Biofuels Brochure

A Sustainable Solution for the Maritime Industry

Discover the future of sustainable shipping in a world striving to reach net-zero emissions by 2050. With global shipping contributing 2-3% of all emissions, the maritime industry is adapting to new regulations, including the expansion of the EU ETS scheme, creating challenges and opportunities.

Learn how biofuels, including biodiesel, offer an eco-friendly alternative, providing insights into types, advantages, and challenges. Explore quality concerns, testing methods, material compatibility, and alternatives like HVO, CNSL, and TPO. Join us on a journey toward greener shipping solutions with VPS Bio-APS, offering protection and expertise.

EXPERIENCE ▶ INNOVATION ▶ SUSTAINABILITY

Moving Forward

Leading the way for sustainable solutions

Introduction

With 2-3% of global emissions attributed to global shipping, the entire industry is now on a drive to reduce emissions to net zero or close to by 2050. In 2023 the IMO introduced additional interim checkpoints of 20% global greenhouse gas emissions reductions compared to 2008 in mid-2023 but striving for 30% by 2030 with a 70% (striving for 80%) reduction by 2040. On top of this the EU ETS scheme will be expanded in 2024 to include all vessels over 5000GT transporting general cargo or passengers with the share of emissions subject to the ETS being increased from 40% in 2024 to 70% in 2025 and 100% in 2026. Methane and nitrous oxide emissions will be added to the EU ETS from 2026. Offshore vessels will also be added to the scheme from 2027. There will also be the FuelEU Maritime initiative in 2025 mandating the increased use of environmentally friendly fuels.

With all of these new requirements (and additional costs and complexity) operators and owners are now looking very closely at how to reduce their emissions including looking at alternative fuels that can help reduce emissions and remove the need to burn fossil fuels. As a result more and more biofuels are being used in shipping, usually in blends with traditional fuels but also at 100% (B100).

Biodiesel | FAME

FAME (fatty acid methyl esters) or more commonly referred to as biodiesel, has been used within the automotive industry for many years. The composition of FAME is dependent on the feedstocks used in the manufacturing process and can vary greatly between each batch, between each supplier and where it is purchased around the world.

FAME has one big advantage in that it is a ‘drop-in’ replacement for traditional fuels and can be used at varying amounts up to 100%. For example, a B30 fuel will be a blend of 30% FAME and 70% conventional fuel. Due to the changes in chemical structure between each FAME, its performance as a fuel can vary greatly too. Carbon chain length and degree of unsaturation can influence the cold flow properties, with the degree of unsaturation also influencing oxidation stability and oxygen content.

	Automotive	Shipping	Increased Risk for Shipping
Storage time in tank	Days/Weeks	Weeks/Months	Fuel stability
Storage temperature	Ambient	Elevated	Fuel degradation / stability
Amount of fuel loaded	ca 200 litres	ca 1,000 Tonnes	
Transport environment	On land	At sea	Microbial growth due to presence of water

Table 1: Comparing FAME use in shipping with FAME use in the automotive industry.

The level of oxygen content has an influence on the energy content, which is already lower than for conventional marine fuels. With the introduction of the EU ETS and with FAME from sustainable sources, such as used cooking oil, having a zero CO2 emissions factor, being able to accurately measure FAME content in fuel will be an advantage to vessel owners and operators. Several test methods already exist for determining the level of FAME in biofuels (including ASTM D7371, ASTM D7963, EN14078 and EN14103). There are limitations to these test methods but they are the current test methods recognised by the industry.

FAME, due to its partially oxidised nature compared to conventional hydrocarbon-based fuels is also susceptible to microbial growth, especially in the presence of water, which can lead to sludge, increased acidity and rancidity, which can then lead to other problems such as blocked filters and corrosion. Again, due to its partial oxidation and some of the esters in the fuel being unsaturated, FAME can have significantly reduced oxidation stability which can cause sludge, filter blocking, darkening and acidity increase.

All that said, FAME does provide an environmental benefit from a well to wake perspective and with careful management onboard should cause no issues in its use, especially in blends with conventional fuel.

FAME pros

- Decades of operational experience in other sectors, e.g. automotive.
- Biofuels are considered to have a zero CO2 emissions factor by EU ETS.
- Biofuels are considered “drop in”, i.e. can replace conventional marine fuels without significant modification.

FAME cons

- Price can be 100% more expensive than VLSFO.
- Calorific Value is up to 10% lower in pure FAME.
- Each biofuel has its own fuel management considerations, benefits and concerns.

FAME quality concerns

- Microbial activity
- Affinity to Water
- Cold flow properties
- Oxidation stability
- Lower Calorific Value – note, the traditional GCV calculation per ISO8217 does not apply for fuels with >10% FAME.
- Renewable content - VPS modified EN14078 method provides a more accurate determination of renewable content, ensuring correct carbon taxes can be assigned, eg EU ETS.

Material compatibility considerations when using biofuels

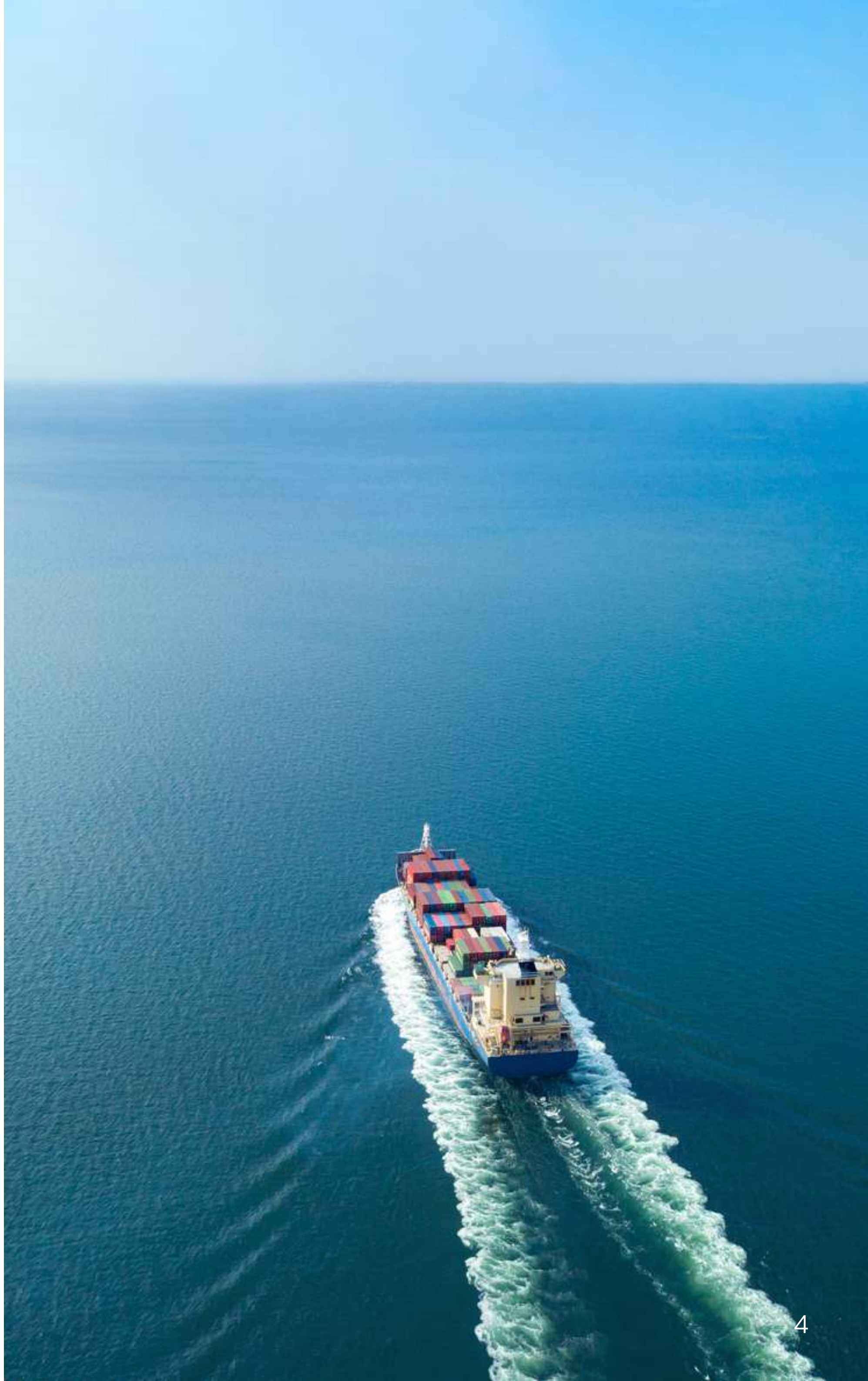
Handling and using FAME (and other biofuels) also has a lot of considerations that owners and operators need to be aware of and this includes compatibility with other materials:

Material	Recommended	Not recommended
Metals	Carbon steel, stainless steel, Aluminium	Brass, Bronze, Copper, Lead, Tin, Zinc
Elastomers	Flurocarbon, Nylon, Teflon, Viton	Nitrile rubber, Neoprene, Chloroprene, Natural rubber, Hypalon, Styrene-Butadiene rubber
Polymers	Carbon filled acetal	Polyethylene, Polypropylene, Polyurethane, PVC
Others	Fiberglass	

Table 2: Compatability issues with materials when using FAME.

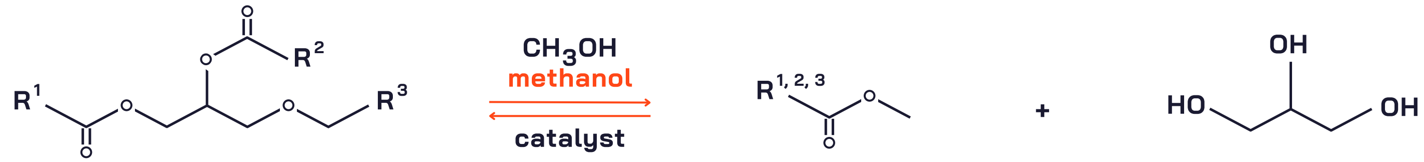
Biodiesel versus Renewable Diesel

We have also seen other sources of material being used as options for fuel. Hydrogenated Vegetable Oil (HVO) is derived from waste oils from cooking and is highly processed and hydrogenated to remove any unsaturation and oxygen containing molecules like esters. As such HVO is often referred to as renewable diesel and performs in a similar way to conventional diesel. When comparing HVO with FAME we see higher energy content, good oxidation stability, superior cold-flow properties and little or no microbial growth. This is due to the fact the HVO is hydrogenated and any partial oxidation (as found with FAME) has been removed during the hydrogenation progress.



The difference between FAME and HVO

FAME



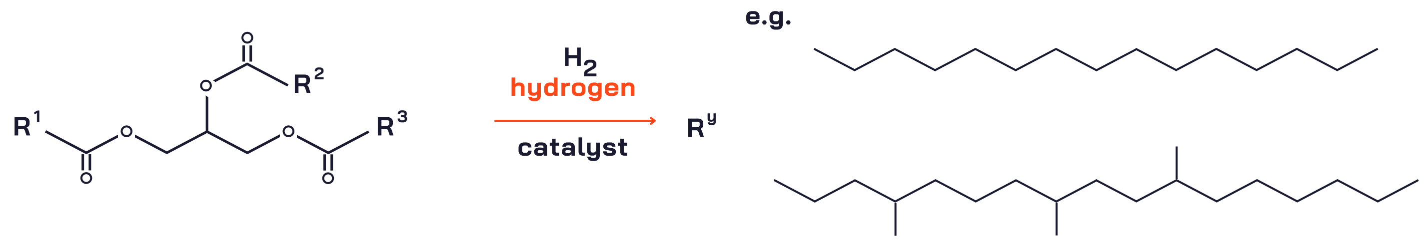
Fatty Acid Triglyceride

Fatty Acid Methyl Ester

Glycerine

R^x = single bond, double bond or multiple bond carbon & hydrogen chains

HVO



R^y = single bond straight and branched carbon and hydogen chains

Cashew nut shell liquid (CNSL) and tyre pyrolysis oil (TPO) have also been suggested as marine fuels either as a 'B100' or in blends. CNSL is highly acidic and contains very different molecules compared to FAME which are phenolic in nature. These phenolic molecules have many uses outside the marine industry but as a fuel they could be susceptible to polymerisation under the right conditions of heat and potential prolonged storage. However, in blends with traditional fuels CNSL could be suitable as a fuel but more testing is needed to confirm its suitability. TPO is a relatively new technology and further testing is needed to prove its suitability as a marine fuel.

100% Bio	Stability	Energy Content	Cold-Flow Properties	Corrosivity	Microbiological Activity
FAME	High levels of unsaturation causes instability. Plus, storage time, temperature and light affect stability. for FAME stability measure Ox. Stab, Iodine Value, PUFA content.	Low at around 37MJ/kg	Poor Cold-Flow	Acid Number Avg of 0.5mgKOH/g, but increases upon Oxidation. Can be corrosive to Copper.	Prone to microbial growth over time when water present and warm temperatures.
HVO	Hydrogenation removes oxygen from the fatty-acid feedstock. HVOs more stable than FAME.	High at up to 44MJ/kg	Superior to FAME	Superior to FAME	Little chance of microbial activity
CNSL	Good Ox Stability, but Unsaturated Phenolic compound, with high Iodine-value, very reactive & unstable.	Avg at around 39-40MJ/kg	Good Cold-Flow Properties. PP-48 C	CNSL exhibits high acid number which is corrosive.	Little chance of microbial growth. Inherent anti-microbial properties.

Table 3: Comparison of FAME Properties versus HVO and CNSL.

VPS biofuel testing

VPS has tested many, various biofuels blends. This includes R&D projects and trails with both suppliers, research agencies and shipping companies. Our current experience is that many different biofuels, although different to traditional marine fuels, are reliable and effective fuels.

VPS as introduced an Additional Protection Service for biofuels to offer greater understanding and protection to shop operators based on our experience and expertise. VPS Bio-APS can be applied to different types are biofuels that are currently being used from 100% FAME through to blends with any conventional marine fuel (MGO or HFO). VPS has templates for:

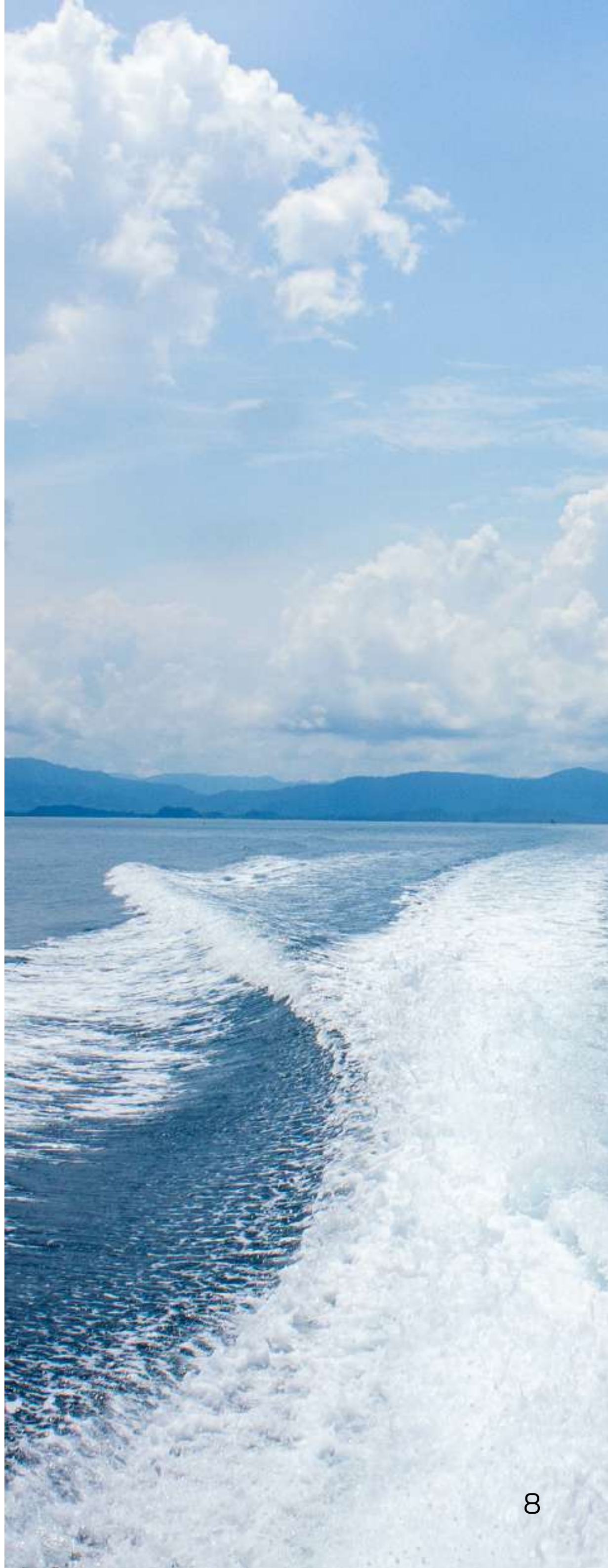
- **Bio-MGO**
  Blends of B10 through to B70 with distillate fuel
- **Bio-HFO**
  Blends of B10 through to B70 with residual fuel
- **Bio-FAME**
  Covers all PURE FAME

Bio-APS for Bio-MGO blends

Parameter	Test Method	Purpose of Test
ISO 8217 Test Slate	As specified in ISO8217 standard	Ensure fuel is fit for use as bunker fuel
FAME content	ASTM D7371/EN 14078 modified	Accurate measure of renewable C content
Net Calorific Value	ASTM D240	Accurate measure of CV (usual calculation method does not work for biofuels)
Cloud Point	EN ISO3015 modified (LP1305)	Cold-flow property
Bacteria, Yeast, Fungi	LP2301	Microbiological activity
Cetane Index	ASTM D4264	Combustion property
Oxidation stability (at 110 °C) - Rancimat	EN 15751	Stability of the biofuel
Iodine value	EN 14111	Susceptibility to oxidise
TAN / Acid Value	ASTM D664	Corrosivity
Sulfur content (ppm)	ASTM D4294	Understand level of lubricity in the fuel
Lubricity (HFRR)	EN ISO12156-1	Poor lubricity due to low S levels

Bio-APS for Bio-VLSFO and Bio-HFO blends

Parameter	Test Method	Purpose of Test
ISO 8217 Test Slate	As specified in ISO 8217 standard	Ensure fuel is fit for use as bunker fuel
FAME content	ASTM D7371/EN 14078 modified	Accurate measure of renewable C content
Net Calorific Value	ASTM D240	Accurate measure of CV (usual calculation method does not work for biofuels)
WAT/WDT	LP 1307	Cold-flow property (WAT needed due to dark colour of oil)
Bacteria, Yeast, Fungi	LP 2301	Microbiological activity
Oxidation stability (at 110 °C) - Rancimat	EN 15751	Stability
Iodine value	EN 14111	Susceptibility to oxidise
TAN / Acid Value	ASTM D664	Corrosivity
GC/MS Headspace Screen	LP 3404	Chemical contamination of HFO/VLSFO



Bio-APS for FAME

Parameter	Test Method	Purpose of Test
FAME content	EN14103	Accurate measure of renewable C content
ISO 8217 Test slate	ISO 8217	Ensure fuel is fit for purpose as a bunker fuel
Cloud Point	ISO 3015	Cold Flow Property
Net Calorific Value	ASTM D240	Measure of the energy content
Flash point	EN ISO 2719	Health & Safety Measurement (SOLAS)
Cetane Index	ASTM D4264	Combustion property
Copper strip corrosion (3 h at 50, 100, 150°C)	ASTM D130	Potential Corrosivity
Steel corrosion @ 20,60, 120°C	LP2902	Potential Corrosivity
Oxidation stability (at 110 °C)	EN 15751	FAME Stability
TAN / Acid value	ASTM D664	Measure of Corrosivity
Iodine value	EN 14111	Measure of Unsaturation

Bio-APS for FAME

Parameter	Test Method	Purpose of Test
Water content	ASTM D6304	Operational Issues
Bacteria, Yeast, Fungi (BYF)	LP2301	Microbial activity
Sulfated ash content	ASTM D874	Operational Issues
Sulfur content (ppm)	ASTM D4294	Operational Issues
Group I metals (Na+K)	IP501	Operational Issues
Group II metals (Ca+Mg)	IP501	Operational Issues
Phosphorus content	IP501	Operational Issues
Linolenic acid methyl ester	EN 14103	FAME Stability (PUFA's)
Methanol content	EN 14110	Protection from Potential Ester breakdown
Monoglyceride, Diglyceride, Triglyceride content	EN 14105	Operational Issues
Free glycerol	EN 14105	Operational Issues
Total glycerol	EN 14105	Operational Issues

Conclusion

The maritime industry is current working to reduce emissions to meet the IMO target of net-zero on or around 2050. There have been lots of measures adopted over the last few years to improve fuel efficiency and reduce emissions. This has included slow steaming, vessel design, air lubrication etc. However, all of these methods still involve the use of fossil fuels. So, the next step is to start using alternative fuels with significantly reduced or even zero carbon footprints. This has started with many new builds and some retrofits on vessel with dual fuel engines allowing the use of alternative fuels such as methanol.

In the future we will also start to see other fuels being used, such as methanol and hydrogen, and there is a lot of current research ongoing around the use of ammonia as a zero-carbon fuel and also some consideration around the use of nuclear energy to power vessels.

Join us on this journey

Join us in the journey towards a greener, more sustainable maritime industry. At VPS, we are committed to accelerating the shift towards a low-carbon future, and we invite you to be part of this transformative change.

Are you a vessel owner or a stakeholder in the maritime industry? Let's collaborate to reduce your carbon footprint and make your operations more eco-friendly. With VPS, you will gain access to data-driven solutions, expert advice, and digital tools that guide you along the path to sustainability. Together, we can create a more environmentally responsible and economically efficient maritime sector.

Contact us today and let's pave the way to a cleaner, greener future for the maritime industry.

Contact

marketing@vpsveritas.com

vpsveritas.com