

# Locomotive Testing With Biodiesel



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## Introduction

The environmental impact is a warning in the railway sector, mainly due to CO<sub>2</sub>e emissions from locomotive operations. MRS Logística invests in strategies to ensure the conservation of natural resources, as well as the gradual transition to the use of biofuels.

Biodiesel is a renewable fuel, low of sulfur, of animal or vegetable origin, which balances part of the emissions generated during combustion. Brazil is one of the largest biodiesel producers in the world: in 2023 it produced more than 7.5 billion liters, a record according to the National Agency of Petroleum, Natural Gas and Biofuels.

Currently, the Brazilian government establishes a blend of 15% biodiesel (B15) in diesel available across the country. Part of MRS Logística's strategy consists of increasing the percentage of biodiesel in the fuel beyond the mandatory limits, to reduce the environmental impacts resulting from the company activities.

## Experimental work

In 2024, tests were carried out on a GE-AC44i locomotive with pure biodiesel (B100) and some blend variations (B25, B50 and B75), for observing the behavior of a 7FDL16 diesel engine when exposed to different levels of biofuel. The biodiesel used was made of new soy oil, with no other types of fat added. The base fuel used for blending was the standard Brazilian diesel, S500, with up to 500 ppm of sulfur and 14% of biodiesel. Blends were done in the field, using graduated tanks.

The experiment used an external fuel tank to measure the fuel mass consumption at each of the locomotive's acceleration notches over a period of 15 minutes. As designated in the ABNT NBR 16721:2018 standard, the material under test was placed in a load cell that was responsible for receiving the return and supply of the fuel, as shown in Figure 1.

To make the measurements comparable, the mass and operation time obtained through the test were calculated together with the power reported on the locomotive system. This was done to transform the mass and time collections into a specific unit of fuel consumption, measured in g/hp.h (grams per horsepower hour).

## Results

In all experiments, the locomotive electronic injection adapted well to changes in fuel, as power delivery was not a problem, keeping the engine's vital variables stable and within the correct operation limits, indicating that the use of any concentration of biodiesel is viable for engine operation in train.

However, as expected, fuel consumption increased as more biodiesel was added to the mixture, justified by the fact that this type of fuel has a lower calorific value than conventional diesel.

After data normalization to the MRS's main train type duty cycle and blends correction to the calculated mass of fuel used, the increase in fuel consumption by mass – when compared to current standard Brazilian fuel (B14) – were: 9.4% (B100), 6.1% (B74.2), 3.0% (B48.4 ) and 0.8% (B22.6). In summary, there is a proportional increase among the blends tested. Fuel consumption per notch can be found in Graph 1.

During the tests, fuel samples were collected for lab analysis confirmation of the blend achieved after fuel mixtures. In total, four Brazilian laboratories, including one of the largest fuel suppliers in country, tried to analyze the biodiesel content of the samples. All failed, as they didn't have parametric curves to do so, what brought an uncertainty to the test results.

## Conclusions

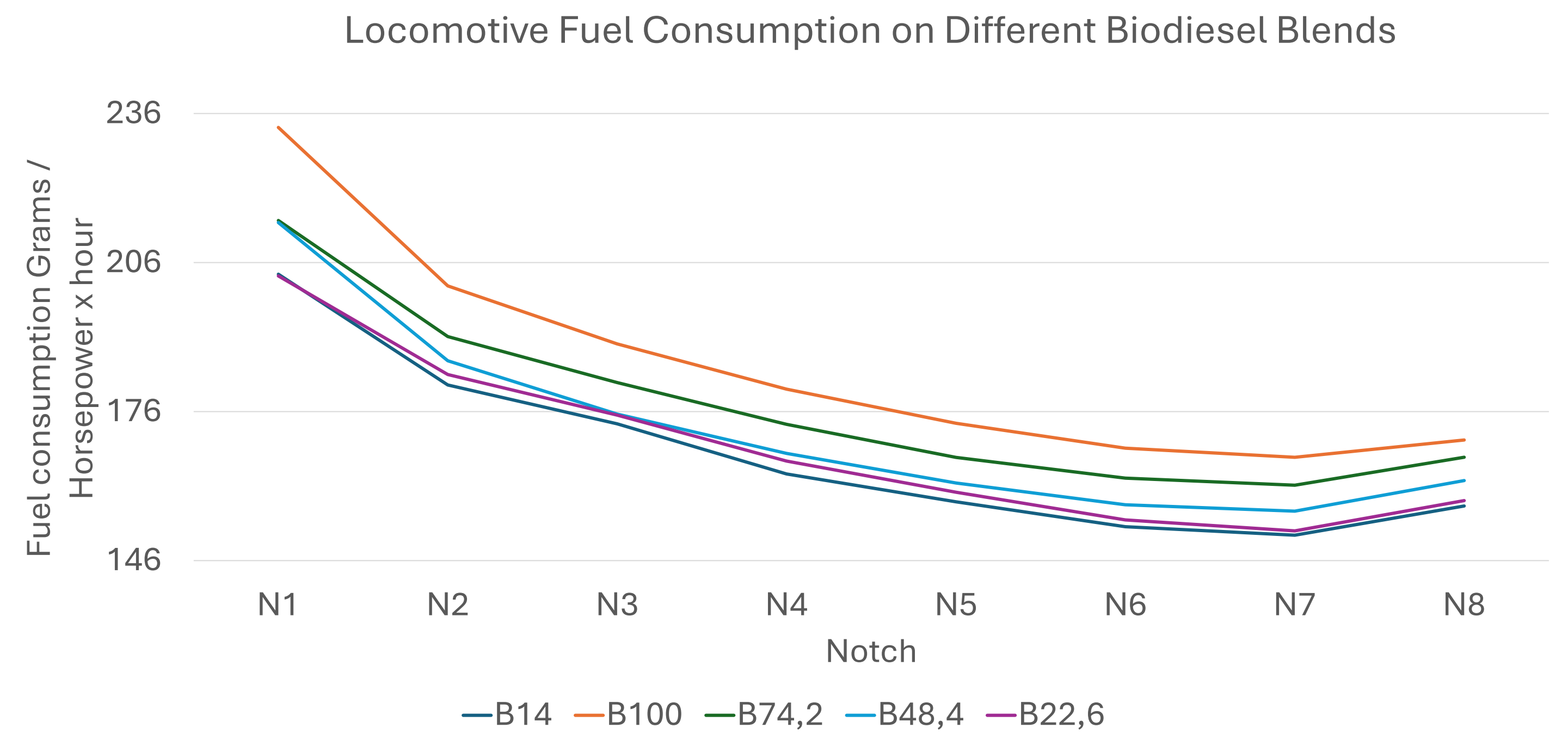
The static tests allowed a 7FDL16 engine behavior observation under biodiesel blend variations. It allowed the measurement of fuel consumption for each notch of engine operation. Local laboratories couldn't confirm exact blend after fuel mixtures, what brings some uncertainty, but it does not invalidate results, since the blends were done locally, in a controlled environment.

The conclusion of this phase enables dynamic tests, using locomotives fueled with higher content of biodiesel in train operation to validate the performance and evaluate the consequences of using this fuel for long periods of time.

This work aims to support MRS's decarbonization goals, with solutions that make sense economically and invest on Brazilian market strengths.



Figure 1: Fuel test setup



Graph 1: Fuel test results

## References

Associação Brasileira de Normas Técnicas, ABNT, 2018. *NBR16721 Locomotivas - Avaliação de aditivos para redução de consumo de combustível pelo motor a diesel*

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