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Brazil – Energy In Transition

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The Leader in Maritime
Testing & Surveys

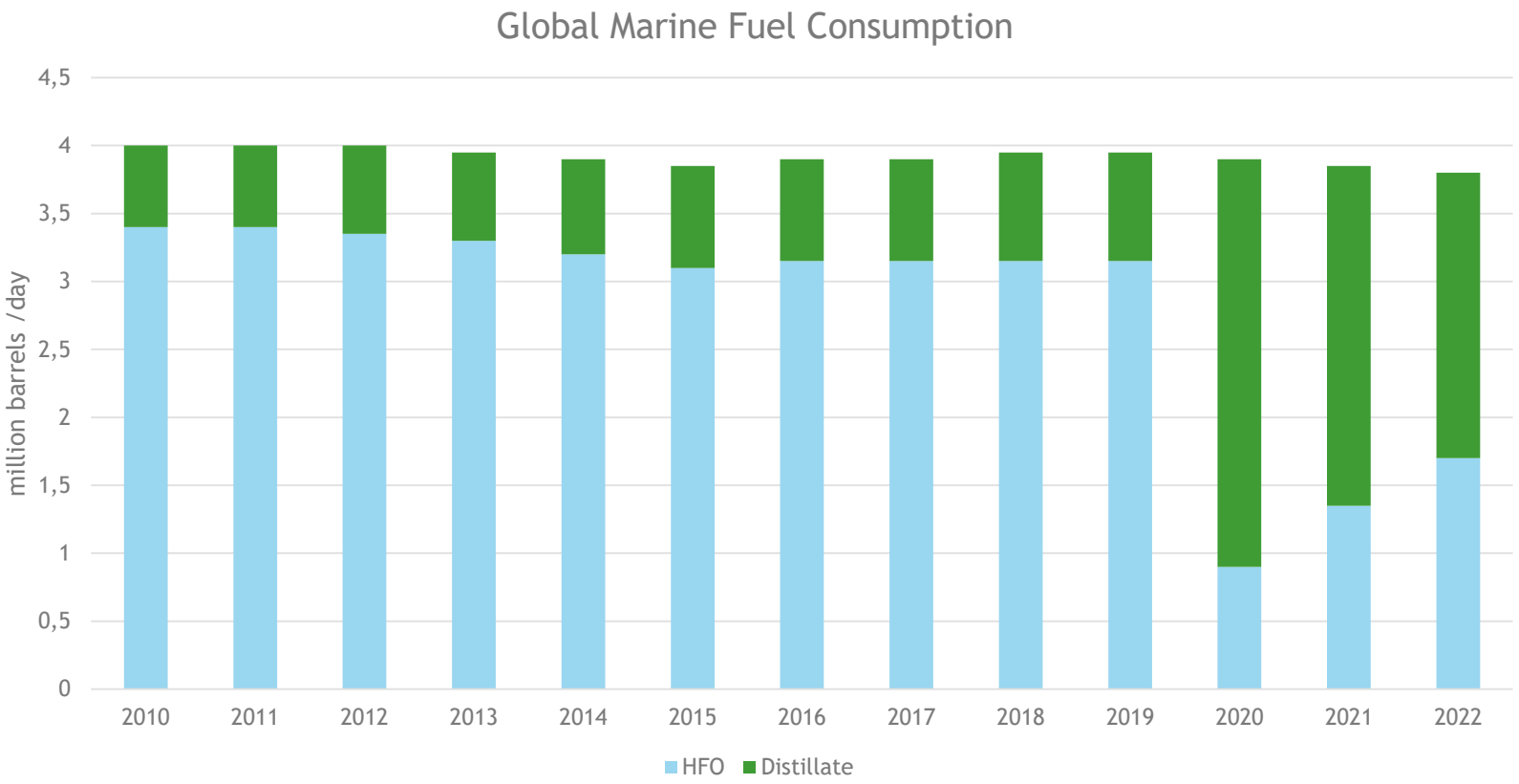
2020 Fuels

Quality Of New & Existing Fuels

As of January 1, 2020, the International Maritime Organization (IMO) will require ships to burn fuel with sulfur content 0,50% maximum unless they are fitted with scrubbers.

This is the biggest change in ship propulsion since ships burned coal.

Industry Fuel Forecasters:



3 million barrel/day switch from HFO to Distillate in 2020

Marine accounted for 45% of global demand for HFO in 2015 & 3% of global distillate demand.
Marine will account for less 25% of global HFO demand during 2020 & 10% of distillate demand.

What are the source materials?

The new ECA compliant fuels available today can be broadly characterised as follows:

- Hydro treated vacuum gasoils
- Heavy gas oil fractions:
  - After desulphurisation
  - From very low sulphur crude sources
- Hydrocracker fractionator bottoms
- Residue thickened fuels(ULS distillates + LS residues)
- Desulphurised residues
- Others

Fuel Terminology

- Ultra low sulphur fuel oil (ULSFO), max 0.10%
- Very low sulphur fuel oil (VLSFO), max 0.50%
- Low sulphur fuel oil (LSFO), max 1.00%
- High sulphur fuel oil (HSFO), above 1.00%

- LS MGO – max 0.10%
- HS MGO – above 0.10%

Some New ECA Fuels (NEFs)

- ExxonMobil HDME 50
- Shell ULSFO (RMD80)
- Lukoil Eco Marine Fuel
- CEPSA Diesel Oil (DMB)
- Neste Diesel Oil (DMB)
- BP (DMA/DMB/RMD80/HCRO
- Chemoil DMB
- Bominflot IF 30
- Gazprom Marine Bunker 0.10%
- Stena Oil ECA 0.10%
- SK Energy 0.10%

Key Properties Of A Few NEFs

	Shell ULSFO 0.1S	ExxonMobil HDME50	ExxonMobil AFME200	Lukoil	Ostsee	ISO8217 DMA	ISO8217 RMD80
Density @15C	790 to 910	905-911	929-931	887-895	865-923	890	960
Viscosity @50C	12 to 36	34 to 39	133-147	12.3-13.9	7.2-25	-	80
Viscosity @40C	-	-	-	-		3 to 6	-
Al+Si	<2-7	< 2	< 5	<2-3	<2-6	-	40
MCR	1.8-2.5	< 0.3	< 10	<.1-0.2	0.1-2.2	0.30 (MCR10%)	14
Pour Point	18-30	9 to 18	18-21	9-24	21-30	-6 to 0	30

The new ECA fuels are difficult to fit into Tables 1 or 2 of ISO8217

Operational recommendations

- Avoid mixing with any other fuel in storage tanks
- Use empty tanks or ensure tanks are drained as much as possible before loading a new fuel
- Ensure heating requirements are feasible for the vessel.
- The fuel should be kept at least 10C above the pour point.
- New fuel should not be used before analysis results are known
- The change-over process should be carried out as quickly as possible
- Pre-emptive replacement of old elastomer seals could eliminate the risk of unexpected leakage from filter covers and pipe joints using “O-rings”.

Summary of NEF Quality Since 2016

- Based on sample analysis conducted by VPS, the vast majority of fuels in this category are of excellent quality.
- Fuels from individual suppliers tend to be of consistent quality.
- There are however significant differences in key properties between different suppliers, reflecting the different source materials used.
- Compliance with the sulphur limit is generally very good with only a few exceeding the limit a little.
- There is one supply chain that delivers fuels with consistently high calcium levels. This may have a negative impact in some engine post combustion zones.
- At this moment in time these fuels represent a very low risk method of achieving ECA compliance for sulphur.

Some history

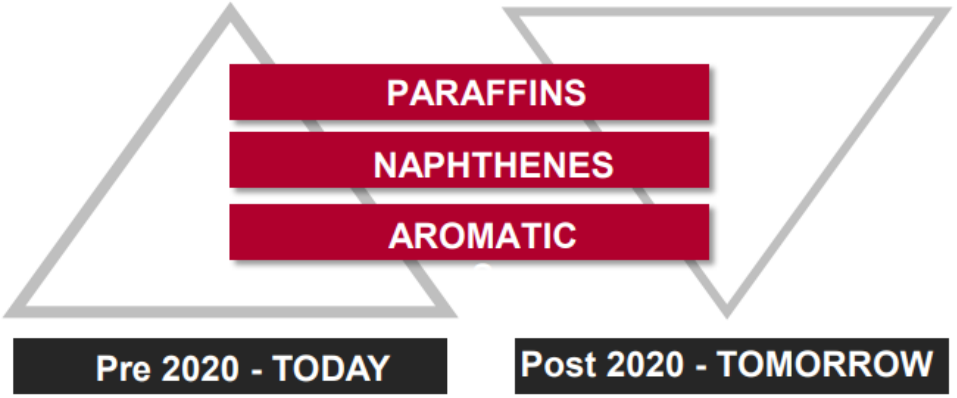
- **1.50% and 1.00% fuels resulted in;**
- Increased blending, leading to unstable fuels
- Higher density fuels
- Higher concentrations of catalytic (Al+Si) fines

- **0.10% fuels resulted in;**
- Increased distillate demand
- Introduction of new ECA compliant fuels (ULSFOs)
- Significant worse cold flow properties
- Flash points issues (automotive)
- Lower viscosity fuels

- **0.50% fuels will result in…….???**

What to expect operationally?

- Stability due to heavy blending
- Compatibility due to use of complex blends
- Cold flow due to more waxy base products
- High CCAI due to larger difference in density and viscosity
- Increased cat fines (Al+Si) due to use of cat cracker residue
- Low flash point due to use of inland market distillates



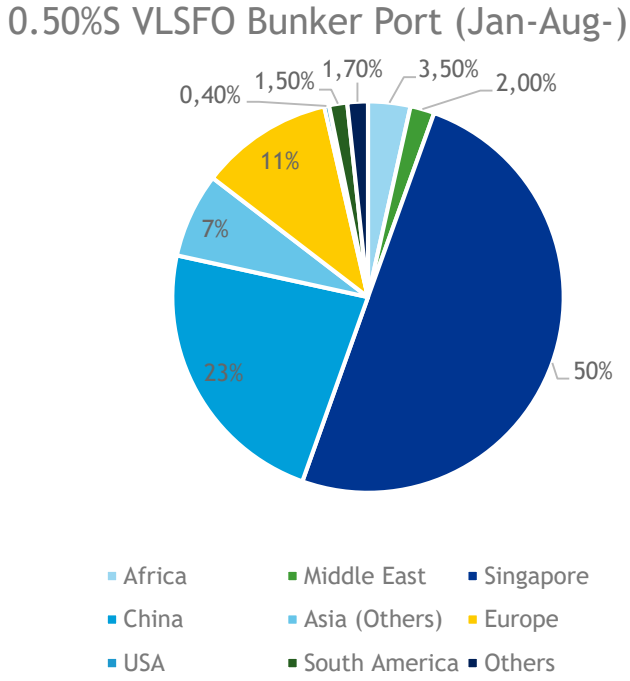
Ref: KBC/Mel Larson

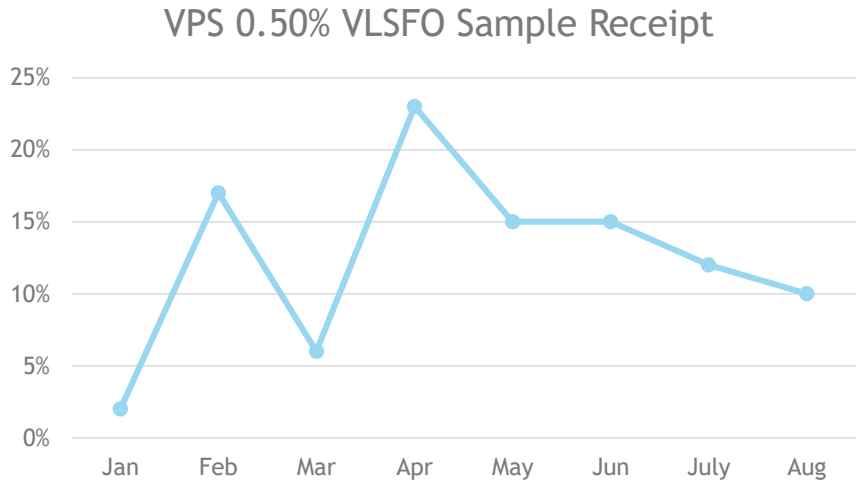
Stability Study VPS

Sample	RSN (Trans%)	TSP (% m/m)	TSA (% m/m)	TSE (% m/m)	Asphaltenes (% m/m)
1	1.1	0.02	0.03	0.02	1.80
2	0.1	0.01	0.01	0.01	3.45
3	0.1	<0.01	<0.01	0.01	0.02
4	0.1	<0.01	0.01	<0.01	0.04
5	0.8	0.18	0.21	0.19	0.39
6	15.7	0.03	0.02	0.04	7.43
7	0.5	0.02	0.04	0.03	0.25
8	1	0.16	0.22	0.08	1.81
9	1.4	0.01	0.03	0.02	1.03
10	11.7	0.01	0.01	0.01	2.74
11	0.6	0.01	0.01	0.01	0.55
12	1.5	0.01	0.02	0.02	1.98
13	2.1	0.01	0.02	0.02	2.22
14	2.2	0.01	0.01	0.01	0.89
15	1.4	0.03	0.01	0.01	1.20
16	11.5	0.01	0.01	0.01	2.66

0.50% S VLSFO's (Jan-Aug 2019)

	Low	High			
Density	882	997.8	Kg/m3		
Viscosity	6.4	509.6	CSt		
Al+Si	2	82	PPM		
Pour Point	-3	33	Degrees C		
TSP	<0.01	0.5	%		
Net Energy	35	42.5	KJ/Kg		
Sulphur	0.12%	3.34%	76% samples <0.50% S		





- Note – Large variances within regions, but offerings often consistent from individual suppliers.

Immediate Observations*

- **Densities & Viscosities -** Very wide variance.
- **Fuel separators and viscosity controllers** must be in good order, and able to cope with the possible range.
- Large differences between Density and Viscosity affects **CCAI.**
- **Pour Point** – Wide range up to +33°C. **Tank heating** will be required.
- **Al + Si** - Many VLSFO's are showing considerably higher cat fine levels. Must be ensured that fuel handling systems are working efficiently.
- **Sediment** - Off spec rate is higher than average.
- **Energy Content** - Concerns have been expressed about lower energy content. But so far energy content is similar to distillates, but higher than residual fuels.
- **Sulphur** - Generally compliant!
- **General observation** - Challenges notwithstanding, these are good fuels. Many are residual-based grades of fuel and should be handled as such.

Brazilian VLSFO's August thru November 2019

	Range
Viscosity	30 - 113 cst
Density	9308 – 9454
Ash	0.01 or less
Aluminum plus Silicon	3 - 29 PPM
Sulfur	0.49 - 0.52
Total Sediment Potential	0.01 or less
Net Energy	41.75 - 41.85

- Overall excellent quality
- Wide range of viscosities. Watch pre-heat temperatures
- Sulfur at or over the line. Perhaps not 2020 compliant yet.

Operational issues.

Temp sensitivity?

Suggested storage and separation temperatures for NEF's

Viscosity @ 50°C	Separator inlet temp
Up to 20cSt	40°C
20 to 30cSt	50°C
30 to 40cSt	60°C
40 to 50cSt	70°C
50 to 70cSt	80°C

Storage temperature to be at least 10°C above the pour point

Viscosity Control

- VLSFO's have a wide viscosity range, generally anywhere between 30 to 380 cSt.
- Critical that Viscosity controllers are working, and heaters are capable achieving and maintaining injection viscosity.
- To Achieve injection viscosity of 12-15 cSt…..

Viscosity @50°C	Preheat Temperature
30 cSt	70°C
80 cSt	95°C
180 cSt	112°C
380 cSt	125°C

- If using high separator temperature of say 95°C, lower viscosity fuels may need to be cooled in the day tank!
  - 30 cSt fuel at 95°C would give 8 cSt injection viscosity

Handling Differing Densities

- VLSFO has a wide density range, from 882 – 998 kg/m3.
- Ensure separators can handle the range, or even better compensate for it, e.g. Alfa Laval S Flex.
- Another reason to test fuels or have BQS including density analysis. Could seriously overpay if supplier has overstated density!

What To Expect from 2020 New Fuels (VLSFOs)

- 2020: More new fuels offering compliance at <0.5% S. Many Blended products (ULS distillates + LS residues)
  - Hydro treated vacuum gas oils
  - Hydrocracker fractionator bottoms
  - Light Cycle Oils
- Increased number of **Stability** issues due to heavy blending
- **Probable Compatibility** issues due to use of complex fuel blends
- **Cold-flow** concerns due to more waxy base products
- Higher **CCAI** due to larger differences in density and viscosity
- Elevated **Cat-Fines** (Al+Si) due to use of cat-cracker residues
- Low **Flash-Point** due to use of inland market distillates & distillate blending

Handling Issues

- Always segregate bunker lots. No mixing.
- If mixing is unavoidable perform a compatibility test beforehand.
- Be aware of specific heating requirements for hybrid fuels due to varying viscosities. Minimum storage temp should be 10°C above pour point.
- Low viscosity ECA distillates may require chilling for proper viscosity control prior to injectors.
- Some ECA fuels have a “cleansing” effect on storage tanks and pipelines. Suggest cleaning tanks in advance. If not possible, be prepared for additional sludge at the purifier. Consider reducing sludge cycle time at purifiers during initial changeover.
- In-line auto filters may backwash more frequently due to cleansing effect.

VPS DATA SHOWS THAT HYBRID FUELS ARE MORE SENSITIVE TO MIXING

Summary

- Heading towards 2020 & Beyond…
- Fuel Management Challenges will increase and become more complex.
- Wider range/choice of fuels available with many considerations
- Either with use of a single fuel type or…….
- Switching between fuel types
- Key factors will be Availability & Price, Supply & Demand.
- Every fuel type has its pro's & con's
- Work with a Fuel Management Partner to effectively measure and monitor fuel quality, to improve operational efficiency and ultimately protect your assets, comply with legislation and save money!!

Thank You

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