

# BIODIESEL AS AN EFFECTIVE DECARBONIZATION TRANSITION SOLUTION FOR EXISTING SHIPS

To achieve decarbonization in the maritime industry at the scale and speed required to meet the goals of the Paris Agreement, readily available solutions are needed to reduce greenhouse gas (GHG) emissions for existing shipping fleets.

As part of a quest to precipitate the decarbonization of its ships, The CSL Group (“CSL”) launched its biodiesel pilot project in 2019 with tests on the auxiliary engine of one vessel in its Great Lakes fleet. In 2020, the project progressed to testing on the main and auxiliary engines of two vessels, and in 2021, trials were conducted on eight CSL Lakers.

CSL’s pilot project was successful in demonstrating the technical viability of biodiesel for existing marine engines and its efficacy as a transition fuel towards the decarbonization of the marine transportation sector.

In 2022, CSL completed the trial phase and transitioned to the next stage of implementation, establishing the CSL Biodiesel Program. During 2022 and 2023, eight CSL Lakers operated on B100 biodiesel. The program continues in 2024 with the intention to broaden biodiesel usage to additional vessels in the fleet.



## WHY TEST BIODIESEL ON SHIPS?

Biodiesel is a drop-in fuel option for vessels that does not require retrofitting or major modifications to ships or infrastructure. The fuel can be delivered through existing supply and bunkering facilities and, depending on the source of feedstock, can reduce well-to-wake greenhouse gas emissions by over 80%.



## TESTING AND ANALYSIS

Over the duration of CSL's trials, various grades of biofuels were tested on bulk carriers and self-unloading bulkers on a range of engine loads and configurations. The fuel's NO<sub>x</sub> emissions were measured in accordance with the NO<sub>x</sub> Technical Code, while sulphur content was measured in accordance with ISO 8754.

Emissions testing and fuel analysis were conducted at different bio-content concentrations to measure environmental compliance. In 2019, B50 fuel, a blend of 50% biodiesel and 50% marine diesel oil (MDO) was initially tested and increased to B80 fuel, a mix of 80% biodiesel and 20% MDO.

In 2020, the ships trials commenced with a B50 fuel, progressed to B80 and reached B100, which is pure biodiesel made of 100% bio-content second-generation biofuel. In 2021, eight CSL vessels used B100 continuously for a duration of five to eight months.

During each test, engine emissions were measured at 25%, 50%, 75% and 100% load according to their technical file, as well as at their normal operating loads to demonstrate a typical operation.

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## BIODIESEL SOURCE

Sourced in North America and supplied by Canada Clean Fuels, the biodiesel used during CSL's tests was produced entirely from waste plant material, specifically refuse soybean oil. Production of biofuel did not affect food production or supply chains.

The carbon intensity of the selected biodiesel is 21.4 gCO<sub>2</sub>eq/MJ, as measured using the Canadian Clean Fuel Regulation methodology.

Throughout the program's initial stages until 2023, all eight vessels were fueled with biodiesel at Windsor, Ontario. Beginning in 2024, biofuel bunkering was relocated to a new facility.

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## DUE DILIGENCE

Prior to commencing the biofuel trials and receiving approvals from the flag state and port state control, DNV was engaged to conduct a risk assessment. Mitigating actions were developed for the following identified risks:

- increase in NO<sub>x</sub> emissions
- waxing at cold temperatures
- spontaneous combustion of soaked rags
- low viscosity of the fuel
- degradation of the piping system
- loss of fuel conditioning module
- clogging of filters
- fuel degradation in storage tanks
- inadequate fuel treatment
- lube oil contamination.

## FUEL PROPERTIES AND MEASUREMENTS

A biofuel standard for marine fuel did not previously exist at the concentrations used in CSL's trials, however a new ISO specification is slated for release in 2024 that will cover all grades of biofuel.

The fuel was evaluated against ISO 8217:2017 with the exception of bio content, which was measured in accordance with EN 14103, a European standard for measuring high concentrations of biofuel.

All grades of biofuel and their properties were analysed, confirming their compliance with the values specified in ISO 8217:2017. The standard allows for up to 7% FAME, which stands for fatty acid methyl esters, molecules obtained from vegetable oils by transesterification.

As expected, each biofuel blend tested by CSL contained much higher concentrations of FAME. Additionally, although the standard allows for a pour point at  $-6^{\circ}\text{C}$ , CSL conducted its testing under conditions where temperatures did not drop below of  $0^{\circ}\text{C}$ . Throughout the trial period, bunker tanks were not heated and tank temperature remained around  $13^{\circ}\text{C}$ .



## RESULTS

CSL's tests successfully demonstrate that biodiesel is a technically viable and practical fuel option for existing ships to reduce well-to-wake GHG emissions and reduce  $\text{SO}_x$  and  $\text{NO}_x$  emissions below regulatory limits.

Among the findings:

- Total  $\text{NO}_x$  emissions remained within Tier II limits for all grades of trialed biofuels.
- During B50 and B80 trials,  $\text{NO}_x$  emissions were less than indicated in the technical file, suggesting that biofuels may be effective in reducing  $\text{NO}_x$  emissions.
- The sulphur measured in all grades of trialed biofuels was below North America Emissions Control Area limits.
- $\text{SO}_x$  emissions were lower than the minimum measurable value of the vessel equipment.

Now running for four years, CSL's Biodiesel Program has attained the following achievements:

- Over 75,000 running hours on B100 biodiesel
- An average of 15,000t B100 consumed each navigation season from May to October since 2021.
- A total of 50,000 tonnes of B100 consumed over the duration of the program
- Life cycle carbon emissions savings of 120,000 tonnes.

## CONCLUSION

Biofuels represent a viable means to reduce airborne emissions from shipping without a large capital investment from shipowners. The lack of technical issues associated with their use on vessels also make them a low-risk option for shipowners and for the marine industry in general.

# ADDRESSING THE CHALLENGES TO THE WIDESPREAD USE OF BIOFUELS

CSL considers biodiesel a key solution for decarbonizing existing tonnage and an integral part of its broader decarbonization strategy. While CSL has experimented with FAME biodiesel, it is important to recognize that renewable diesel could offer similar benefits while addressing issues such as cold flow properties and lower calorific value associated with FAME.

The primary barriers to widespread biodiesel adoption are primarily financial. These challenges could be addressed through collaborative efforts, such as:

## **GOVERNMENT INCENTIVES**

Governments can provide subsidies, tax breaks, or other financial incentives to encourage the production and use of biodiesel. This can help bridge the cost gap between biodiesel and fossil fuels, making it more attractive for shipping companies to switch.

## **ECONOMIES OF SCALE**

Increasing the scale of biodiesel production and utilization in the marine industry can help drive down costs through economies of scale.

## **CARBON PRICING**

Implementing carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems, can help internalize the environmental costs of fossil fuels and level the playing field for biodiesel. This can make biodiesel more financially competitive by reflecting the true cost of carbon emissions.

Through the collective implementation of these strategies, biodiesel can become financially viable in the shipping industry and compete effectively with lower-priced fossil fuels. However, it will require collaboration and commitment from governments, industry stakeholders, and consumers to overcome the challenges and realize the potential of biodiesel as a sustainable alternative fuel.



The CSL Group is a world class provider of complex marine solutions and the largest owner and operator of self-unloading ships in the world. Headquartered in Montreal with operations throughout the Americas, Australia, Europe and Africa, CSL provides a broad range of shipping and handling services, and delivers millions of tonnes of cargo annually for customers in the construction, steel, energy and agri-food sectors.