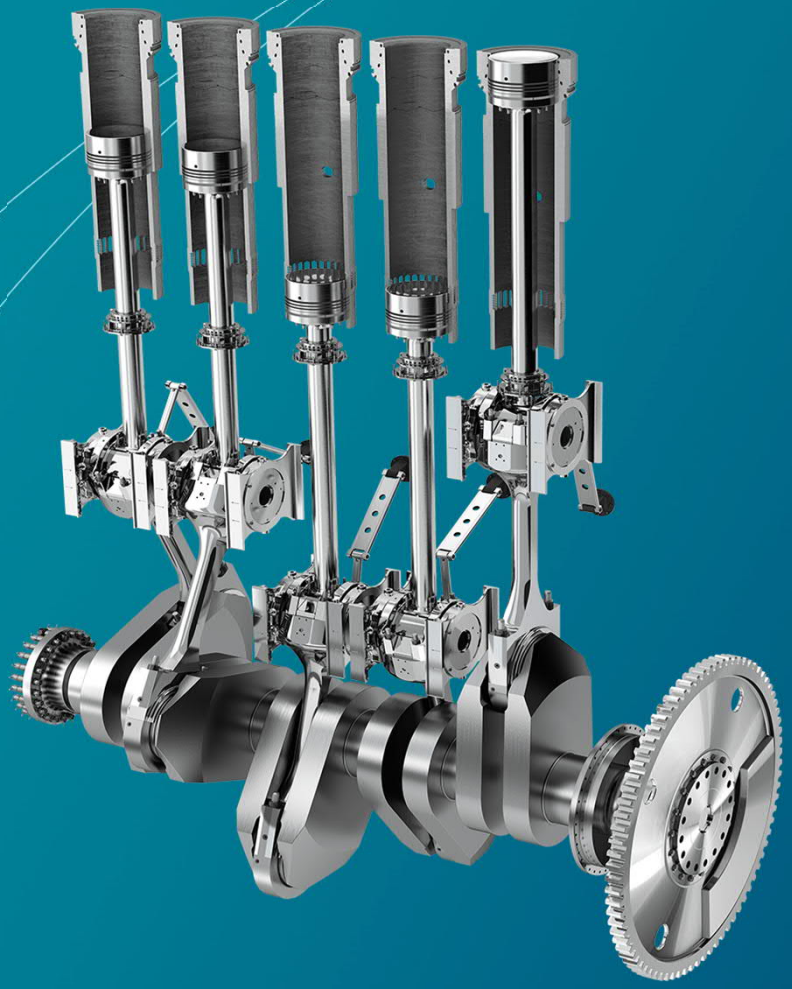


WinGD X-type Engines, Service Experiences with Actual Marine Fuels and Lubricants

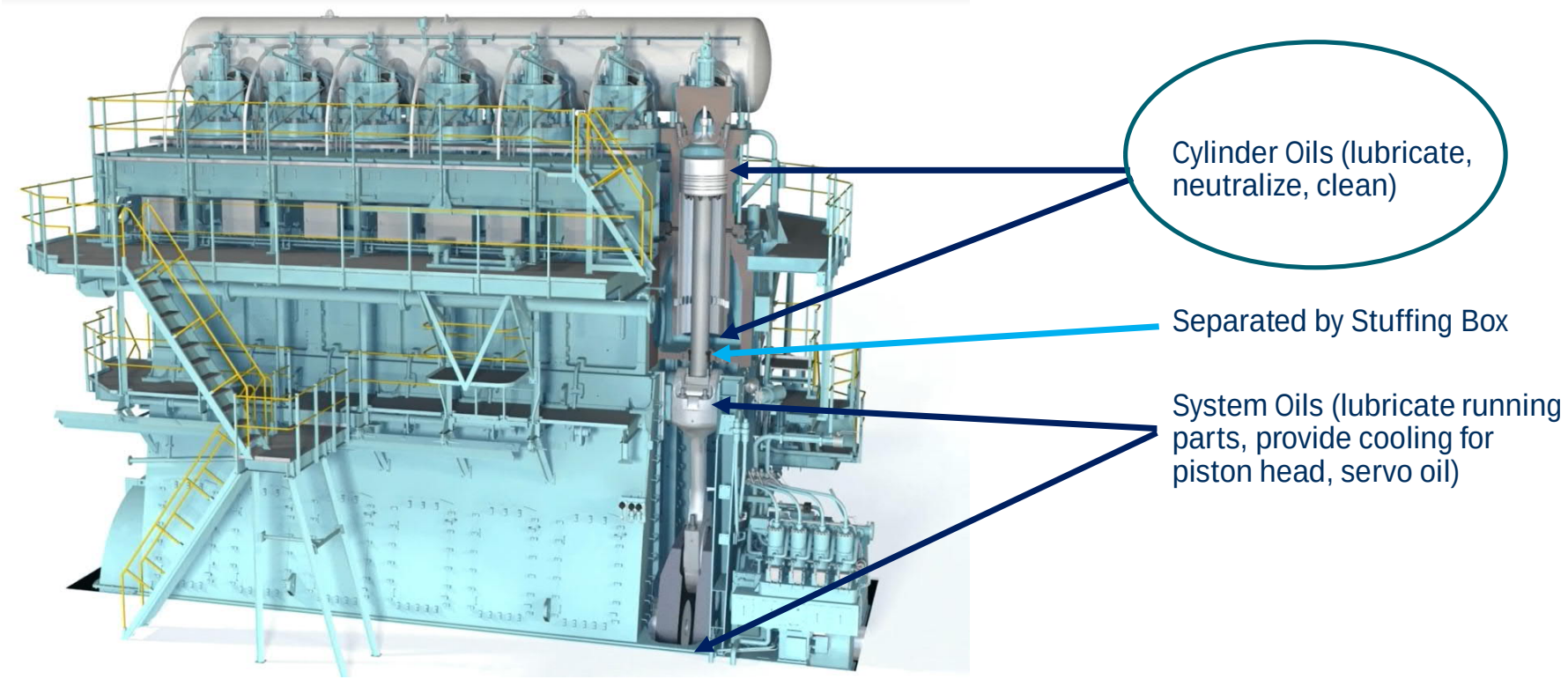
Konrad Räss, Head Customer Operation Support

WIN GD

Contents

Introduction

2-stroke System oil & cylinder oil



Introduction

Fuel naming

Names of fuels after 1st January 2020

The consensus of the marine market is a simplified terminology for fuels used in the market after 1st January 2020, in accordance with the most relevant characteristics. All fuels basically fall under the same category: Fuel oil (FO). The key differentiator is whether the fuel needs to be heated or not; the second criterion is its sulphur content. Grade designations according to ISO 8217:2017 [2] will remain applicable; however, using the simplified terminology as listed in Table 1 allows a straightforward determination if a fuel is fit for the purpose at hand.

Definition of fuel abbreviations:

- HFO: Heavy Fuel Oil
- MGO: Marine Gas Oil
- DM: Distillate Marine (fuel that does not need heating)
- RM: Residual Marine (fuel that needs heating)
- MDO: Marine Diesel Oil
- ULSFO: Ultra Low Sulphur Fuel Oil
- VLSFO: Very Low Sulphur Fuel Oil
- HSFO: High Sulphur Fuel Oil

Table 1. Naming of fuels after 1st January 2020

Sulphur content	HFO (RM-grades)	MDO (DMB, DFB)	MGO (DMA, DFA, DMZ, DFZ)
S ≤ 0.10 %	ULSFO RM	ULSFO DM	
0.10 % < S ≤ 0.50 %	VLSFO RM	VLSFO DM	
0.50 % <S	HSFO RM*	HSFO DM*	

* fuels allowed only for ships with exhaust abatement technologies yielding sulphur oxide reductions equivalent to using fuels compliant with the respective sulphur limit

& LNG

Introduction

Feedback from large ship owners expert on compliant fuels

- Beginning of 2020 we did experience issues with VLSFO fuels
- On the engine side we learned that the “borderline cases”, i.e. engines in poor maintenance condition and engines not being equipped as recommended, were suffering, but in the meantime these “borderline cases” have been considerably reduced thanks to a focused action, and I dare to say that today our fuel related engine issues are back to normal (= like in the good old days with HSFO just before 2020).
- We have seen fuels with “abnormal” combustion properties, and we have tried to correlate this with some standard fuel analysis parameters, but it is not straight forward.
- However, despite of this, we are not really concerned about the compliant fuels as such, but for some of them we have seen a rather low self-ignition temperature (= increased fire risk in engine room) that we intend to address.
- On the fuel handling and upstream side we have experienced clogged filters, but overall we have been doing quite well thanks to our 2020 preparations.
- So, after 1 ½ years with all kinds of fuels, things here are well under control

Introduction

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& LNG

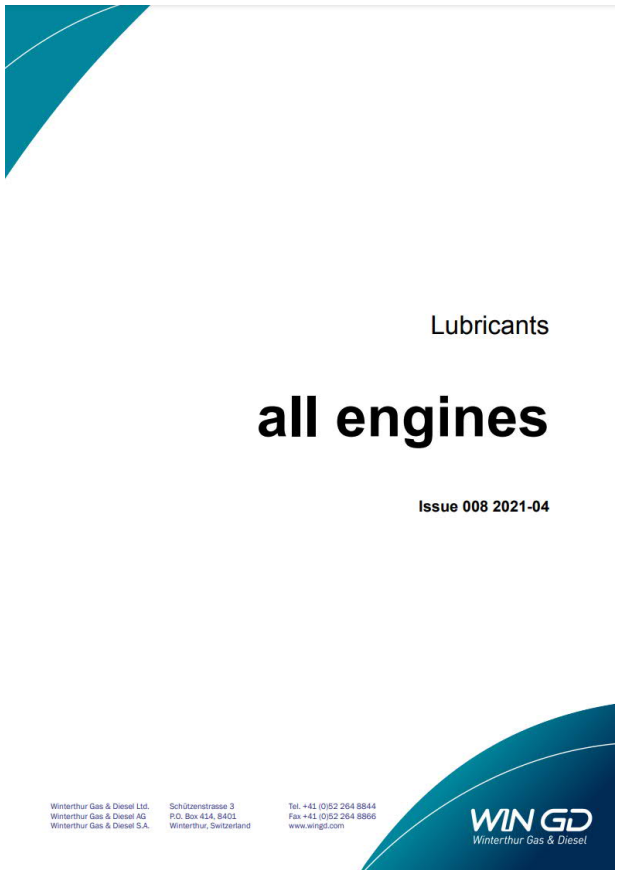
Lubrication

Guideline: Lubrication, Cylinder Oil & System Oil

- Requirements for oils
- Lists of validated oils, or data on where to get up to date lists of validated oils
- Procedures for oil selection
- Procedures for oil analysis interpretation
- Procedure for running-in new components

Link:

https://www.wingd.com/en/documents/w-2s/tribology/fuel-lubricants-water/lubricants-for-wingd-engines-v8.pdf/



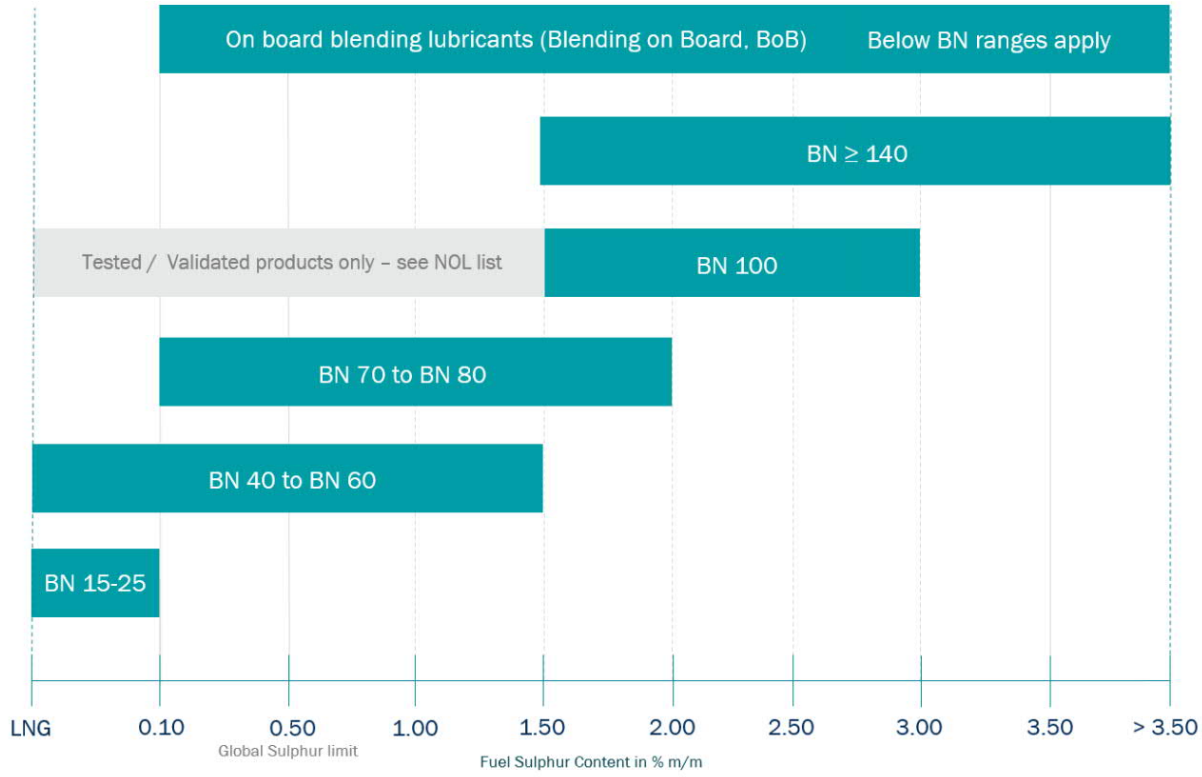
Lubrication

Cylinder Oil Selection

1. Detect the BN range which is suitable for the fuel to be used based on the sulphur content.

2. Go to the list of validated lubricants

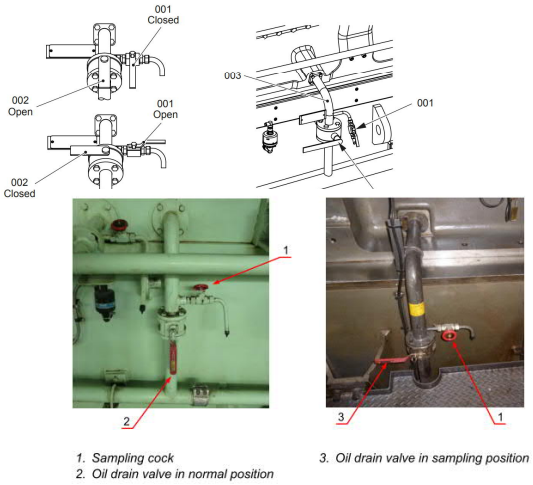
Fig 1-1 Selection of cylinder oil BN related to the fuel sulphur content



Lubrication

Cylinder Oil Monitoring & Feed Rate Optimisation

Fig 1-4 Location of ball valves - dirty oil samples



1. *Sampling cock*
2. *Oil drain valve in normal position*
3. *Oil drain valve in sampling position*

Fig 1-2 Interpretation of the oil analysis for cylinder oils with BN 25 or lower

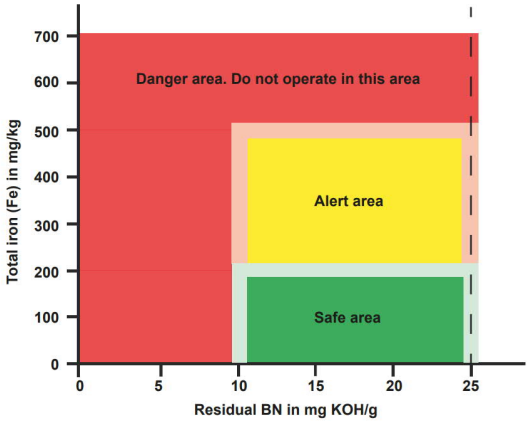
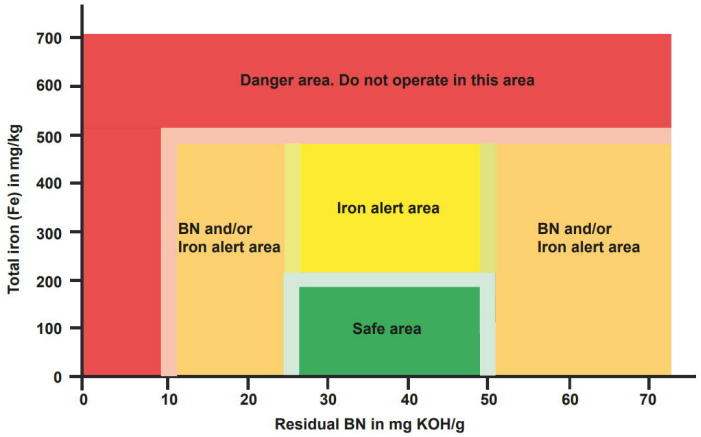
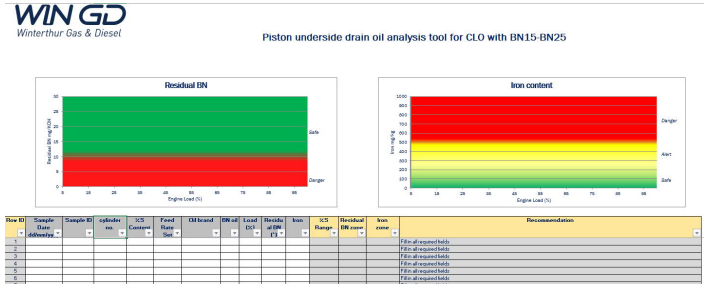


Fig 1-3 Interpretation of the oil analysis for cylinder oils with BN 40 or higher



Feed rate optimisation based on residual BN and Fe values in the drain oil. Drain oil tool available for support.

https://www.wingd.com/en/documents/w-2s/tribology/wingd-piston-underside-drain-oil-analysis-tool-v2.xlsx/



Lubrication

Cylinder Oil Monitoring & Feed Rate Optimisation

- The cylinder drain oil shall be analyzed first with on-board test kits to take immediate actions
- WinGD recommends to send the samples as well to an on-shore laboratory for testing
  - Higher accuracy
  - More properties like viscosity, other elements than Fe
  - System oil contamination (P, Zn)

On-board test kit examples

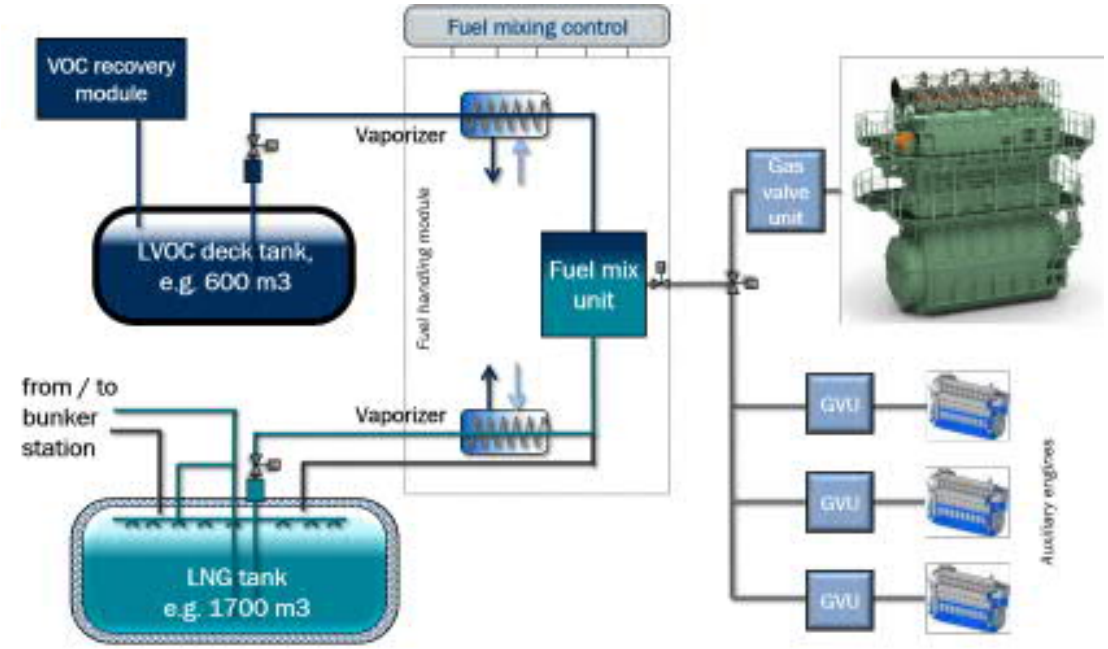
X-DF engines

X52DF Service Feedback

LNG or LNG& LVOC

Example, X52DF powering Shuttle Tankers (with DPS mode)

- LVOC (Liquified Volatile Organic Compounds)
- No special engine tuning necessary



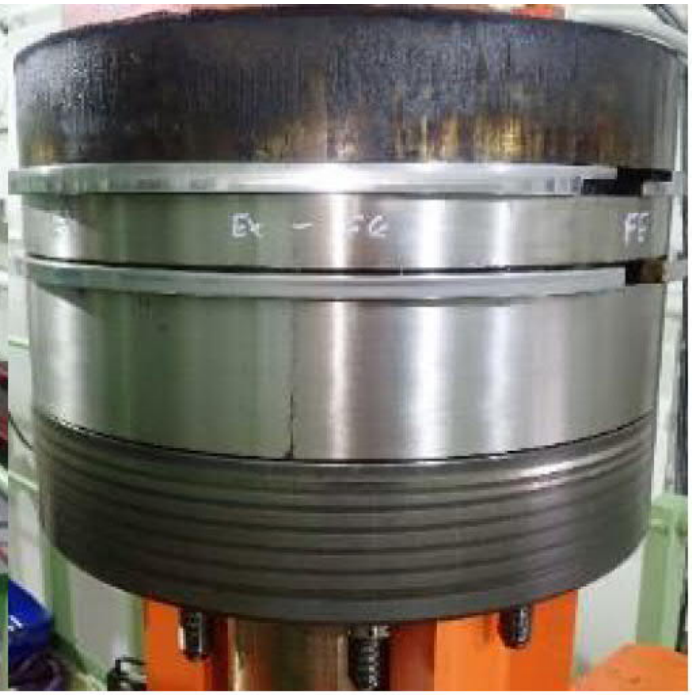
X52DF Service Feedback

Check up on first X52DF after 6000hrs – good condition of key components

X52DF powering Shuttle Tankers (with DPS mode)

- Piston rings in spotless condition (2 ring pack)
- Little deposits on piston crown and ring grooves
- Original honing marks on cylinder liners visible
- BN40, 1.1g/kWh (room for improvement)!

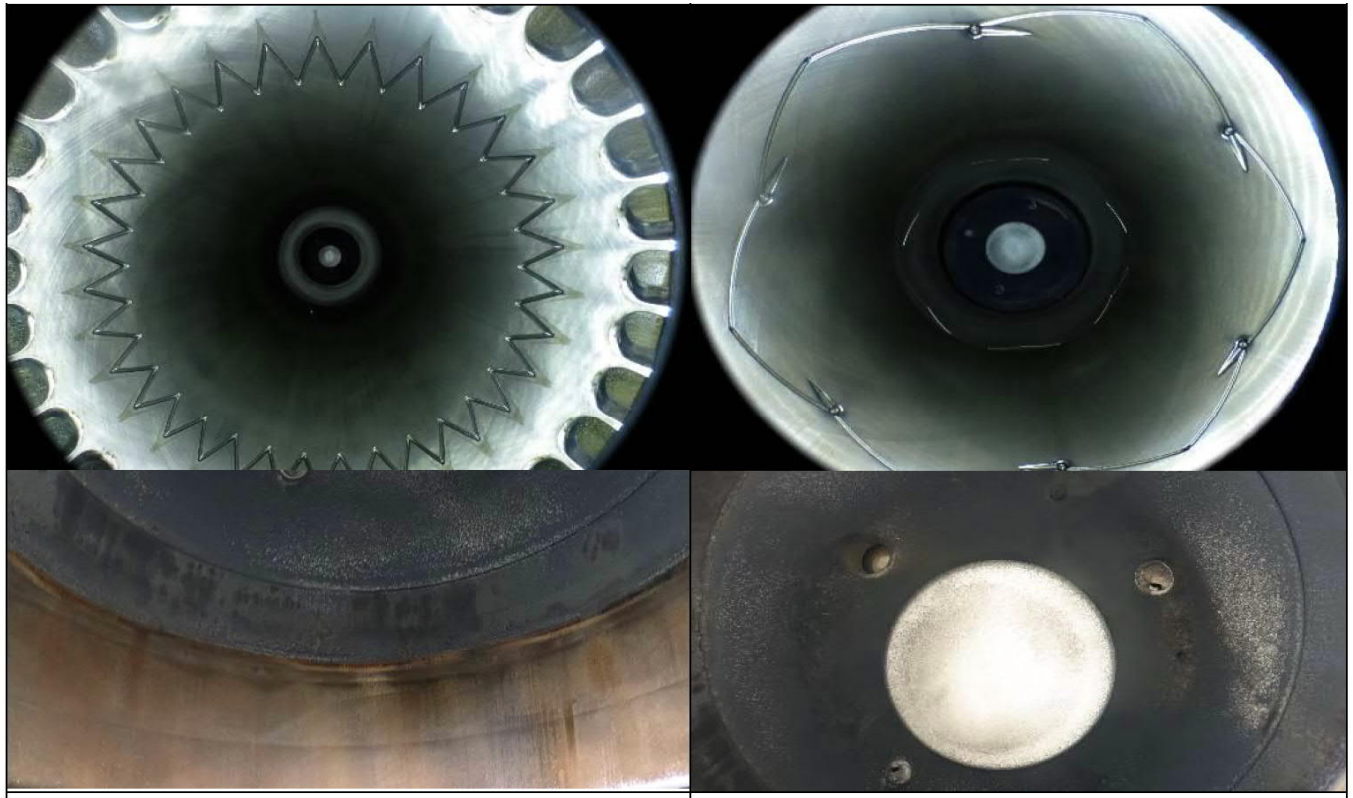
Free-end



Exhaust – Free-end

X52DDF Service Feedback

- BN40, 1.1g/kWh
- 6106h
- 0%S



Liner: in good condition rusty appearance	Liner: combustion chamber valve with calcium dep.

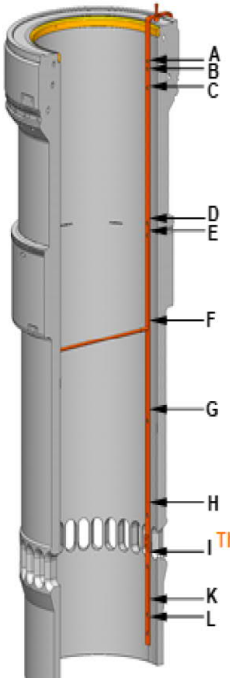
X52DDF Service Feedback

- BN40, 1.1g/kWh
- 6106h
- 0%S

Liner: TDC honing marks still visible up to

X52DDF Service Feedback

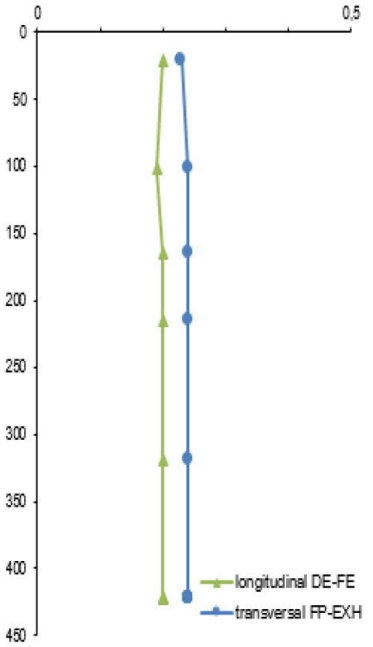
- BN40, 1.1g/kWh
- 6106h
- 0%S



	Distance from top	longitudin DE-FE	transversa FP-EXH	Wear [mm] DE-FE	Wear [mm] FP-EXH	Wear [mm/1000h] DE-FE	Wear [mm/1000h] FP-EXH
A	21	520,20	520,23	0,00	0,00	0,00	0,00
TDC	102	520,19	520,24	-0,01	0,01	0,00	0,00
B	164	520,20	520,24	0,00	0,01	0,00	0,00
C	214	520,20	520,24	0,00	0,01	0,00	0,00
D	319	520,20	520,24	0,00	0,01	0,00	0,00
E	422	520,20	520,24	0,00	0,01	0,00	0,00
F							
G							
H							
I							
K							
L							

Max. wear	longitudinal:	0,00	0,00	0,00	mm/1000h
	transverse:	0,00	0,00	0,00	mm/1000h
Theoretical lifetime till wear limit:		######	######	######	hrs
		B-A	TDC-A	max-A	

Remarks:



X52DDF Service Feedback

- BN40, 1.1g/kWh
- 6106h
- 0%S

	Unit # 6	Insp. 01
	Engine & Component hours	6106
Cylinder Liner	Wear rate, mm/1000h	0,001
	Estimated lifetime hours	3600000
Crown ring groove A	Wear rate, mm/1000h	0,002
	Estimated lifetime hours	200000
Crown ring groove B	Wear rate, mm/1000h	0,002
	Estimated lifetime hours	175000
Crown top surface	Wear rate, mm/1000h	very low
	Estimated lifetime hours	> 36000
Piston ring A	Wear rate, mm/1000h	0,006
	Estimated lifetime hours	52905
Piston ring B	Wear rate, mm/1000h	0,004
	Estimated lifetime hours	90000
Exhaust valve Spindle plate	Wear rate, mm/1000h	0,050
	Estimated lifetime hours	120000
Exhaust valve Spindle shaft	Wear rate, mm/1000h	0,001
	Estimated lifetime hours	360000
Exhaust valve Guide bush	Wear rate, mm/1000h	0,010
	Estimated lifetime hours	110000

X82DF Shop Test experience

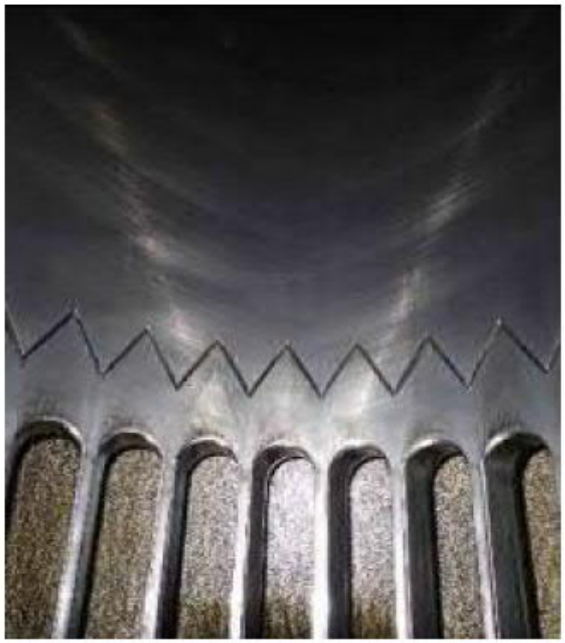
AET 2388 7X82DF HSD, after TC matching, 24.3h, BN40 1.2g/kWh

X92DF Service Feedback

MV J.S. First 12X92DF

- BN 40 / 57
  approx. 0.9g/kWh

CC Jacques Saade after 2’400 rhs:



X52DF Service Feedback

- BN40, 1.1g/kWh
- 6106h
- 0%S

Deposit on the valve seat edge up to 5mm

Service Experience

Lube oil caused deposits on exhaust valve, BN>40

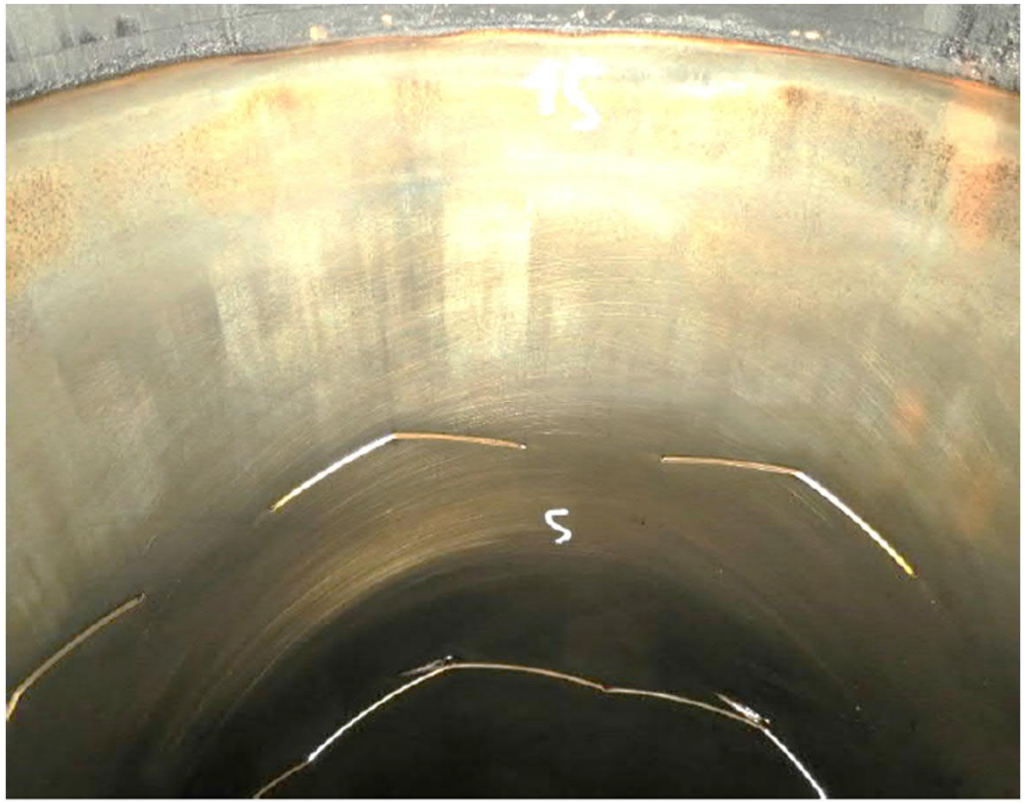
X-Diesel engines

X52 Service Experience

Piston Running – MV St.

6X52 – Unit#1 – 5054h

- HFO 1.54% sulphur content
- BN 100 cylinder oil
- Feed rate 0.95 g/kWh



- Honing marks visible above umbrella grooves
- Liner low wear rate 0.01 mm/1000h
- **Estimated lifetime 360’000 h**

X52 Service Experience

Piston Running – MV St.

Cylinder liner: good condition and litte wear

Black spots on liner running surface

X52 Service Experience

Piston Running – MV St.

6X52 – Unit#1 – 5054h

- HFO 1.54% sulphur content
- BN 100 cylinder oil
- Feed rate 0.95 g/kWh

- Clean piston ring pack
- Low deposit build-up in the crown ring grooves and at the ring backside
- Top piston ring wear rate 0.008 mm/1000h
- **Estimated lifetime 38’000 h**
- **Two piston ring pack with excellent results**

X52 Engines – Service Experience

Piston ring – MV St.

The X52 engine is the first engine with 2 piston ring pack standard.

Two ring pack in excellent condition

X52 Service Feedback

Engines equipped with scrubbers, start operation with BN 100

- BN100, 1.05g/kWh
- 2025h
- Cooling temp outlet 89°C
- 3.18%S

Engines equipped with scrubbers, show tendencies for lube oil depletion that leads to an insufficient liner surface cleaning

-> Demand for higher BN products

X52 Service Feedback

Engines equipped with scrubbers, start operation with BN 100, some weeks later with BN140

- BN140, 1.1g/kWh
- Approx. 2800h
- Cooling temp outlet 91 °C
- 3.42%S
- Rest BN 68

X92 Service Feedback

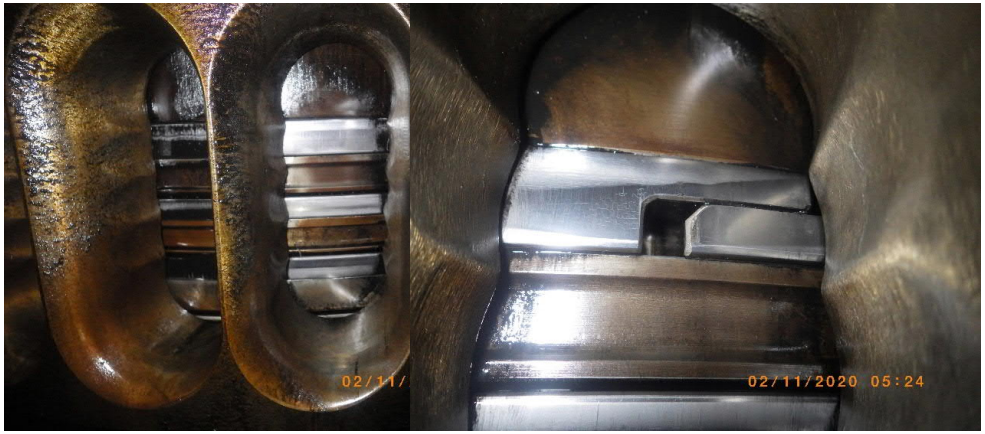
Engines equipped with scrubbers

- BN100, 1.1g/kWh
- Approx. 4353h
- +/- 3%S
- Some cold corrosion visible
- Operator is going to tests BN140

X92 Service Feedback

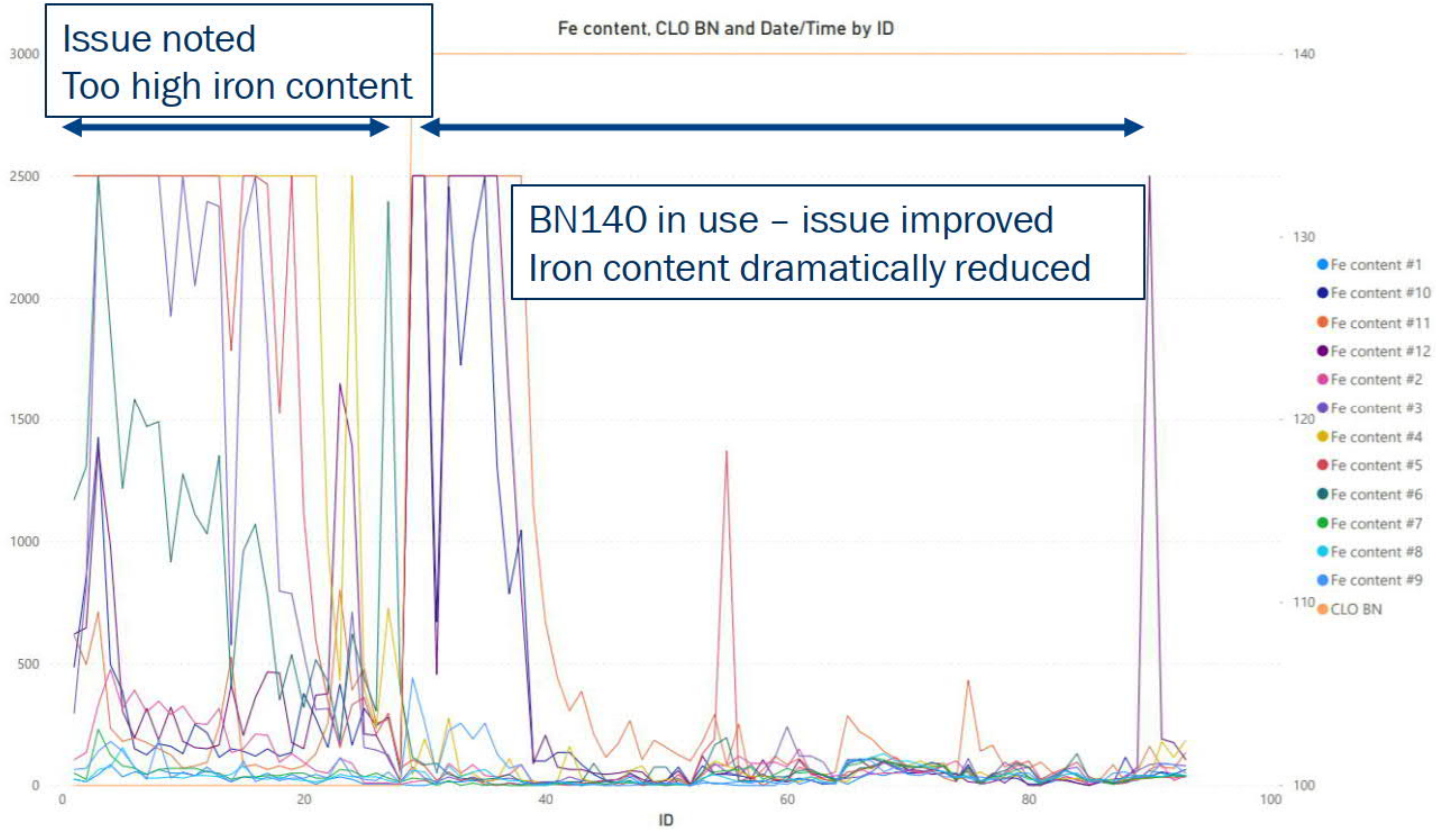
Engines equipped with scrubbers

- BN100, 1.1g/kWh
- Approx. 4353h
- +/- 3%S



RT-flex 96C Service Feedback

Incorrect lube oil selection (non portfolio engine, high S%, BN100/140)



Change of oil BN was decisive to cure the issue

Summary / Conclusions

Summary / Conclusion

Experience with X-DF and X-Diesel engines

- The use of compliant fuels with 0.5%S max. is unspectacular

- LNG operated DF engines show very close to zero piston ring and cylinder liner wear
- Lube oil feed rates must be optimised to keep deposit layer thickness on hot component surfaces small
- On X-DF Engines the piston underside drain oil analysis concentrates mainly on Fe. The BN drop cannot be used as indication of the oil depletion
- Corrosion is definitely not necessary for good piston running behaviour, provided that the component design is made correctly!

- HFO operated engines using non compliant fuels show tendencies for a higher BN requirement (black spots or signs of cold corrosion)
- Higher BN lubricants in combination with lower feed rates keep OPEX low and components clean
- On X-Diesel Engines the piston underside drain oil analysis concentrates on rest BN and Fe. The BN drop is a good indication of the oil depletion level

Thank you

Konrad Räss

Head Customer Operation Support

konrad.rass@wingd.com