VLSFO Operations
1st Q 2020

2- stroke engine forum

05 May 2020

Timothy Wilson
VLSFO+ Operations – ‘Diversity of fuels here to stay’

- Diverse fuel formulations
- Compatibility/Segregation
- Forward bunker planning
- Temp. control – Viscosity- cold flow/ heating and cooling
- Lube oil management -CLO cylinder/ rings - monitor
Viscosity variability – effective temperature control

VLSFO
2-480 cSt
Inj. Temp 40–150 °C
Differential 110 °C

HSFO
100 – 700 cSt
Inj. Temp 100-150 °C
Differential 50 °C

ULSFO
2-100 cSt
Inj. Temp 40 -115 °C
Differential 75 °C

Viscosity Sulphur Distribution 2019 -2020
Higher Paraffinic Content = Improved Combustion

VLSFO vs HFO pour point (01/01/2019 - 25/03/2020)

- HSFO – 1% > 21 °C
- VLSFO – 29% > 21 °C
- HSFO – 18% > 6 °C
- VLSFO – 58% > 6 °C

VLSFO overall properties:
- More paraffinic =
- Higher pour point
- +Higher energy values
- +Lower MCR
- +Lower Density
- +Lower CCAI
- +Lower Ash
- + good engine condition
- + correct fuel preparation

= Improved combustion
= lower BC Emissions
Off Specification HSFO versus VLSFO 2020

Top 80% of Off Spec

Pre 2020
Viscosity, Water, Density, Catfines

Post 2020
Sediment and Sulphur

8% of bunkers tested off spec ( >Limit + 95%)
Summary focus on VLSFO 0.50% 2Q - 2020

Proactive fuel management

- Forward bunker planning = segregation
- Selection of Supplier
- Knowledge of fuel before or on loading
- Fuel temperature control – ‘loading to injector’
- Compliance risk – Manage evidence chain
- Minimise onboard storage time
- Monitor fuel system and engine performance

Lloyd's Register FOBAS

6
Thank you!

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Riviera Maritime Media Ltd Two-stroke engine forum: Peace of mind when running a two-stroke engine on VLSFO

Tuesday 5 May 2020

Kjeld Aabo
Sales and Promotion Two stroke Marine
Member of WG ISO 8217 & Chairman CiMAC Fuels
2020 Fuels

What may / will happen in 2020?

Key parameters for 0.50% Marine Fuel Oil blending will be:

Stability (Total Sediment)
- Paraffinic vs Cracked blend components

Pour Point
- ULSFO /VLSFO close to PP limits

Acidity
- Sweet crude sources with high AN (e.g. DOBA)

Viscosity
- No minimum limit in ISO 8217, Table 2

CCAI
- Larger difference between viscosity and density

Pre 2020 - TODAY

Post 2020 - TOMORROW

Ref: KBC/Mel Larson
0.50% S VLSFO – First feedback from the field
List of observations - PRELIMINARY

Sporadic cases of scuffing and high wear
Several cases of scuffing and high wear
- Cat fines – from cleaning of the tanks
- No cermet on the piston rings
- Lubrication feed rate too low
- High wear due to cold corrosion

Fuel system
- Stuck high pressure fuel pumps
- Gasification of low viscosity fuel

Cold flow properties of the fuel
- Temperature control

Incompatibility between fuels
0.50% S VLSFO – First feedback from the field
List of observations - PRELIMINARY

Sporadic cases of scuffing and high wear

Cat fines – from cleaning of the tanks. Dissolving of the old sludge in tanks -> if too much, it cannot be removed in the separators.
0.50% S VLSFO – First feedback from the field
List of observations - PRELIMINARY

Sporadic cases of scuffing and high wear

No cermet on the piston rings.

Cermet coating must be measured and the wear must be recorded.

– Once 100 µm is reached, the rings should be replaced.

<table>
<thead>
<tr>
<th>Cermet-coating thickness action table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 100 µm</td>
</tr>
<tr>
<td>100-50 µm</td>
</tr>
<tr>
<td>50-20 µm</td>
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</tbody>
</table>
0.50% S VLSFO – First feedback from the field
List of observations - PRELIMINARY

Sporadic cases of scuffing and high wear

Lubrication feed rate too low.

Old, worn lubricators may have lost efficiency, and do not feed the expected feedrate

New lubricators volumetric efficiency: 90-100%

Expected efficiency in control system: 97%, but as for all pumps wear may cause the efficiency to be reduced

Reduction of volumetric efficiency from 97% to 80% means that the actual feed rate at a setting of 0.6 g/kWh in reality is 0.49 g/kWh
Summary: 0.50% S fuels

What to consider – for the ship?

Properties of the 0.50% S VLSFO family
- Cat fines
- Viscosity
- Density
- Pour point
- Compatibility

Fuel change-over

Compatibility of mixed fuels

Fuel tank system considerations

Temperature

Viscosity

Clean the fuel
Disclaimer

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This data serves informational purposes only and is especially not guaranteed in any way.
Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.
Thank you very much!

Kjeld Aabo
Director New Technologies
Sales and Promotion Two stroke Marine
Member of WG ISO 8217 & Chairman CIMAC Fuels
Two-stroke engine forum: peace of mind when running a two-stroke engine on VLSFO

Cylinder condition monitoring

John Schakel
Global Product Application Specialist Marine
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What OEM’s recommend what is the engine maintenance history

Cylinder condition monitoring more important than ever.

Documenting the inspections to observe trends and changes.

Shell LubeMonitor helping customers running two-stroke engines reliable
What OEM’s recommend

➢ Winterthur Gas & Diesel
   ➢ Do regular checks of the piston and piston ring conditions through scavenge port inspections.

➢ MAN Energy Solutions
   ➢ Vessels in service, which have not yet optimized the feed rate for ULSFO or VLSFO operation, should start at the existing feed rate or 1.0 g/kWh and then reduce the feed rate based on inspections until the minimum feed rate is reached.

➢ Engine maintenance history
   ➢ What was the engine condition prior change to VLSFO and lower BN cylinder oil?
     ➢ Cold corrosion issues, clover leaf liner shape, sharp piston rings?
     ➢ Engine-, liners-, crown-, running hours?
Cylinder condition monitoring more important than ever

- Cylinder condition monitoring by drain oil analysis
- Scavenge port inspection
  - Monitor ring clearance!
  - Monitor ring coating thickness!
  - Monitor deposit formation on top land and ring lands!
- Take the following pictures
  - Top land
  - Ring lands
  - Close up of piston ring surface
  - Liner and piston crown.
- A visual history to observe trends and changes is critical to take correct actions.
Monitoring ring clearance

![Ring clearance - Trend - Engine#2 - VLSFO](chart.png)

- Ring clearance vs. Engine hours
- Units: Unit#1, Unit#2, Unit#3, Unit#4, Unit#5, Unit#6, Unit#7
- Data range: 45,000 to 51,000 engine hours
Cylinder condition monitoring more important than ever

Scavenge port inspection

- Inspection at 3,949 hours
- Inspection at 4,253 hours
Shell LubeMonitor

Knowing what’s going on in your engine

Equipment manufacturer’s graph
Last set of samples are identified with cylinder numbers

Laboratory results

Difference between laboratory and onboard results
VLSFO Fuel Quality….The Story So Far

• Steve Bee
  • Group Commercial & Business Development Director
Bunkered Quantities Tested by VPS

Bunkered Quantity per month - per Fuel Type - 2019-2020

BUNKERED QUANTITY (MT)

BUNKER MONTHS

Jan'19 | Feb'19 | Mar'19 | Apr'19 | May'19 | Jun'19 | Jul'19 | Aug'19 | Sep'19 | Oct'19 | Nov'19 | Dec'19 | Jan'20 | Feb'20 | Mar'20 YTD

HSFO | VLSFO | ULSFO | MGO

VPS – Maritime Propulsion Webinar 2020
VLSFO Sulphur Content

North America:
- Avg: 0.45
- Min: 0.20
- Max: 0.54

Europe:
- Avg: 0.47
- Min: 0.04
- Max: 1.02

Africa:
- Avg: 0.44
- Min: 0.16
- Max: 0.50

Russia:
- Avg: 0.44
- Min: 0.14
- Max: 0.54

Middle East:
- Avg: 0.47
- Min: 0.43
- Max: 0.60

China:
- Avg: 0.45
- Min: 0.26
- Max: 0.62

Asia Pacific:
- Avg: 0.41
- Min: 0.05
- Max: 0.56

VLSFO Sulphur Compliance
Feb-March 2020

- 1.7% ≤ 0.46%S
- 0.6% 0.47 - 0.50%S
- 50.5% 0.51 - 0.53%S
- 47.2% > 0.53%S
- 1.7% 0.46%S
- 0.6% 0.47 - 0.50%S
- 50.5% 0.51 - 0.53%S
- 47.2% > 0.53%S
VLSFO Off-Specification by Test Parameter

Break-down of global off-specs by parameter | Feb-March 2020

Global VLSFO Off-Spec Ratio
Feb-March 2020

- On-Spec VLSFO Samples
- Off-Spec VLSFO Samples
VLSFO Stability (TSP & WAT/WDT Analysis)

Global Overview of VLSFO TSP Statistics  Feb-March 2020

- **North America:**
  - Avg: 0.02
  - Min: <0.01
  - Max: 0.20

- **Europe:**
  - Avg: 0.02
  - Min: <0.01
  - Max: 0.21

- **Russia:**
  - Avg: 0.02
  - Min: <0.01
  - Max: 0.09

- **China:**
  - Avg: <0.01
  - Min: <0.01
  - Max: 0.16

- **Middle East:**
  - Avg: <0.01
  - Min: <0.01
  - Max: 0.09

- **Africa:**
  - Avg: 0.03
  - Min: <0.01
  - Max: 0.30

- **Singapore:**
  - Avg: 0.02
  - Min: <0.01
  - Max: 0.23

- **Asia Pacific:**
  - Avg: <0.01
  - Min: <0.01
  - Max: 0.28

**VLSFO WAT & WDT Distribution  Feb-March 2020**

- Temperature Range in °C
  - >60°C
  - 51-60°C
  - 41-50°C
  - 31-40°C
  - 21-30°C
  - ≤20°C

- % Share of Total WAT/WDT-Tested VLSFO Samples
  - WDT %
  - WAT %
  - PP %
VLSFO - CatFines

Distribution of VLSFO Cat Fines | Feb-March 2020

- **North America:**
  - Avg: 23
  - Min: <2
  - Max: 130

- **Europe:**
  - Avg: 22
  - Min: <2
  - Max: 68

- **Africa:**
  - Avg: 14
  - Min: <2
  - Max: 49

- **Russia:**
  - Avg: 4
  - Min: <2
  - Max: 22

- **Middle East:**
  - Avg: 16
  - Min: <2
  - Max: 52

- **China:**
  - Avg: 24
  - Min: <2
  - Max: 60

- **Asia Pacific:**
  - Avg: 11
  - Min: <2
  - Max: 55

- **Singapore:**
  - Avg: 27
  - Min: <2
  - Max: 72

% OF TOTAL VLSFO SAMPLES

- <15 ppm: 44.3%
- 15-40 ppm: 42.1%
- 41-60 ppm: 13.3%
- >60 ppm: 0.3%
Thank you for your attention!

YOUR FUEL MANAGEMENT PARTNER

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