drain oil monitoring must be strictly followed, residual BN must not be lower than BN10, iron (Fe) must be measured as well and should be below 500 ppm. Additionally, piston and piston ring condition must be inspected through scavenge ports in regular intervals. The cylinder lubrication oil feed rate may be increased above 1.2 g/kWh if required.*
2. ***0.1% < Sulphur < 0.5% m/m:*** Operation only permitted if strictly followed on board piston underside drain oil monitoring and regular inspections of piston rings and liners guarantee operation in safe area according to Figure 1.
3. **0.5% < Sulphur < 1.0% m/m:** *Operation only permitted if strictly followed on board piston underside drain oil monitoring and regular inspections of piston rings and liners guarantee operation in safe area according to Figure 1.*
4. **1.5% < Sulphur < 2.0% m/m:** *Operation only permitted if strictly followed on board piston underside drain oil monitoring and regular inspections of piston rings and liners guarantee operation in safe area according to Figure 1.*
5. **2.5% < Sulphur < 3.5% m/m:** *Operation only permitted if strictly followed on board piston underside drain oil monitoring and regular inspections of piston rings and liners guarantee operation in safe area according to Figure 1.*

Figure 2: Relationship between fuel sulphur content and cylinder oil BN

NOTES:

- Since 1 January 2015, only fuel with a maximum of 0.1% m/m sulphur must be used in ECAs (SO_x scrubbers can be used to reduce the effective exhaust sulphur content).
- Use BN100 cylinder oil if fuel sulphur content is above 2.5% m/m and no piston underside drain oil monitoring is done.
- Monitor the residual BN of the PU drain oil to select the applicable BN of the lubrication oil and to get the best feed rate. At the same time, do regular inspections of the piston rings and cylinder liners to prevent corrosion and particles on the top land. The set feed rate should never exceed the upper limit of 1.2 g/kWh except fuels with a sulphur content in the range of 0.1% m/m to 0.5% m/m using cylinder oils with BN15 and BN25. For fuels with a sulphur content in this range, see Figure 2. If the feed rate is at the value given, and the results from piston underside drain oil monitoring indicates a rest BN < 25, the BN of the cylinder oil must be increased. For more information, see Technical Bulletin RT-161.

Cylinder oils of excessively high BN for the fuel sulphur cause excessive accumulation of particles on the piston crown. Monitor carefully the particles on the piston crown through the scavenge ports. These particles can break down the lubricant film and cause the piston, piston rings and cylinder liner wear.

NOTE:

The BN 40 products can be used safely with heavy fuel oil with a sulphur content in the range 0.5% to 1.5% m/m. The feed rate must be changed in relation to the remaining BN measured in the piston underside drain oil or scrape down samples.

Intermediate BN cylinder oils (BN 50 to BN 60) are still available. Only use these cylinder oils if the performance is monitored regularly from the PU drain oil analysis. Also, do regular inspections of piston rings and cylinder liners through the scavenge air ports. The inspections must be done during the adjustment of lubricating oil feed rate to operate the engine in the safe area shown in Figure 1. Incorrectly adjusted piston underside BN can lead to excessive corrosive wear and scuffing. For the limits and recommendations, refer to the previous Chapter 3.1. If the residual PU drain oil is below the limit for safe operation (even at a feed rate of 1.2 g/kWh), a higher feed rate setting is not necessary. However, a cylinder oil with a higher BN must be chosen.

ATTENTION:
Use only the cylinder and system oils given in Appendix 1. The oil supplier assumes all responsibility for the performance of the lubricating oils in service of all Wärtsilä 2-stroke engines to the exclusion of any liability of any Wärtsilä company belonging to the Wärtsilä group. The oil supplier along with other possible manufacturers and distributors of the products in question shall indemnify, compensate and hold harmless Wärtsilä and companies belonging to the Wärtsilä group from and against any claims, damages and losses caused by the lubricating oils in question.

To avoid problems with fuel sulphur content, it is good practice to keep enough of the previous bunker. This can be used until an analysis of the sulphur content of the new bunker has been received. The Bunker Delivery Note (BDN) and bunker analysis can show inaccuracy in measuring the sulphur content and possible different HFO composition. The sulphur content used to set the correct feed rate must be the higher value of the BDN or the bunker analysis to ensure safe operation.

3.4 General recommendations

Service experience has shown that when operating below 60% CMCR, the engine corrosion behaviour can vary significantly. Therefore Wärtsilä recommends the following:

Wartsila recommends a cylinder lubricating oil of BN 100 if the engine is to operate at continuous low load (i.e. for more than 24 hours at below 60% CMCR) and with HFO that has a sulphur content above 2.5% m/m. The feed rate cannot be adjusted sufficiently to compensate for the lower alkalinity unless the PU drain oil results inspections of piston rings and cylinder liners are different. The maximum allowed feed rate for stable operation on other than 100 BN, 15 BN and 25 BN lubricants is 1.2 g/kWh. If the results from the piston underside drain oil monitoring would require higher feed rates for 25 < BN < 100 cylinder oil, a change to 100 BN cylinder oil must be done. For BN ≤ 25 see Figure 2 see Technical Bulletin RT-161 for details. BN 100 lubricants are available from most of the lubrication oil suppliers (see Data & Specification bulletin RT-138, Appendix 1). A high BN lubricant adapted to the piston running and corrosion condition of the engine can also be achieved by using the Blending on Board package. This product allows the flexible on board production of a “fit for purpose” cylinder lubricant down to 30 BN to overcome corrosion or to operate with low sulphur residual fuels.

It is important to monitor the corrected residual BN on a regular basis and to ensure that the value is met as shown in Figure 1.
An on-board monitoring programme should at least permit the assessment of the residual BN from piston underside drain oil. The measurement of total iron and chromium in the piston underside oil is also recommended. A sudden increase of the values of iron or chromium would indicate the occurrence of significant cold corrosion and appropriate countermeasures should be applied (see also Technical Bulletin RT-161, entitled “Cylinder lubrication” for more information).

ATTENTION:
The safe area operation for piston underside drain oil is limited to an upper value of BN 50. Not following this recommendation causes excess alkalinity in the oil film of the cylinder lubrication oil.
This lets particles collect on the running surface of the cylinder liner, which causes bore polishing (see Figure 3).

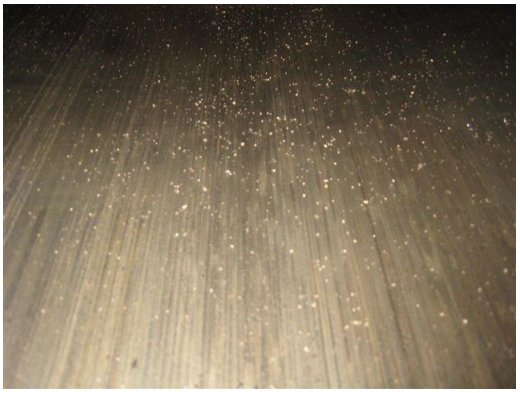


Figure 3: Damage to running surface

3.5 Use of intermediate BN lubricating oils

Conditions for use of intermediate BN lubricating oils:

When oils with an intermediate BN are used, Wartsila recommends the application of an **on-board** programme to monitor and assess the PUS drain oil. The upper feed rate allowed for the cylinder oil is 1.2 g/kWh. If residual BN measurements are not satisfactory at 1.2 g/kWh, a higher BN cylinder lubrication oil must be chosen instead of intermediate oil. See Technical Bulletin RT-161 for more information about the procedure of feed rate optimization and choosing the correct BN cylinder oil.

ATTENTION:
Intermediate BN oils (BN50 to BN60) can only be used in combination of HFO with a sulphur content in the range 0.5% m/m to 2.5% m/m.

4 Turbocharger oil

To select and maintain the turbocharger lubricating oil, the recommendations given in the turbocharger supplier's instruction manual must be obeyed.
The turbocharger oil is normally system oil, or turbine oil depending on the turbocharger supplier's recommendations.

5 Turning gear oil

For the choice and maintenance of the lubricant, the recommendations given in the turning gear supplier's instruction manual must be obeyed.

6 Lubricant for flywheel and pinion gear teeth

The selection and application of the lubricant must be in compliance with the specification published in the Maintenance Manual Group 3, Chapter 3206–1 "Turning gear" and the recommendations by the engine manufacturer. In addition, the lubricant suppliers are given in:

- Appendix 2 "Lubricants for flywheel and pinion gear teeth".

7 Environmentally acceptable lubricants

Environmentally Acceptable Lubricants (EAL) are currently required for ships operating in USA waters, and this area may be extended in future. These lubricants which are required for all 'oil to sea interfaces' which include stern tubes, thrusters, rudders, stabilisers, variable pitch propellers, underwater ropes and machinery and underwater transmissions are made with base oils and additives which are significantly different to those used for system and cylinder oil. Consequently EAL's should not be mixed into system or cylinder oils where they are to be used in engine applications. Even small contaminations of EAL (depending on base oil quality) into system and cylinder oil can lead to elastomer compatibility, water emulsification and high temperature deposit formation issues.

8 Appendices

1. Validated Cylinder and System Oils.
2. Lubricants for Flywheel and Pinion Gear Teeth.

9 Contacts

9.1 How to contact Wärtsilä

For questions about the content of this Data & Specifications bulletin, or if you need Wärtsilä assistance, services, spare parts and/or tools, please contact your nearest Wärtsilä representative.
If you do not have the contact details at hand, please follow the link “Contact us” – “24h Services” on the Wärtsilä webpage:
www.wartsila.com

9.2 Contact details in case of emergency

9.2.1 Operational support

For questions concerning operational issues, please send your enquiry to:
technicalsupport.chts@wartsila.com
or phone 24hrs support: +41 52 262 80 10.

9.2.2 Field service

If you need Wärtsilä Field Service, please send your enquiry to:
ch.fieldservice@wartsila.com
or phone 24hrs support: +41 79 255 68 80.

9.2.3 Spare parts

If you need Wärtsilä spare parts and/or tools, please contact your nearest Wärtsilä representative or your key account manager.