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INVESTIGATION OF THE EFFECTS OF WALNUT BIODIESEL ON A DIESEL ENGINE EXHAUST EMISSIONS

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Abstract

Diesel engines are the most efficient thermal machines capable of reaching up to approximately 40% of thermal efficiency. Different studies are carried out to increase the efficiency of diesel engines and also to reduce environmental pollution. The studies aimed at improving the combustion process constitute the most important part of them. As is known, with the improvement of combustion process; Besides increasing the efficiency of the engine, environmental pollution is also reduced. For this reason, in recent years to improve combustion process in diesel engines; Both structural (conconstructive) studies and fuel-related studies are underway. Structural works include exhaust manifold designs, improving the shape of the combustion chamber, increasing the valve count and Valve section area, regulations and improvements in the spraying system, the expansion of the turbocharger application, etc. Located. In the studies related to fuels; More economical use of existing fuels and studies on different alternative fuels can be given as examples. In this study, Biodiesel was produced from walnut oil by transesterification method. The walnut biodiesel is then mixed with the Eurodiesel fuel, which will be 7% (B7) and 10% (B10) by volume. Eurodiesel fuel was accepted as comparison fuel. Diesel engines with common-rail fuel system were used in the experiments. The results of the tests were compared with the emission values of CO, CO_2, HC, O_2, smoke and NOx with Eurodiesel fuel values.

Keyword: Walnut, biodiesel, engine, emissions

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1. Introduction

Because biodiesel is chemically similar to diesel fuel, you can incorporate biodiesel directly into the fuel tank of any diesel vehicle [1]. There are many advantages to using biodiesel as a vehicle fuel. Biodiesel is found to be less emissions, produced with its own country resources without external dependence, does not affect the performance of the engine and is obtained from plants. Biodiesel can be defined as solar-powered liquid fuels as plants grow with solar energy [2,3].

Biodiesel thermal value is very close to the thermal value of the engine and the number of Biodiesel Cetane is higher than the number of the array [4]. With the use of biodiesel, the engine operates with less of a hit, while the specific fuel consumption, power and torque values close to the string are achieved. The biodiesel engine has better lubrication characteristics than power-reducing deposits and diesel [5].

Biodiesel is a good solvent. It can solve some paints in contact with painted surfaces. Due to the ability to solve biodiesel, the insulating elements used in diesel engine should be replaced and used with substances that biodiesel cannot solve [6].

Walnut is a versatile plant that can grow naturally in our country, fruit can be evaluated at the same time as timber, leaf and green shells. Turkey walnut (Juglans regia L.) is one of the country home of the plant. It is reported that the existence of walnut trees in Anatolia and its production are based on at least 3000 years ago and even transported them to other growing areas in the world [7]. In many parts of our country, walnut trees are considered as great and festivals are organized on behalf of them. Walnut is a long-lived plant that can grow in every region of our country. Unlike other fruit varieties, the ability to produce fruit without the necessity of hanging is the main reason for walnut being a widely grown fruit. In addition, the valuable form of timber was also a factor in widespread walnut breeding in Anatolia [8,9] .

In this study, a four-stroke, common-rail fuel system, a water-cooled, 4-cylinder diesel engine, the effects of biodiesel engines on engine emissions were investigated. The results were evaluated by comparison.

2. Material and Method

Biodiesel was produced from walnut oil used in this study using transestrification method. Two mixtures are considered in the volumetric mixture. These;

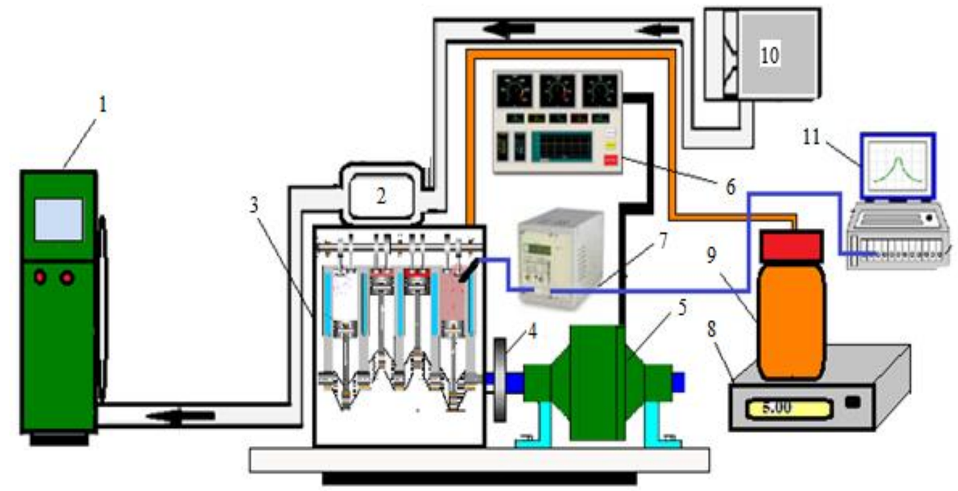
1. 100% Diesel (witness fuel)

2.% 7 Biodiesel +% 93 Eurodiesel

3.% 10 Biodisel +% 90 Eurodiesel

Experiments were carried out on the engine with common rail fuel system with these prepared mixtures. The work on biodiesel blends in engines with common-rail fuel systems is quite new. If it is related to walnut biodiesel, the work done is very few.

The experiments used a diesel engine with a four-stroke, four-cylinder, electronic fuel injection system with a common-rail fuel system. The test setup used in the study is shown in Figure 1 Technical specifications of the engine used in the survey Table 1 shows the characteristics of the engine dynamometer Table 2 and Table 3 show the specifications of the exhaust emission device.



1. Emission Device	5. Hydraulic Dynamometer	9. Fuel Tank
2. Turbocharger	6. Control Panel	10. Orefiz Plate
3. Test Engine	7. Charging Amplifier	11. AVL Cylinder pressure gauge
4. Mesh	8. Precision Balance	

Figure 1. Schematic view of the test set

Table 1. Technical specifications of the engine used in the study

Engine	**1.9 Multijet**
Number of cylinders and layout	4, a single row of the front transverse
Cubic capacity (cc)	1910
Compression ratio	5.18: 1
Maximum power hp - d / d	105 - 4000
Maximum torque Nm (kgm) - d/d	200 - 1750
Fuel	diesel
Fuel supply	Electronically controlled Common Rail type MultiJet direct injection, turbocharger and intercooler
Ignition	compressional
Bore x Stroke (mm)	82 x 90.4

Table 2. Technical specifications of the engine dynamometer

Model	BT-190 FR
Capacity	100 kW
Maximum speed	6000 rpm
Maximum torque	750 Nm

A Bosch BEA 350 emission device was used to measure emissions of exhaust gases. Technical specifications of the emission device are given in Table 3.

Table 3. Technical specifications of the exhaust emission device

Parameters	Measurement Range	Precision
HC	0-20.000 ppm	1 ppm
CO_2	0-20%	0.1%
CO	0-15%	0.001%
O_2	0-21.7%	0.01%
NOx	0-5000 ppm	1 ppm

The engine is heated to the operating temperature before starting the measurements. The experiments were performed at a full throttle position in different engine cycles. First, the experiment was performed using Eurodiesel fuel. Then the other fuels in volume were used in the B7 and B10 mixtures respectively.

3. Results and Discussion

The main reason for the presence of CO among combustion products is the inadequacy of oxygen or the absence of complete combustion. Figure 2 shows the variation of % CO in the exhaust gases with respect to engine dynamics in the use of biodiesel-Eurodiesel fuels mixtures. When the figure is examined, it is seen that the amount of CO increases a little as the cycle increases. B10 fuel use seems to have decreased by more than 28% in CO values. This reduction is due to the presence of oxygen in the content of biodiesel.

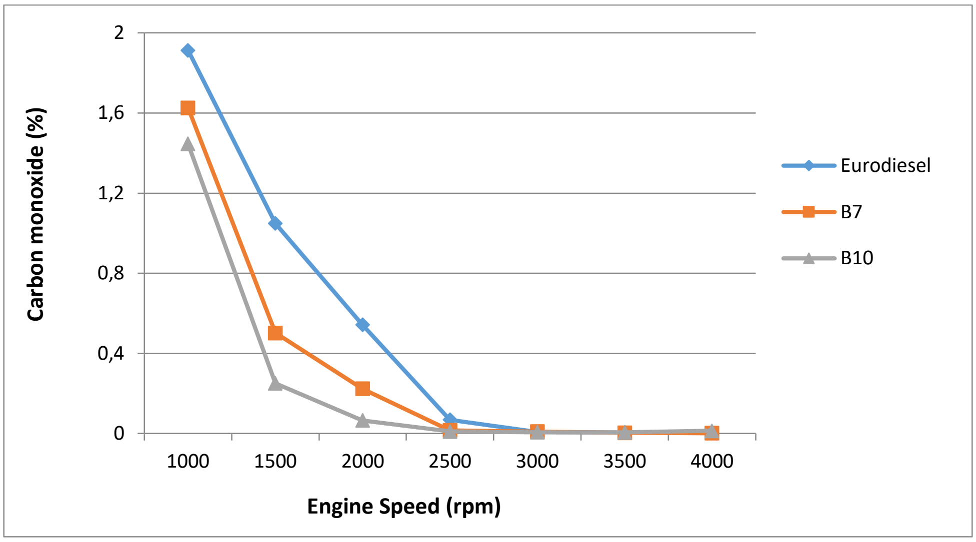


Figure 2. CO change according to engine speed

The variation of CO_2 values in the exhaust gases with respect to engine dynamics is shown in Figure 3. The increase in the amount of CO_2 in the exhaust gases shows a good combustion. With the use of biodiesel and Eurodiesel mixtures, CO_2 emissions have been reduced by up to 14%. This decrease can be explained by the impoverishment of the mixture due to the presence of O_2 in the content of biodiesel.

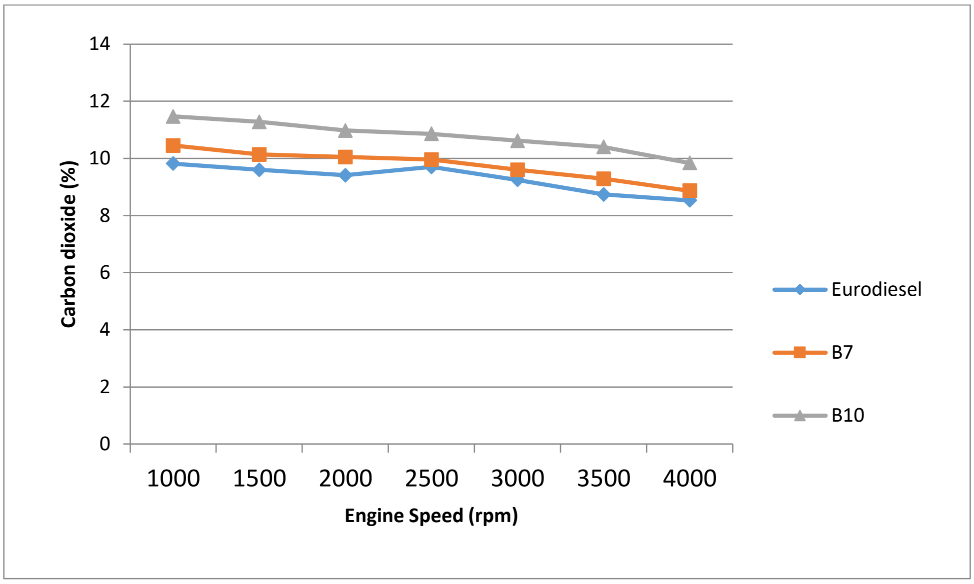


Figure 3. Change of CO_2 according to engine speed

HC means unburned fuel. The use of biodiesel-Eurodiesel mixtures in Figure 4 shows a change in HC values according to different engine revolutions. The lowest HC value was measured in the use of B7-B10 fuel. In the use of Eurodiesel fuel, HC values decreased by more than 50%. This situation suggests that combustion is better.

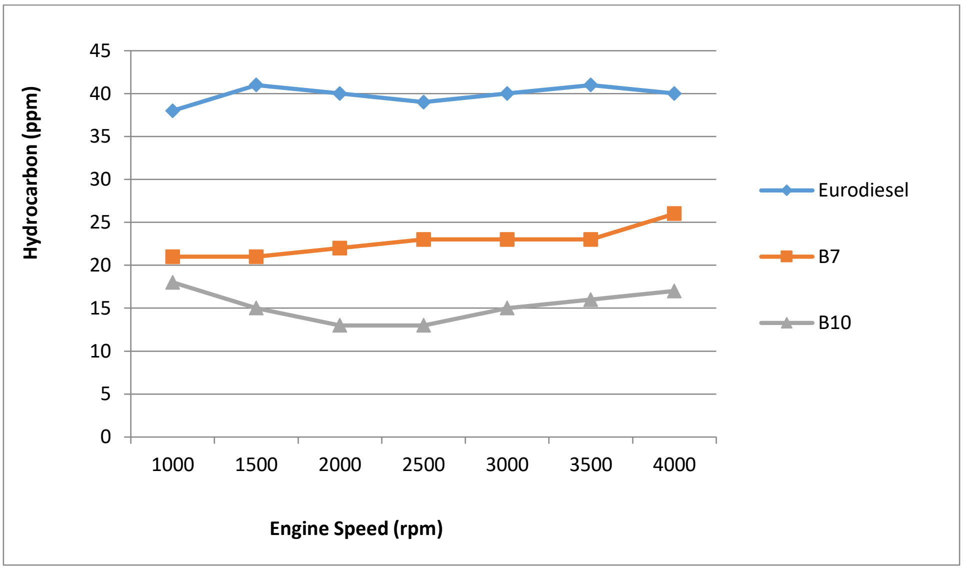


Figure 4. HC change according to engine speed

Oxygen values (O_2) change in exhaust gas according to engine rpm has given in Figure 5. At 1000 rpm lowest O_2 values recorded on Eurodiesel, and highest recorded on B100. Increasing engine speeds caused a little drop in O_2 until engine reached 2000 rpm but after engine speed passed 2000 rpm O_2 level started to increase. Since biodiesel contains more O_2 compared to eurodiesel, it shows higher O_2 values on biodiesel mixture fuels.

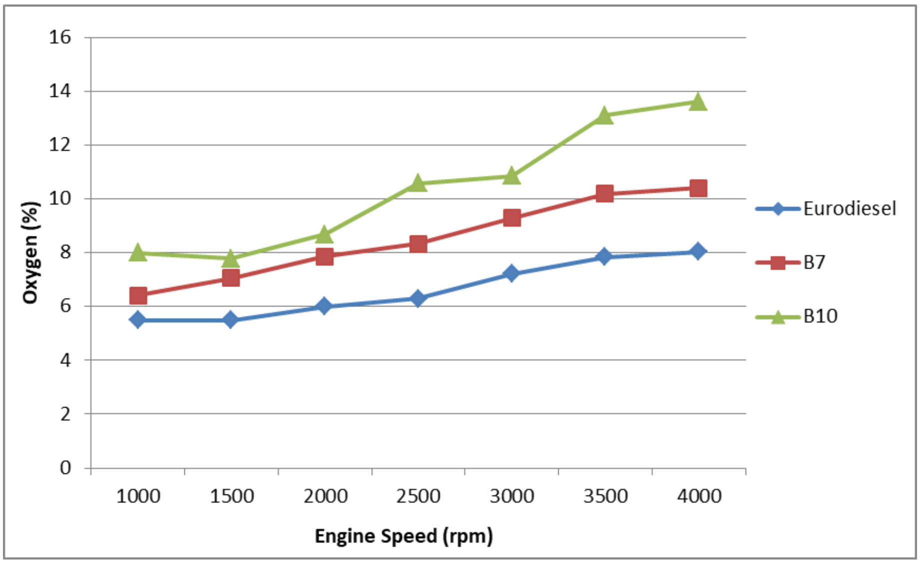


Figure 5. O_2 (%) value

In Figure 6, the use of bioethanol-unleaded gasoline mixtures shows a change in NOx values relative to different engine revolutions. The highest NOx value was measured in the use of B7-B10 fuel. The use of this fuel has shown that NOx values increase by more than 10%. This is expected because of the presence of oxygen in the biodiesel.

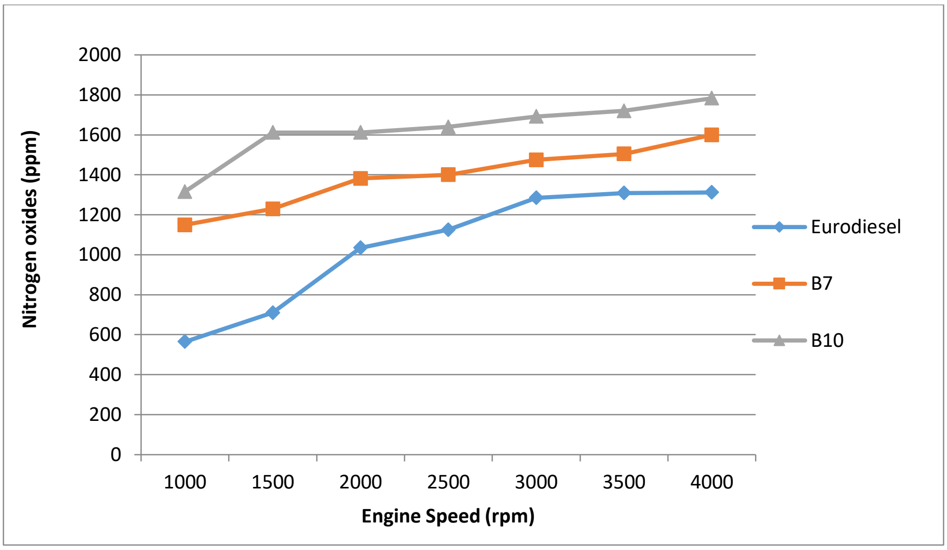


Figure 6. NOx change according to engine speed

Change in smoke emission values is given in Figure 7. If reviewed, highest exhaust gas smoke emissions recorded on 1000 rpm. Smoke emissions decrease with the increase of engine rpm. The lowest emissions recorded on B10 fuel. Smoke emission decreases according to biodiesel percentage increase in fuel mixtures.

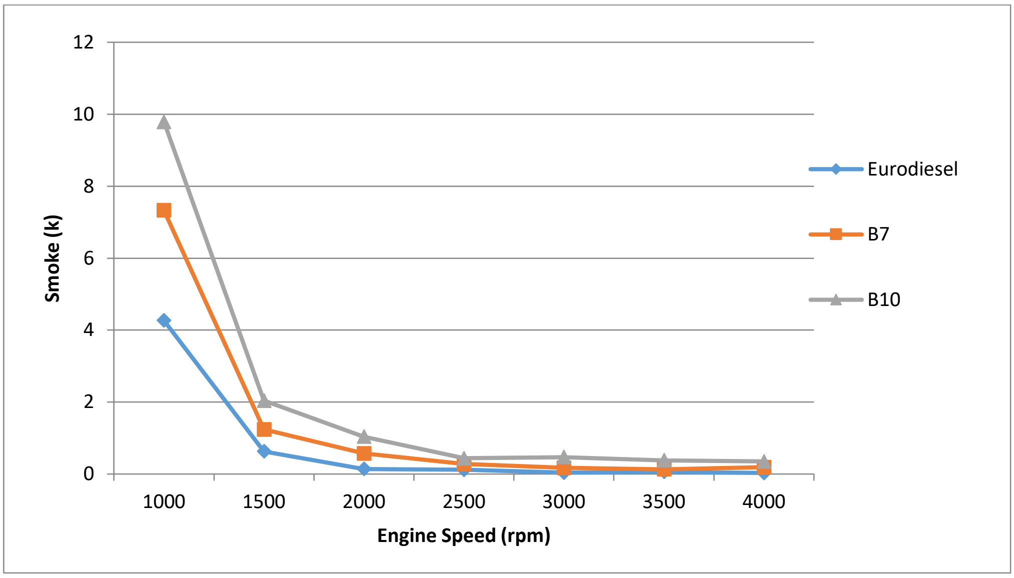


Figure 7. Smoke emission value of fuel

4. Results

This study was done with, eurodiesel and safflower oil product biodiesel mixtures. This fuels are Eurodiesel B7, B10 mixtures. This mixture was used on a diesel engine with common-rail fuel system and emission values of these fuels reviewed. So, the result are:

1. Lowest CO values recorded with B10 which is 28% lower than Eurodiesel.
2. Highest CO2 values recorded with B100 which is 14% higher than Eurodiesel.
3. Lowest HC values recorded with Eurodiesel and highest recorded in B10.
4. Lowest O2 values recorded with B0 fuel and the highest O2 value recorded with B10 which is 30% higher than Eurodiesel.
5. Highest NOx value recorded with B10 which is 40% higher than Eurodiesel.
6. Increase in biodiesel percentage of mixtures leads to smoke emission to diminish.

This study shows that biodiesel fuel on diesel engine reduces NOx emissions every other. Adding more biodiesel to eurodiesel fuel, highly affects vehicle emissions is the most important polluter of the world, so show us the importance of cleaner fuels sharper.

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