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Study Regarding Biodiesel Influence on Lubricity of Diesel Fuel

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Abstract

The new specifications of Diesel fuels involve a variable content of biofuels in order to reduce the CO_2 emissions. Biofuels have very good burning characteristics, but also some disadvantages. The ultra lo sulfur gas oils are new mixing components of Diesel fuels and despite their very good characteristics they have a lower lubricity than sulfurous gas oils. This characteristic is very important for the new cars because the fuel pump is lubricated by fuel itself and, therefore, it must be corrected by additives, but is better when a mixing component makes this work. In this paper we present the results of the study regarding the lubricity of different mixtures between ultra low sulfur gas oil and Biodiesel, by using a lubricating test system HFR2. These results show the synergic effect of Biodiesel – gas oil mixture which presents a better lubricity than each component. As a conclusion we have to recommend Biodiesel as lubricating component of Diesel fuels.

Key words: *lubricity, Biodiesel, Diesel fuels*

Introduction

The use of biofuels in automotive engines has been known for a long time, but in Europe the production and use of these fuels has been developing more seriously only just the past five to ten years. This is due to European and national policies aiming at security of supply and the reduction of CO_2 emissions. Biofuels are an important technology for reducing the emissions in transport, as they do not lead to any additional CO_2 emissions released to the air, apart from the emissions due to production and transport of the biomass and biofuels [1]. The most important application of biofuels is the Biodiesel usage as a bio-component of Diesel fuel. Applying the EU Directive CE/2003/30, each European country must introduce a different content of biofuels in the transportation fuels. Taking into account that new specifications of Diesel fuels involve the reduction of sulfur at a very low level of 10 ppm and a variable content of Biodiesel, it is compulsory to know which will be the behavior of the new formula of Diesel fuel in automotive engines. This paper investigates the lubricity of different mixtures of ultra low sulfur gas oils and Biodiesel in order to establish an optimum formulation for the final Diesel fuel.

Experimental

The lubricity of different Diesel fuels was obtained by using High Frequency Reciprocating Tester HFR2. This device is a mechanical test unit suitable for wear testing or relatively poor lubricants like Diesel fuels. The machine uses an electromagnetic vibrator to induce a small amplitude oscillatory motion in the upper mobile specimen (ball), while it also presses on the lower fixed specimen (plate). Lubricating power is appreciated by the wear spot size produced by the friction between the ball and the plate which is immersed in the tested fluid. The testing parameters are presented in the Table 1.

Table 1 – Testing parameters [2]

Characteristics	**Value**
Volume of tested fluid, ml	2±0,2
Stroke length, mm	1±0,02
Reciprocation frequency, Hz	50±1
Fluid temperature, °C	60±1
Applied weight, g	200±1
Testing time, min	75
Specimen dimensions, mm	Ball: 6 / Plate: 10

The characteristics of the tested low sulfur gas oil (LSGO) are presented in table 2, and for Biodiesel in Table 3.

Table 2 – Low sulfur gas oil characteristics

Parameter	**Method**	**Limits**	**LSGO**
Density at 15°C, kg/m^3	SR EN ISO 3675-02	820-845	842,8
Viscosity at 40°C, mm^2/s	SR EN ISO 3104-02	2,0-4,5	2,43
Cetane Index	calculation	min. 46	47,7
Flash point, °C	SR EN ISO 2719-03	min. 55	66
CFPP, °C	SR EN 116	-	- 27
Sulfur Content, mg/kg	SR EN ISO 20486-04	max. 10	7,5
Color, units Union	SR ISO 2049	-	0,5
Distillation: - %vol at 250°C	SR EN ISO 3405-03	max. 65	45
- %vol at 350 °C		min. 85	95
- 95%vol distilled:		max. 360°C	350
Copper strip corrosion (3 hours at 50°C)	-	Class 1	Class 1
Lubricity (MWSD)*, µm	SR ISO 12156-1	max. 460	360

*- MWSD = Medium Wear Spot Diameter at 60°C, corrected at standard conditions (Water vapor pressure of 1,4 kPa).

The testing procedure consists in measurements of lubricity with HFR2 machine for mixtures of LSGO and Biodiesel noted BXX, where XX is the content of Biodiesel in the mixture. Table 4 presents the test results of different mixtures between 2%v/v to 50%v/v.

Table 3 – Biodiesel characteristics

Parameter	Method	Characteristics	Limits	
			Min.	Max.
Density, kg/m^3	SR EN ISO 3675	883,3	860	900
Viscosity, mm^2/s	SR EN ISO 3104	4,9	3,5	5,0
Ester Content, %wt.	SR EN ISO 14103	97,4	96,5	-
Flash point, °C	SR EN ISO 3679	165	101	-
Sulfur Content, mg/kg	SR EN ISO 20486	3,00	-	10
Acid Value, mg KOH/g	SR EN 14104	0,20	-	0,50
Iodine Value , gIodine/100g	SR EN 14111	115	-	120
Cetane Number	SR EN ISO 5165	52,5	51	-
Lubricity (MWSD)*, µm	SR ISO 12156-1	237	-	460

*- MWSD = Medium Wear Spot Diameter at 60°C, corrected at standard conditions (Water vapor pressure of 1,4 kPa)

Table 4 – *Lubricity of LSGO-Biodiesel mixtures*

Parameter	B02	B04	B10	B15	B20	B25	B30	B50
Lubricity (MWSD), µm	323	225	190	180	169	161	154	156

Results and discussions

The lubricity of Diesel fuels is very important for the new cars because the fuel pump is lubricated by fuel itself and, therefore, it must be corrected by additives, but is better when a mixing component makes this work. The experimental data show that LSGO have a very poor lubricity (MWSD = 360 µm) and it is compulsory to add some additives to correct this value, but in our case we can observe that Biodiesel increases the lubricity of the Diesel fuel in a synergic manner, because some mixtures have a better lubricity than each mixing component (Figure 1).

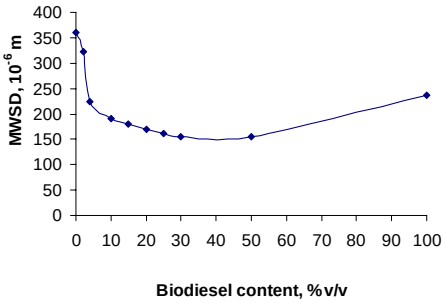

Fig. 1. Lubricity variation vs. Biodiesel content

The results of this study show that Biodiesel is a very good lubricating component and its presence in Diesel fuel will increase the fuel' lubricity. More than this, from Figure 1 it is easy to observe that the MWSD of the mixture decreases to a minimum value of 154 µm for a Biodiesel content of 30%v/v. This synergic effect is difficult to be explained and future research will try to find a relationship between this phenomenon and chemical structure of each mixing component.

Conclusions

The new specifications for Diesel fuels involve the usage of LSGO mixed different quantities of Biodiesel in order to respect the EU and national legislation. If the low sulfur content of these fuels represents a very good characteristic from the environmental protection, this could be a problem if is asked a good lubricity in the fueling pump. To correct the lubricity without additives it is possible now if an adequate quantity of Biodiesel is used. The EU legislation asks to use 5,75%v/v of Biodiesel for 2010, but this quantity is not enough to assure a good lubricity for Diesel fuel. Our study shows that the best lubricity for Diesel fuel is obtained when 30%v/v of Biodiesel is added in Diesel fuel.

References

1. *Final report of VIEWLS-WP5* (Nederland) 2010
2. V. Frangulea, D. Stanica-Ezeanu, *Licence report*, UPG Ploiesti, 2010

Studiu privind influenta Biodieselului asupra lubricității combustibilului Diesel

Rezumat

Noile specificații ale combustibililor Diesel implica un conținut variabil de biocombustibil pentru a reduce emisiile de CO_2. Biocombustibilii au caracteristici de ardere foarte bune, dar şi unele dezavantaje. Motorinele cu conținut foarte redus de sulf sunt componenți de amestec buni pentru combustibilii Diesel, dar deşi au caracteristici foarte bune, prezinta o lubricitate mai mica decât motorinele cu sulf. Această caracteristică este foarte importantă pentru autoturismele noi deoarece pompa de combustibile este unsă de combustibilul însuşi şi, prin urmare, acesta trebuie corectat cu aditivi, dar este mai bine când un component de amestec face acest lucru. In această lucrare se prezintă rezultatele studiului privind lubricitatea diferitelor amestecuri de motorină cu conținut redus de sulf şi Biodiesel, folosind un sistem HFR2 de testare a lubricității. Rezultatele arată efectul sinergic al amestecurilor Biodiesel-motorină, care prezintă lubricități superioare față de cei doi componenți de amestec. Ca o concluzie, noi vrem să recomandăm folosirea Biodieselului ca şi component de majorare a lubricității combustibililor Diesel.