MARINE FUEL SPECIALTIES
Enhancing your fleet performance

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TECHNICAL BULLETIN

Customer Technical Service

CASHEW NUT SHELL LIQUID

What is CNSL and why has it entered the marine fuel debate?

Cashew Nut Shell Liquid (CNSL) is a by-product of cashew processing, historically used in polymers, resins and coatings. With increasing regulatory pressure across industries, the demand for biofuels is expected to rise significantly to support decarbonization and the transition to net zero. CNSL, being a waste-derived and renewable material with large-scale availability, is now being explored as a potential marine biofuel stream. However, its application is still under evaluation. While CNSL offers advantages such as availability and cost-effectiveness, industry experience highlights significant technical challenges, making it likely suitable only for marine engines with higher tolerance for lower-grade fuels.

Is CNSL recognized as a viable fuel – or classified as a contaminant?

As per the biofuel guidelines written by CIMAC in 2024, they advise the use of CNSL as a marine fuel component need consultation and possibly consensus of the OEM and Class, noting uncertainties in chemical behaviour and unpredictable effects on machinery. ISO 8217 does not recognize CNSL as a standard category, meaning its presence can render a fuel “off-specification.” OEMs also remain cautious due to highly variable quality across suppliers. While some refined CNSL streams show promise, untreated variants are widely regarded as high-risk.

How does CNSL compare to other marine fuels?

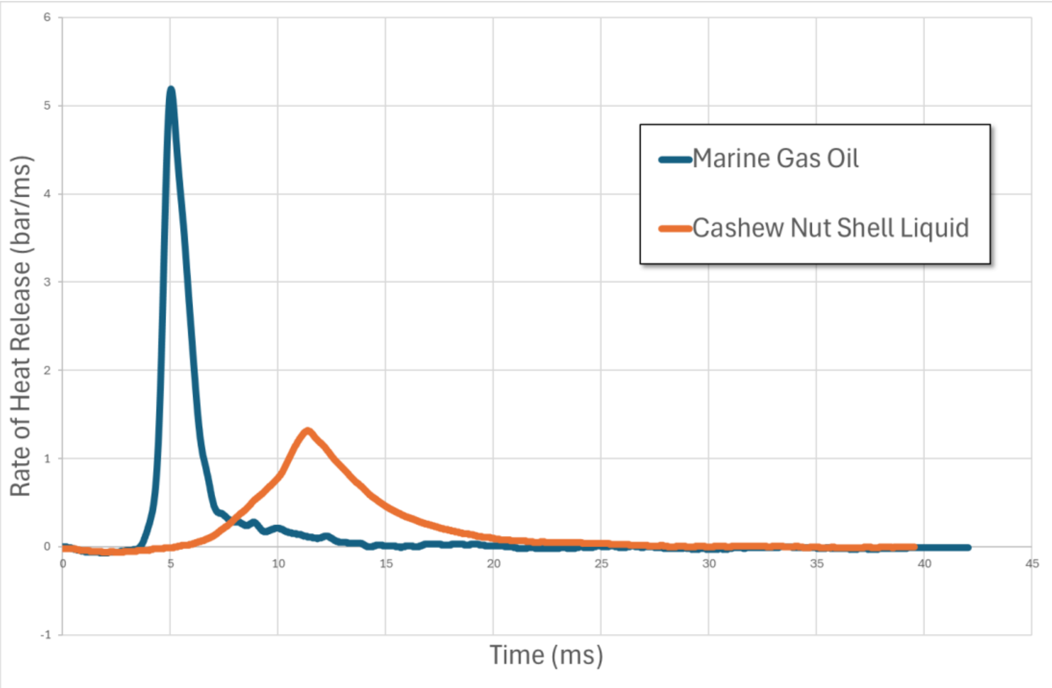
Fuel Grade	MGO	HVO	Iso-HVO	FAME	CNSL
Full Name	Marine Gasoil	Hydrotreated Vegetable Oil	Isomerised Hydrotreated Vegetable Oil	Fatty Acid Methyl Ester	Cashew Nut Shell Liquid
What does it look like?					
What is the typical viscosity at 40°C?	5cSt	4cSt	3cSt	4cSt	53cSt
What is the typical flash point?	82°C (60 minimum ISO 8217)	72°C	85°C	156°C	Composition dependent 160-230°C
What is the typical Cetane Number*?	48 (40 minimum ISO 8217)	70	51	65	9
What is the typical Pour Point?	<-6°C	-9°C	<-30°C	Source Dependent Palm Oil +15°C Rape Seed Oil -15°C	<-33°C
What are the lubricity properties?	Poor – requires additive treatment	Very poor - requires additive treatment	Very poor - requires additive treatment	Naturally Excellent	Naturally Excellent

The cetane number* is a measure of the **combustion quality of diesel fuel. It indicates how quickly and efficiently the fuel ignites in a diesel engine.*

How does CNSL perform in combustion?

Testing shows CNSL has an **extremely low cetane number, about 10** compared with marine gasoil averagely more than 40 which can cause long ignition delays, poor flame propagation and high smoke/soot formation. This will directly impact engine efficiency and reliability. Even when combined with good quality MGO the cetane number of the overall fuel is significantly reduced. Fortunately, with our years of experience, we know that the cetane number can be improved by using additives that promote cleaner combustion, such as shortening ignition delay, which helps reduce soot and prevent engine performance deterioration.

The combustion profile of CNSL compared to MGO is shown below. The graph is generated using the test method IP541 - *Determination of ignition and combustion characteristics of residual fuels*. It shows the rate of heat release against time when the fuel is combusted in controlled conditions. It clearly shows the huge difference in combustion profile and how difficult it would be to combust the fuel within the normal engine compression ratio and timing.



Does CNSL present a corrosion risk?

Corrosion testing (ASTM D665 performed at Innospec´s R&D Center) produced atypical results: probes developed a uniform black lacquer rather than conventional rust. Although classified as “non-corrosive” under test criteria, the unusual deposit raises questions about long-term equipment compatibility.


Steel rod corrosion test result


Innospec Inc R&D Center


Typical corrosion test result

So how stable is CNSL under Oxidation?

Paradoxically, CNSL demonstrates good oxidation stability in laboratory testing (>43 hours induction time vs. EN590 requirement of >20 hours). However, field experience shows that when blended with residual fuels, CNSL can contribute to gum and sediment formation. This suggests the issue is not intrinsic instability, but adverse interaction with other fuel components.

What operational problems have been reported with CNSL?

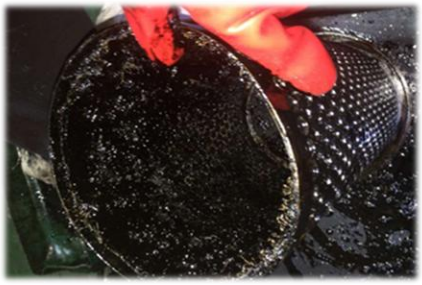
When combined with residual fuel oils, sludging is expected to be a significant issue. Below Sludging pictures from CNSL fuel, GCMS CRA Analysis detected Pentadecenylphenol ($C_{21}H_{34}O$) at 5571 ppm. This compound is commonly known as Cardanol Monoene and is found in cashew nut shells. High levels of Cardanol (Pentadecenylphenol) can lead to the formation of gums and sediments which have the potential to cause issues with purifiers, filtration and fuel pumps.

Documented vessel experience includes:

- Sludge formation and purifier overloading
- Injector fouling and filter blockage
- Turbocharger fouling due to eutectic deposits (potassium/vanadium interaction)
- Elevated exhaust temperatures and abnormal combustion patterns

Case studies include "B100" fuels found to contain up to **50% CNSL**, which resulted in severe operational disturbances.

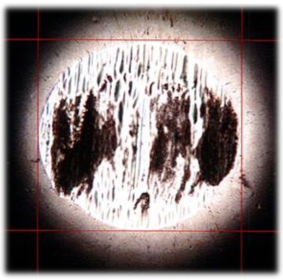
Such incidents underline the importance of verifying fuel composition prior to use.



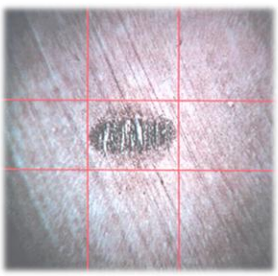
⚠ **Caution:** Untreated CNSL poses significant operational risks. We strongly recommend controlled blending with stabilizers, dispersants, and/or ignition improvers to maintain fuel operability. CNSL quality can vary. Processed CNSL with high Cardanol content (above 98%) appears less reactive and potentially safer, while unprocessed CNSL streams may cause issues, as noted above. Innospec trials show effective risk mitigation with additives. Specific products can be recommended depending on the base fuel.

Can CNSL provide any technical benefit?

Simple answer: Yes. CNSL exhibits **excellent natural lubricity**. HFRR testing returned a wear scar of ~190µm — substantially below the marine fuel maximum of 520µm. This property could reduce fuel pump and injector wear, mitigating a known weakness of conventional distillates. *However, whether this advantage outweighs CNSL's combustion and deposit issues remains debatable.*



Poor Quality Fuel HFRR Wear Scar of 651µm



CNSL test sample HFRR Wear Scar of 190µm

Analysis conducted at Innospec's Fuels Technology Centre

What is the industry opinion of CNSL?

Ultimately, it is up to the industry to determine if these products are fit-for-purpose. Research is ongoing. ISO working groups are considering potassium limits to address eutectic deposit risks. Engine trials are assessing blends with MGO and VLSFO. Screening methods for CNSL contamination are becoming more accessible. For now, CNSL remains both a biofuel pathway and a contamination hazard - depending on quality, processing, and additive support.

How can ships mitigate the risk of CNSL use or CNSL fuel contamination?

These fuels are high-risk because they are prone to poor ignition, soot formation, and fuel instability. To reduce operational risks, Innospec recommends:

1. Use safer blending ratios – for example, 80/20 MGO to CNSL. A 70/30 blend was tested with a cetane number of 26.
2. Perform GCMS testing – to identify potential contaminants and understand associated risks.
3. Monitor onboard – check fuel stability and compatibility, especially at the start and end of consumption.
4. Apply additives – tested solutions that improve fuel stability and combustion (see table below).

Product Name	Function	Applicable fuel type	Key benefits
Octamar™ ecopower	Fuel Stabiliser Combustion improver Ignition improver	MGO (when blended with CNSL)	Reduces fuel consumption Improves ignition Reduces soot and smoke
Octamar™ Ultra HF	Fuel Stabiliser Combustion improver Ignition improver	VLSFO, up to B30. If found contaminated with CNSL	Reduces sludging Reduces fuel consumption Improves ignition Reduces soot and smoke
Octamar™ Complete	Fuel Stabiliser Combustion improver Ignition improver	HSFO, up to B30. If found contaminated with CNSL	Reduces sludging Reduces fuel consumption Improves ignition Reduces soot and smoke

The products listed above have been tested for their ability to improve vessel fuel economy through these effects and are routinely used by shipping companies worldwide for this benefit alone.

The above recommendations cover some, but not all, methods to mitigate the risks of using CNSL, CNSL-blended, or CNSL-contaminated marine fuel. Please contact our technical team if you would like more information.

Summary

CNSL is a renewable, waste-derived material being explored as a marine biofuel option due to its availability and cost benefits. However, it presents significant technical challenges, including poor ignition quality, deposit formation, and compatibility issues. Current ISO 8217 standard do not recognize CNSL as a marine fuel, and OEMs remain cautious. While CNSL offers excellent lubricity, its low cetane number and contamination risks require careful management. Key mitigation measures include controlled blending (e.g., 80/20 MGO to CNSL), GCMS testing for contaminants, onboard monitoring and the use of proven additives to improve stability and combustion. CNSL remains both a potential biofuel pathway and a contamination hazard - its safe use depends on quality, processing, and robust risk management.

Please contact your local sales representative for more information.
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