Bulletin of the *Transilvania* University of Braşov • Vol. 2(51) – 2009
Series I: Engineering Sciences

# RESEARCHES REGARDING THE INFLUENCE OF BIODIESEL COMPOSITION ON THE EMISSION GASES AT ENGINES WITH IGNITION THROUGH COMPRESSION

**D. TUTUNEA[1]   M. BICĂ[1]   C. CERNĂIANU[1]**

***Abstract****: In this paper we analyses the composition of burning gases emitted by two different mono-cylindrical engines fueled with biodiesel comparative with petrodiesel. It is researched different blends of biodiesel and diesel with no loading engine and with loading engine. We notice that the main gases of burning tend to decreases when we use biodiesel in different proportion in blend.*

***Keywords:*** *biodiesel, engine, burning gases..*

## 1. Introduction

Biodiesel is a relatively clean burning ester based alternative fuel made from renewable agricultural resources, vegetable oils or animal tallow. In its pure (or neat) form, biodiesel is biodegradable, relatively nontoxic, renewable fuel source. Although pure (neat) biodiesel (B100) contains no petroleum, it can be blended in any ratio with petroleum diesel to create a biodiesel blend, that can be used in any conventional diesel engine with few or no modifications.

The most common biodiesel blend used today is referred to as B20, indicating a formulation of 20 percent biodiesel and 80 percent diesel. A biodiesel is created through a process known as transesterification, in which vegetable oil is combined with an alcohol in the presence of a catalyst or base. Recognized advantages of using biodiesel fuels include the fuel's enhanced lubricity and cetane rating, plus similar horsepower and torque as compared to petroleum diesel. By displacing the use of conventional petroleum-base transportation fuels, the use of biodiesel also contributes to the long-term national energy security goals of Romania. There are also positive environmental effects from biodiesel use.

Many studies have been reported reduction in gases with greenhouse effects when biodiesel is use net or in blend with petrodiesel fuel. In Europe is used biodiesel of rapeseed, sunflower and soy and the main producer of biodiesel is Germany. To permit the use of biodiesel without mixing and without the possibility of gelling at low temperatures, some people modify their vehicles with a second fuel tank for biodiesel in addition to the standard fuel tank. Alternately, a vehicle with two tanks is chosen. The second fuel tank is insulated and a heating coil using engine coolant is run through the tank.

[1] Dept. of ARMA Faculty of Mechanics, University of Craiova.

When a temperature sensor indicates that the fuel is warm enough to burn, the driver switches from the petrodiesel tank to the biodiesel tank. This is similar to the method used for running straight vegetable oil.

## 2. Biodiesel properties

Since biodiesel is made entirely from vegetable oil it does not contain sulfur aromatic hydrocarbons, metals or crude oil residues. The absence of sulfur means a reduction in a formation acid rain by sulfate emissions which generate sulfuric acid in our atmosphere. The flash point of biodiesel is higher then petrodiesel therefore pure biodiesel and blends of biodiesel with petroleum are safer to store handle and use. The use of biodiesel and biodiesel blends results in a notable change in exhaust odor.

Biodiesel from vegetable oil (methyl esters) contain no volatile organic compounds that will give rise to any noxious fumes. The high cetane rating of biodiesel (ranges from 49 to 62) another measure of the additives ability to improve combustion efficiency. We present some properties determined experimentally for biodiesel of rapeseed oil in the Laboratory of Chemistry of Craiova.

*Proprieties of biodiesel* Table 1

| | | |
|---|---|---|
| Density | $g/cm^3$ | 0,875 |
| Viscosity | $mm^2/s$ at $40^0C$ | 4,174 |
| Flash point | $^0C$ | 163 |
| Freeze point | $^0C$ | -9 |

## 3. Experimental research on RY 50 with no loading engine

The experimental research on this engine was done at laboratory of Thermo-dynamics and Thermal Machines of Faculty of Mechanics from Craiova. For the test we use a gas analyzer STARGAS 898 which measure different burning gases: (CO – monoxide of carbon; $0 \div 15{,}000$ % Vol.; CO2 – dioxide of carbon; $0 \div 20{,}00$ % Vol.; HC – unburned hydrocarbons; $0 \div 30000$ p.p.m. Vol.; O2 – oxygen; $0 \div 25{,}00$ % Vol.;), temperature of oil of the engine, the speed of rotation of crankshaft.

*Technical specifications for RY 50* Table 2

| | | |
|---|---|---|
| Cylinders | N | 1 |
| Displacement | $cm^3$ | 224 |
| Compression ratio | | 21:1 |
| Max. torque | Nm | 10,4@2400 |
| Rating kW/HP | N ISO 1585 | 3.5/4.8 |
| Bore | mm | 69 |
| Stroke | mm | 60 |

The experimental researches on the engine focused on the influence of modifying the biodiesel percent in petrodiesel on the emissions of pollutants gases of a mono-cylindrical engine with direct injection. The test consisted in lifting the turation (speed) characteristics of engine without load in forced regime with registration of the following parameters (carbon monoxide, carbon dioxide, hydrocarbons, oxygen, and oil temperature) for 10 speed regimes. In the tests we gradually increased the percentage of biodiesel in order to observe its effects on performance of diesel engines with direct injection and to allow their evaluation compared with classic petrodiesel. As biofuel we use biodiesel from rapeseed oil and for petrodiesel we use a Euro L Diesel purchased from Lukoil gas station from Craiova. We tested six blendes of biodiesel and Euro L Diesel (B10, B20, B30, B40, B50, and B75). In the tests we warm the engine until the sensor of temperature of the engine oil indicates $80^0C$ (the engine enters in thermal regime) and then we start to measure the emission of burning gases.

Results of experimental tests carried out are presented graphical in Figure 1 to Figure 4.

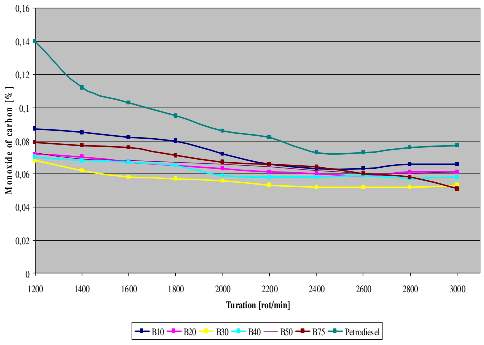


Fig. 1. *The variation of carbon monoxide function of turation for different blends of biodiesel and Euro L Diesel*

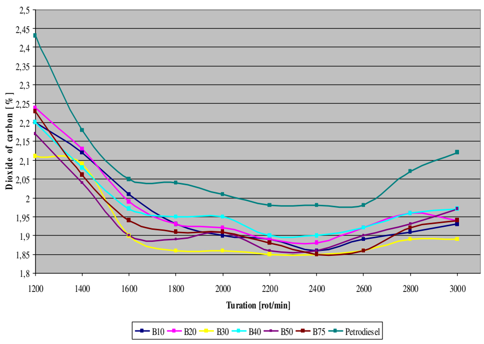


Fig. 2. *The variation of carbon dioxide function of turation for different blends of biodiesel and Euro L Diesel*

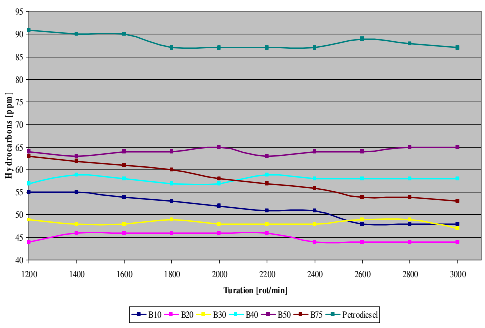


Fig. 3. *The variation of hydrocarbons function of turation for different blends of biodiesel and Euro L Diesel*

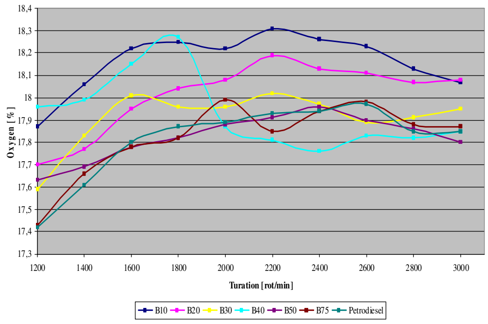


Fig. 4. *The variation of oxygen function of turation for different blends of biodiesel and Euro L Diesel*

## 4. Experimental research on KM186FA with loading engine

The experimental research on the second engine KM186FA was done also at laboratory of Thermodynamics and Thermal Machines of Faculty of Mechanics from Craiova.

The engine is part as a diesel generator Kipor 6500 E.

*Technical specifications for KM186FA* Table 3

| | | |
|---|---|---|
| Engine type | | single-cylinder, Vertical, direct injection |
| Rated power | [kW(Hp)/(r/min)] | 5.7/3000 6.3/3600 |
| Compression ratio | | 19:1 |
| Cylinder NO,-bore stroke | mm | 1-78×62 |

For this research we use an experimental stand made in the laboratory for determining the burning gases of the engine function of load.

The experimental stands for test are presented below in figure 5.

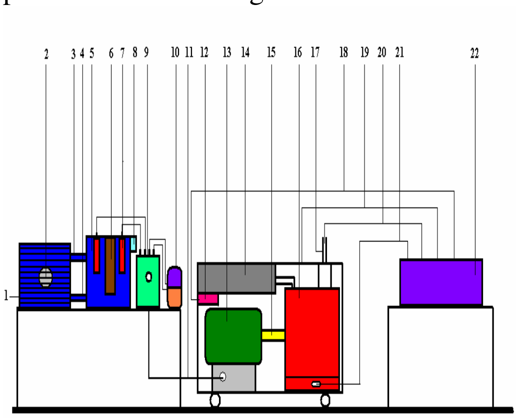


Fig. 5. *The scheme of experimental stand 1-heat exchanger; 2-fan; 3-pipe; 4-pipe; 5-oil tank; 6-oil pump; 7-electric resistance for heating (2kW); 8-control panel; 9-autotransformer adjustable; 10-voltmeter and ammeter; 11-power cable; 12-battery; 13-power generator; 14-fuel tank; 15-transmission; 16-diesel engine; 17-pipe exhaust gas combustion; 18-wire for measurement of rpm; 19-cable for mass; 20-sensor for measuring of burning gases; 21-sensor for temperature oil; 22-system of measuring emissions STARGAS 898;*

Experimental tests consisted in determining the different functional characteristics of a Diesel engine when we use biodiesel of rapeseed oil. The tests consisted in lifting characteristics depending on the load of the engine recording the following parameters (carbon monoxide, carbon dioxide, hydrocarbons, oxygen, and oil temperature) for 5 different loads. The engine of the diesel generator is loaded through an electrical resistance immersed in oil of transformer

In the tests [1] we gradually increased the percentage of biodiesel in order to observe its effects on performance of diesel engines with direct injection to allow their evaluation compared with classic petrodiesel.

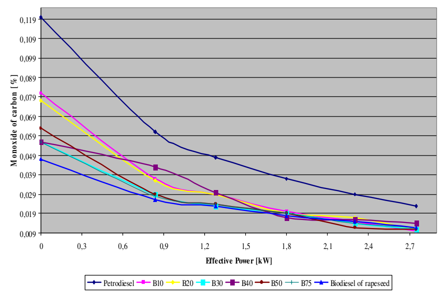


Fig. 6. *The variation of carbon monoxide depending of the load for different blends of Biodiesel of Rapeseed and Euro L Diesel*

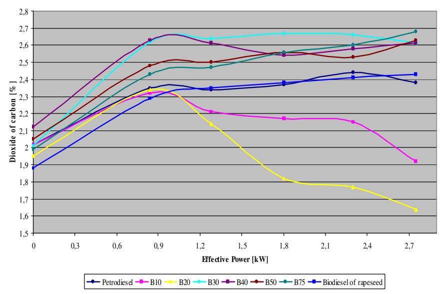


Fig. 7. *The variation of carbon dioxide depending of the load for different blends of Biodiesel of Rapeseed and Euro L Diesel*

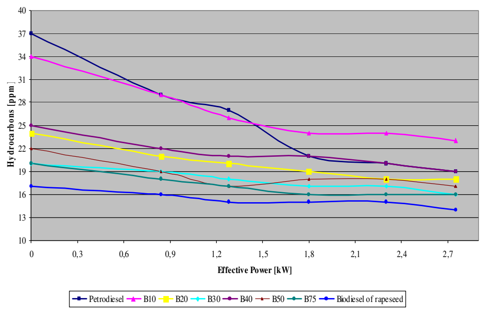


Fig. 8. *The variation of hydrocarbons depending of the load for different blends of Biodiesel of Rapeseed and Euro L Diesel*

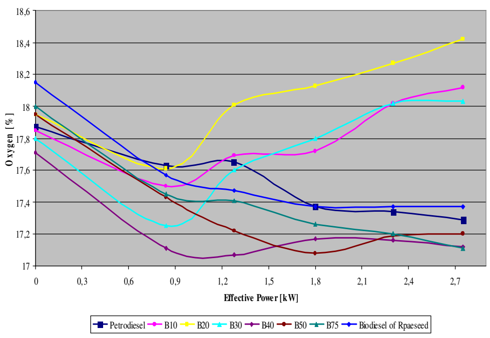


Fig. 9.*The variation of oxygen depending of the load for different blends of Biodiesel of Rapeseed and Euro L Diesel*

## 5. Results and discussion

Analyzing the results obtained in tests [1] on the engine RY 50 when is forced without load for different blends of biodiesel from rapeseed oil and Euro L diesel we can conclude that:- the emissions of carbon monoxide have a decrease in their entire range of speeds compared to diesel, with the largest reductions in the range of speeds (1200÷2200) rot./min. The best results has been achieved with a blend of 30% Biodiesel from rapeseed oil and 70% Euro L Diesel, with a reduction in average emissions of 37,04%; - the emissions of carbon dioxide have decrease in their entire range of speeds compared to diesel, with the largest reductions in the range of speeds (1200÷2000) rot. / min, the best results has been achieved with a blend of 30% Biodiesel from rapeseed oil and 70% Euro L Diesel, with a reduction in average emissions of 7,95%; - the emissions of hydrocarbons have a decrease in their entire range of speeds compared to diesel, with the largest reductions in the range of speeds (2400÷3000) rot. / min, the best results has been achieved with a blend of 20 % Biodiesel from rapeseed oil and 80% Euro L Diesel, with a reduction in average emissions of 49,01%; - the oxygen increase and the best results are obtained for a mixture of 10% Biodiesel from rapeseed oil and 90% Euro L Diesel with the highest values with a medium value of 1.91%.

By analyzing the results from tests on the engine KM186FA of the Kipor generator 6500 E with load for different blends of biodiesel from rapeseed oil there are the following results:

- the emissions of carbon monoxide have a decrease function of load with the increases of biodiesel content of blend, so good results are observed for all mixtures with a reduction in average 46.81%. The best results are obtained for biodiesel from rapeseed oil with an average reduction of 52.95%;
- in carbon dioxide emission we notice varying results, so it is a reduction of emissions for blends with 10% of 20% content of biodiesel of rapeseed, with an increase in $CO_2$ emissions for the other blends. Biodiesel from rapeseed is characterized by a reduction in

emission at low power with increasing emission at higher power;

- the emissions of hydrocarbons have a reduction for most blends and the best results has been achieved for biodiesel of rapeseed;
- the emission of oxygen is characterized by both an increases and decreases compared to petrodiesel.

## 6. Conclusions

Based on the analysis of functional parameters of the engine fueled with biodiesel fuel, it can be affirmed that the alimentation with biofuels can provide performance comparable to those achieved with diesel on the characteristic of speed and load.

It was been analyzed different blends of biodiesel of rapeseed tested in separate two monocylindrical engines with load and no load.

In general, combustion is more efficient for the use of these biofuels compared to diesel, because of the presence of the oxygen in molecule of ester.

The results depend on the type of engine (with direct injection or indirect, with normal or admission surcharge), the operating conditions (load, speed), fuel quality, but shows a decrease in overall emissions of CO, $CO_2$, HC and an increases in $O_2$ due to the higher content in oxygen of biodiesel.

## References

1. Tutunea, D.: *The use of unconventional fuels in engine with internal burning*. In: Doctoral Thesis, 2009.
2. Peterson, C. L., Hammond, B., Reec, D., Thompson, J., Beck, S.: *Performance and durability testing of diesel engines using ethyl and methyl ester.* Department of Biological and Agricultural Engineering, University of Idaho, Idaho 83844-2060. 126 p.
3. Tat, E.T.: *Investigation of oxides of nitrogen emissions from biodiesel-fueled engines. A dissertation submit-* S. Lebedevas, A. Vaicekauskas / TRANSPORT – 2006, Vol XXI, No 2, 80–87