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

Konrad Räss, Head Customer Operation Support
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<td>8</td>
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Introduction

2-stroke System oil & cylinder oil

- Cylinder Oils (lubricate, neutralize, clean)
- Separated by Stuffing Box
- System Oils (lubricate running parts, provide cooling for piston head, servo 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>
<thead>
<tr>
<th>Sulphur content</th>
<th>HFO (RM-grades)</th>
<th>MDO (DMB, DFB)</th>
<th>MGO (DNA, DFA, DMZ, DFZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S ≤ 0.10 %</td>
<td>ULSFO RM</td>
<td>ULSFO DM</td>
<td></td>
</tr>
<tr>
<td>0.10 % &lt; S ≤ 0.50 %</td>
<td>VLSFO RM</td>
<td>VLSFO DM</td>
<td></td>
</tr>
<tr>
<td>0.50 % &lt; S</td>
<td>HSFO RM*</td>
<td></td>
<td>HSFO DM*</td>
</tr>
</tbody>
</table>

* 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

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.

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Table 1: Naming of fuels after 1st January 2020

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<td>ULSFO RM</td>
<td>ULSFO DM</td>
<td></td>
</tr>
<tr>
<td>0.10 % &lt; S ≤ 0.50 %</td>
<td>VLSFO RM</td>
<td>VLSFO DM</td>
<td></td>
</tr>
<tr>
<td>S &gt; 0.50 %</td>
<td>HSFO RM</td>
<td>HSFO DM*</td>
<td></td>
</tr>
</tbody>
</table>

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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:
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
Lubrication

Cylinder Oil Monitoring & Feed Rate Optimisation

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

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
X52DDF Service Feedback

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

<table>
<thead>
<tr>
<th>Component</th>
<th>Unit # 6</th>
<th>Insp. 01</th>
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<tbody>
<tr>
<td>Cylinder Liner</td>
<td>Wear rate, mm/1000h</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Estimated lifetime hours</td>
<td>3600000</td>
</tr>
<tr>
<td>Crown ring groove A</td>
<td>Wear rate, mm/1000h</td>
<td>0.002</td>
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<tr>
<td></td>
<td>Estimated lifetime hours</td>
<td>200000</td>
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<tr>
<td>Crown ring groove B</td>
<td>Wear rate, mm/1000h</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Estimated lifetime hours</td>
<td>175000</td>
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<tr>
<td>Crown top surface</td>
<td>Wear rate, mm/1000h</td>
<td>very low</td>
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<td></td>
<td>Estimated lifetime hours</td>
<td>&gt; 360000</td>
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<tr>
<td>Piston ring A</td>
<td>Wear rate, mm/1000h</td>
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<tr>
<td></td>
<td>Estimated lifetime hours</td>
<td>52905</td>
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<tr>
<td>Piston ring B</td>
<td>Wear rate, mm/1000h</td>
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<tr>
<td></td>
<td>Estimated lifetime hours</td>
<td>90000</td>
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<tr>
<td>Exhaust valve</td>
<td>Wear rate, mm/1000h</td>
<td>0.050</td>
</tr>
<tr>
<td>Spindle plate</td>
<td>Estimated lifetime hours</td>
<td>120000</td>
</tr>
<tr>
<td>Exhaust valve</td>
<td>Wear rate, mm/1000h</td>
<td>0.001</td>
</tr>
<tr>
<td>Spindle shaft</td>
<td>Estimated lifetime hours</td>
<td>360000</td>
</tr>
<tr>
<td>Exhaust valve</td>
<td>Wear rate, mm/1000h</td>
<td>0.010</td>
</tr>
<tr>
<td>Guide bush</td>
<td>Estimated lifetime hours</td>
<td>110000</td>
</tr>
</tbody>
</table>
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

CC Jacques Saade after 2’400 rhs:

- BN 40 / 57
  approx. 0.9g/ kWh
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 little 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
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)

- Issue noted: Too high iron content
- BN140 in use – issue improved: Iron content dramatically reduced

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