



Report with Analysis of DMBs produced

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1. Executive Summary

Objectives:

Analyse the DMBs produced for their compliance to EN590 requirements and, if non-compliant, suggest means to achieve compliance.

Significant achievements:

Samples of Ethyl Levulinate (EL) received in June 2012 from UFRJ have lower water content than previous samples received. The lower content of water in the samples allowed for the preparing of blended diesel fuels that comply with the requirements of the EN 590 specification.

Blends were prepared using 5% of Ethyl Levulinate (EL) in diesel and biodiesel. YPF confirmed the blend had a reduction of two points in cetane number.

It was found necessary to add 500ppm of additive to compensate for the reduction in cetane number. Most of the parameters of the blend meet the EN590 specification. The addition of EL within the blend showed an improved performance in lubricity.



2. INTRODUCTION

EL samples produced by University of Rio de Janeiro (UFRJ) that were tested earlier in the project had too high a water content that resulted in the European standard EN590 specification limit being exceeded. UFRJ, therefore added a drying stage in the final stage of the process during the EL manufacture. This drying stage resulted in EL with a lower water content.

Samples of diesel and biodiesel containing 5% of the new DMB were prepared and these samples were evaluated according to EN 590 specification.

3. EXPERIMENTAL PART

At this stage of the work we received a new sample of the product developed at the University of Rio de Janeiro (UFRJ). The evaluated sample in the previous period had a high content of water that does not meet the European standard EN590 specification.

The new sample was subjected to a drying process at UFRJ which had a positive result which is evident in the low water content determined. (see Table 1)

Test	Method	SAMPLES		
		EL (Commercial)	EL (UFRJ) 2011	EL (UFRJ) 2012
density (g/ml) at 15°C	ASTM D-4928	1,0173	1,0178	1,0173
water content (%)	ASTM D 4052	0,07	0,73	0,01

Table 1

At this stage of the project samples of diesel and biodiesel containing 5% of DMB were prepared and assessed according to standard EN590.



The results were similar to those obtained with the sample produced by the University in 2011 (M30). They confirm the reduction of two points in cetane number in diesel and biodiesel. The good performance regarding the protection against wear, is also evident by evaluating lubricity by High Frequency Reciprocating Rig (HFRR) in standard method EN ISO 12156 from the EN590 specification. (see Table 2)

IDENTIFICATION	Especificación EN 590	GO Grade 3	GO + 5%EL	GO + 7% FAME	GO + 7% FAME + 5% EL
Density @ 15°C ASTM D 4052-02, kg/m³	820,0 – 845,0	832,9	840,7	836,2	844,3
Distillation ASTM D 86-09, °C					
<i>95 % vol. Recovered</i>	≤360	345,6	342,3		
<i>Máx.</i>					
<i>% Vol. recovered @250°C</i>	≤65	40,2	43,5		
<i>% Vol. recovered @350°C</i>	≥85	96,1	96,7		
Cetane Index ASTM D 4737-08	≥46,0	52,3	48,6		
Cetane number ASTM D 613-10a	≥51,0	54,2	52,6	53,9	51
Aromatic hydrocarbons IR / EN 12916, % p/p					
<i>Polycyclic aromatic</i>	<11				
Viscosity @ 40°C ASTM D445-09	2,00-4,50	2,567	2,386	2,643	2,463
Carbon Residue s/10% residue (Micro Método) ASTM D 4530-07, %p/p	≤0,30				
Water, mg/Kg	<200	57	70	63	93
Copper strip corrosion 3hs@50°C, ASTM D 130-04	Máx. 1				
Total contamination EN12662-08, mg/Kg	≤24				
Lubricity HFRR, CEC F-06-A-96, μm					
<i>WSD (corrected wear scar diameter)</i>	≤460	489	442	408	339
Rancimat modified EN15751-08, hs	≥20			38,79	36,41

Table 2



No miscibility problems of the DMB with diesel fuel was detected at the percentage assessed in this work. The literature reports problems of miscibility at content of around 20% of DMB.

In this period were evaluated different fuels containing 5% DMB since samples containing 10% demonstrated a too high cetane number reduction. (see Table 3)

CETANE NUMBER REDUCTION

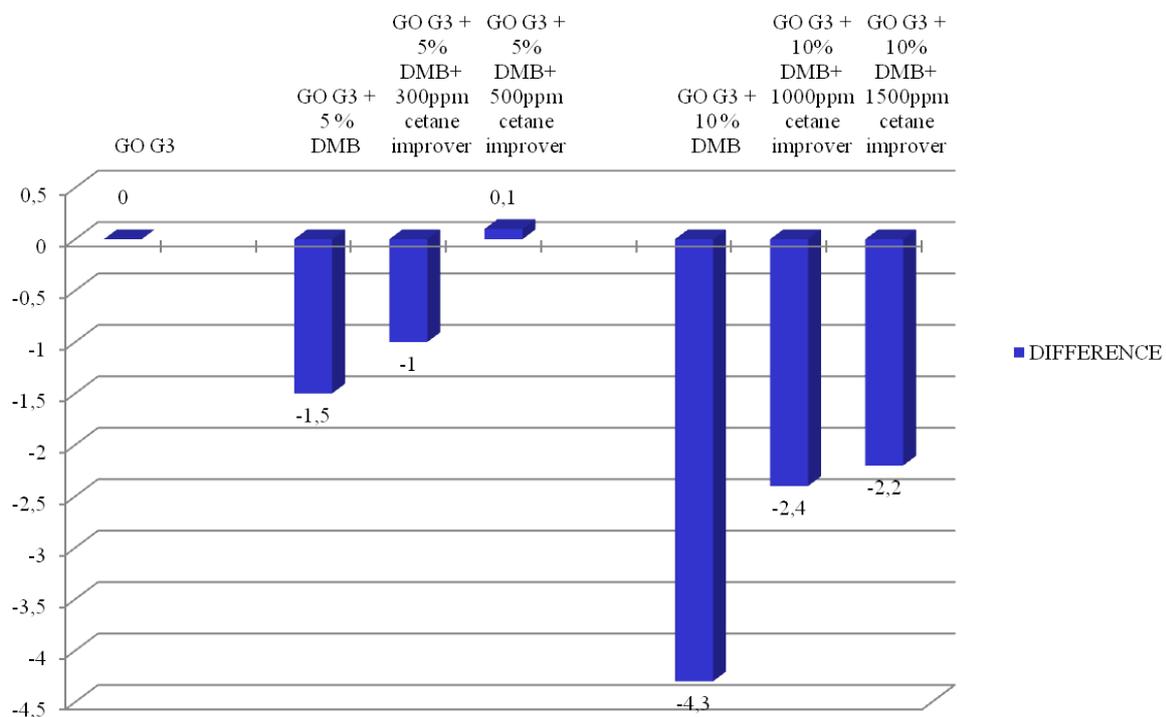


Table 3

To compensate for the reduction in the number of cetane number (ASTM D613) due to the use of DMB it is necessary to add additives in the form of cetane number improvers. It is necessary to add approximately 500 ppm of these additives.



As an extra test which was not originally included in WP5.1 YPF tested a gasoline sample with 5% of the product for compliance with specification EN 228. (see Table 4)

IDENTIFICATION	Especification EN 228	Gasoline	Gasoline+ 5% DMB
Density @ 15°C ASTM D 4052-11, kg/m ³	720-775	749	764
Research octane number, RON	95,0 min	96,2	96,7
Motor octane number, MON	85,0 min	84,7	85
Oxidation stability, minutes	360 min	800	749
Existent gum content (solvent washed) mg/100ml	5 max	<0,5	<0,5
Oxygen content % (m/m)	2,7% max	0,2	1,9

Table 4

The fuel standard and the sample prepared with 5% of DMB had a similar performance.

The sample prepared with the new DMB meets the requirements of specification EN 228.



4. CONCLUSIONS

The samples of diesel fuel and biodiesel prepared with 5% DMB met most of the requirements of the specification EN 590. YPF noticed a good performance against wear when 5% of the DMB is used in the formulation.

It's necessary to add 500 ppm approximately of cetane number improver additive to compensate for the reduction of this parameter when 5% of DMB is mixed with diesel fuel or biodiesel.

The addition of a final stage of drying to the DMB process should be assessed in order to ensure compliance with the EN 590 specification in this aspect.

Determining the cetane number is a measure of the ignition performance of a diesel fuel oil obtained by comparing it to reference fuels in a standardized engine test (EN 5165/ ASTM D 613).

In addition to these determinations, it would be interesting to test the DMB blends in an engine bench test in the future. Properties such as consumption, performance and emissions could be evaluated.

It is suggested in the future to study the use of ethyl levulinate as an oxygenate additive and test mixtures of ethyl levulinate in gasolines in order to check compliance with the EN 228 standard.