CTM-UFMG
CENTRO DE TECNOLOGIA DA MOBILIDADE

TEST REPORT

EVALUATION OF THE ADOPTION OF *BIO BOOSTER* CATALYST IN THE FUEL CONSUMPTION OF A FLEX ENGINE FUELED WITH HYDRATED ETHANOL IN A BENCH DYNAMOMETER UNDER TRANSIENT OPERATING CONDITIONS

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1 - INTRODUCTION

This test report presents the results of the evaluation of the adoption of the *Bio Booster* catalyst, based on Anhydrous Ethanol, on the fuel consumption of a Flex engine on a dynamometer bench under transient conditions, performed by the CTM/UFMG Technical Team for thecompany Horeb Mercosul through a service provision request. In this report the methodology used and the results obtained during this evaluation are presented. The spark ignition engine used in the tests was fed with hydrated ethanol supplied by the contracting party, following an automatic cycle with variable speed and load and transient conditions. At each complete cycle, total fuel consumption was determined using a gravimetric consumption measurement system. Subsequently, the fuel used in the tests was catalyzed with the addition of *Bio Booster*, based on Anhydrous Ethanol, at a concentration of 50 PPM, as recommended by the manufacturer of the product (Horeb Brazil), and this was the only modification performed during the entire test presented here. After this modification, the engine was conditioned for 50 hours of testing, following the same automatic cycle with variable speed and load and transient conditions. After 50 hours of conditioning, the engine went through a new battery of tests, following the same automatic cycle with variable speed and load and transient conditions, and the total fuel consumption was measured again using the same gravimetric consumption measurement system. Thus, it was possible to make a comparative analysis about the influence of the catalyst in the operation of the engine under study.

2 - METHODOLOGY

The experimental methodology was executed in the dependencies of the Mobility Technology Center - CTM/UFMG. Its steps are detailed in the text, according to the chronological sequence of its realization. The activities started with the selection of the test object, being chosen the Sigma engine, manufactured by Ford, 1.596 liters, 4 cylinders, 4 stroke, naturally aspirated, with multipoint indirect fuel injection (PFI), static ignition with lost spark, electronically controlled by reprogrammable electronic management system MoTeC M800.

According to the manufacturer, this engine develops an ABNT Net Power of 110 hp at 6250 rpm (Gasoline) and 115 hp at 5500 rpm (Ethanol) and an ABNT Net Torque of 15.8 kgf.m at 4250 rpm (Gasoline) and 16.2 kgf.m at 4250 rpm (Ethanol). This engine was made available by the CTM/UFMG Technical Team, as well as all accessories required for its operation.

Then, the test room was prepared and modified, where the fuel feeding system was adapted (introduction of polypropylene lines) for storage and conduction of samples of hydrated ethanol and hydrated ethanol added to the *Bio Booster* Catalyst, based on anhydrous ethanol.

This intervention was necessary to meet the recommendation of Horeb Mercosul that the product tested should not remain in contact with components made of stainless steel. In addition to the modifications of the lines, a digital scale and a 50-liter tank were installed in the test room, enough to perform each automatic cycle.

After the modifications in the test room was performed the installation of the engine on the bench dynamometer of the CTM-UFMG laboratory. In this installation stage, in addition to the assembly of the mechanical components, all the necessary instrumentation was performed in the test room.

The first phase of the tests consisted of verifying the engine's electronic control strategies, since a reprogrammable electronic management system (MoTeC M800) was used. Next, the engine underwent an initial running-in and running-in cycle recommended by the manufacturer, in order to ensure that it reached its full operating condition, and then it was characterized in its original configuration and using hydrated ethanol (E100) as fuel without the addition of *Bio Booster*. The objective of this phase was to verify the initial conditions of the test object and create a reference of the engine behavior (*Baseline*) used as a reference for verification throughout the tests.

The automatic cycle configured on the dynamometer was designed based on the conditions of use of an internal combustion engine on public roads, with variable speed and load over time. It has a total duration of 2 hours and 48 minutes, in which the engine operates under different rotation and load conditions ranging from 850 RPM (idling) to 4250 RPM and loads from 0 to 100% throttle opening, simulating gear changes and stops at traffic lights.

The fuel consumption was measured at the end of each complete cycle, being the final value obtained by the difference between the initial and final mass of fuel measured by the gravimetric system used in the tests. This system has a digital scale with nominal capacity of 60 kg and resolution of 0.02 kg. It is noteworthy that the beginning of the fuel measurement was performed after the start and the engine heating phase, starting each cycle with the engine in operation regime and temperatures of the cooling system and lubricant oil stabilized.

Initially, two consecutive measurement cycles were performed with the engine fed with hydrated ethanol without the addition of the *Bio Booster* catalyst, based on anhydrous ethanol, and these results were used as a reference for engine consumption. The arithmetic mean of the results obtained in the two consecutive measurement cycles was calculated.

Following Horeb Mercosul's recommendation, CTM's technical team conducted an engine conditioning, using Hydrated Ethanol added to the *Bio Booster* catalyst, based on Anhydrous Ethanol (E100 ANI) for 50 hours of testing, according to the automatic cycle used to measure fuel consumption.

At the end of the conditioning period (50 hours), two consecutive measurement cycles were performed with the engine fed with Hydrated Ethanol Fuel added to the *Bio Booster* catalyst, based on Anhydrous Ethanol, and these results were used to determine the difference in consumption obtained with the use of this product. The arithmetic average of the results obtained in the two consecutive measurement cycles was again calculated, and these results were compared to those obtained in the previous step.

Once the experimental tests were completed, the data acquired in all tests were treated, which enabled the subsequent preparation of graphs and results, which are presented below.

3 - RESULTS

The results obtained with the engine operating in transient cycle are presented in Table 1. The values obtained with the average mass consumption of fuel are presented, with the results of the engine fed with hydrated ethanol without the catalyst (E100), as well as the results obtained with the engine fed with hydrated ethanol added to the *Bio Booster* catalyst, based on anhydrous ethanol. The results were divided by measurement cycle. The temperature values of the intake air, of the coolant at the engine outlet and of the lubricating oil in the engine crankcase were also controlled in order to make it possible to compare fuel consumption under similar conditions.

Table 1. Fuel consumption values obtained in each transient cycle with the engine fed with hydrated ethanol (E100) and with hydrated ethanol added to *Bio Booster,* based on anhydrous ethanol (E100 ANI).

Original hydrated ethanol (E100)			
	Initial Mass	Final Mass	Difference
1st Cycle	39720 g	23440 g	16280 g
2nd Cycle	33040 g	16780 g	16260 g
		Average	**16270 ± 10 g**
Hydrous Ethanol Catalyzed with *Bio Booster*, Base Anhydrous (E100 ANI)			
	Initial Mass	Final Mass	Difference
1st Cycle	20140	3100	17040
2nd Cycle	26760	9720	17040
		Average	**17040 ± 10 g**

4 - CONCLUDING REMARKS

This test report presents the results of the evaluation of the adoption of the *Bio Booster* catalyst on the fuel consumption of a spark ignition engine fed with hydrated ethanol on a bench dynamometer following a transient cycle.

This report presents the methodology used and the results obtained during this evaluation. The fuel tested was hydrous ethanol purchased in the metropolitan region of Belo Horizonte/MG in its original condition and catalyzed with the addition of *Bio Booster*, supplied by the contracting party and at a concentration of fifty parts per million (50 PPM).

After 50 hours of engine operation with Hydrated Ethanol added to the *Bio Booster* catalyst, based on Anhydrous Ethanol, a reduction of 4.5% (770 g) in total fuel consumption was verified in the transient cycle used.