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Emissions of a Diesel Engine Fueled with False Flax Biodiesel – Diesel Fuel Blends

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Abstract

False flax is a new crop for biodiesel production and has a potential of being feasible raw material as a renewable energy source. In this study, emission characteristics of false flax biodiesel operating on compression ignition engine were performed. Methyl esters were produced by transesterification of false flax oil (FFME) with methanol in the presence of a catalyst (NaOH). The emission characteristics of B10, B20, B100 and diesel fuels were studied. False flax biodiesel improved the carbonmonoxide (CO) and carbondioxide (CO2) emissions which have dangerous effects on the environment. FFME increased the NOx compared to diesel fuel due to its better combustion characteristics and oxygen content. Consequently, False Flax oil, might be a feasible energy source for the compression ignition engines.

Keywords: *Biodiesel, False Flax Oil, Emission Characteristics, Fuel*

1. Introduction

Biodiesel, renewable clean bio-energy, can be produced from vegetable oils, animal fats or used cooking oil which is reacted with alcohol to form esters (biodiesel) and glycerol (Ozcanli et al., 2011 and Serin et al., 2013). As a non-toxic, biodegradable, and renewable alternative diesel fuel, vegetable oil esters are receiving attention (Ozcanli et al., 2012).

Renewable energy sources are attracting more attention due to lower cost and lower pollution relative to fossil fuels (Demirbas, 2010; Gerpen et al., 2004; Ozcanli et al., 2012; Ozcanli et al., 2011; Serin et al., 2013).

Camelina sativa is a new crop with a variety of uses. It is relatively easy to grow with low input costs. It is a spring annual broadleaf oilseed herb of the Brassicaceae family that grows well in moderate climates. Its meal valuable as animal feed, and its oil has important nutritional compenents (alpha linolenic acid and gamma-tocopherol). Camelina seed contains 30-40% oil that could be used as a fuel (Stanisław W. Kruczynski, 2012).

The aim of this study is to investigate the emission characteristics of false flax (Camelina Sativa) biodiesel (FFME) operating on compression ignition engine. Biodiesel was produced from the false flax by transesterification of the crude oil with methanol in the presence of NaOH as a catalyst.

2. Experimental

The experimental study was conducted in Petroleum Research and Automotive Engineering Laboratories of the Department of Automotive Engineering at Cukurova University. False Flax oil is used as a raw material for biodiesel production. The samples of false flax were supplied from a local oil company, Gaziantep, Turkey.

False flax oil methyl ester (FFME) was produced via the transesterification method. In this reaction, methyl alcohol and sodium hydroxide (NaOH) were used as reactant and catalyst. In the reaction, molar ratio of alcohol to oil was 6:1. In this study, two mixtures of false flax biodiesel (FFME) - diesel fuel (D) were evaluated as test fuels. These fuels are 10% FFME-90%D, 20% FFME-80%D, 100% FFME which are called B10, B20 and B100, respectively. Test fuels were mixed on volume basis. After the preparation of test fuel blends, the experiments were evaluated on a compression ignition engine and emission characteristics of fuels were investigated. The technical properties of compression ignition engine and diesel emission analyzer are shown in Table 1 and Table 2.

Table 1.Technical properties of the engine

Brand	Mitsibushi Center
Model	4D34-2A
Configuration	Inline 4
Type	Direct injectiondieselwithglowplug
Displacement	3907 cc
Bore	104 mm
Power	89 kW@3200 rpm
Torque	295 Nm@1800 rpm
AirCleaner	Paper element type
Weight	325 kg

Table 2.Technical specifications of Testo 350-S diesel emission analyzer

Parameter	Unit	Measuring Range	Accuracy
O_2	%	0-25	0.01
CO	ppm	0-10,000	1
CO_2	%	0-50	0.01
NO	ppm	0-3,000	1
H_2S	ppm	0-300	0.1
NO_2	ppm	0-500	0.1
SO_2	ppm	0-5,000	1
HC	%	0-4	0.001
Temperature	^oC	40-1,200	0.1
Combustion Efficiency	%	0-120	0.1

3. Results and Discussion

Emission characteristics of FFME and fuel blends operating on compression ignition engine were determine by TESTO-350 diesel emission analyzer. Figure 1,2 and 3 shows the CO, CO_2 and NO_X emission characteristics, respectively. The fuel properties of biodiesel promote combustion process and improve exhaust emissions such as particulate matter, carbon monoxide (CO), sulfur oxides (SO_x), and unburned hydrocarbons (HC) (Van Gerpen 2005; Lapuerta et al. 2008a; Meng, Chen, and Wang 2008; Jeong, Yang, and Park 2009; Aksoy et al. 2011).

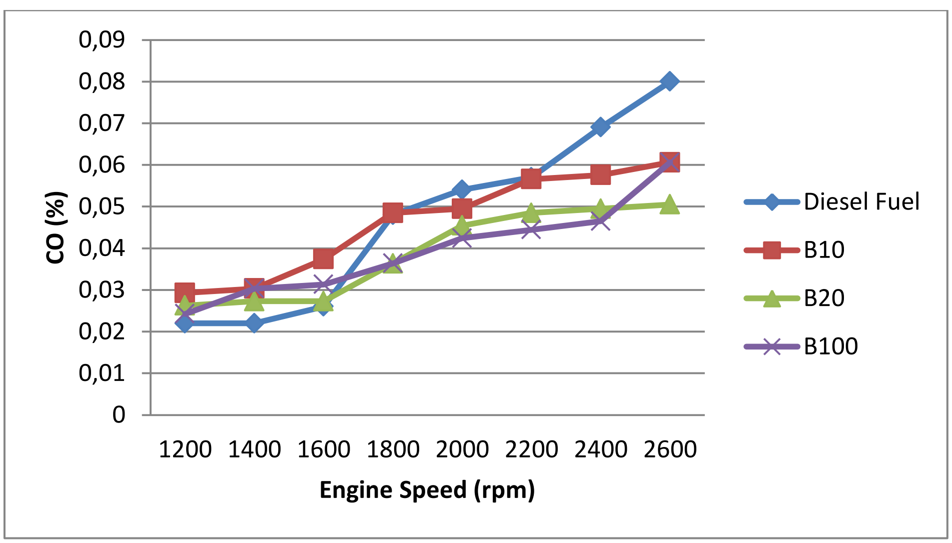

Figure 1. CO (%) characteristics of experimental fuels

Results shows that FFME (B100) usage decreased the CO emissions 16,38% in the means of average CO emissions compared to diesel fuel due to oxygen content of FFME.

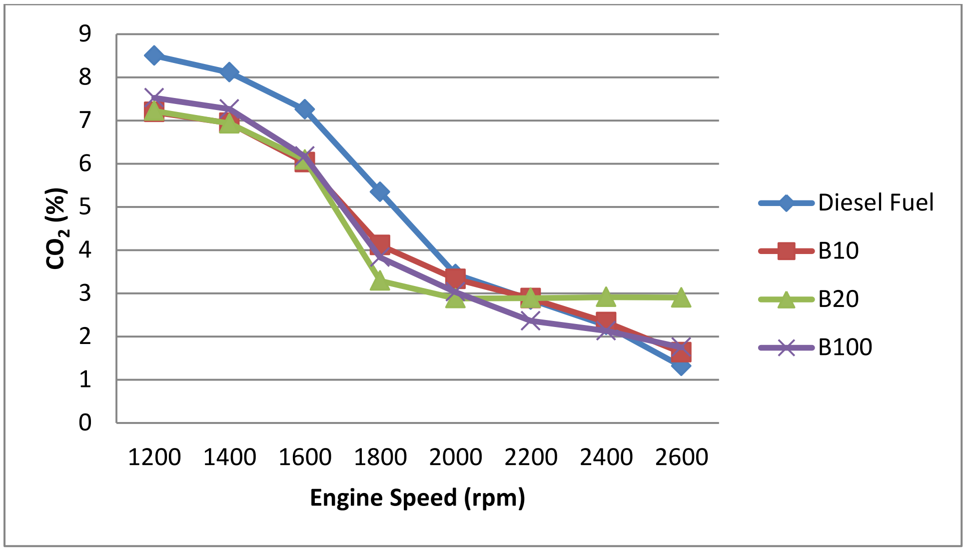

Figure 2. CO_2 (%) characteristics of experimental fuels

Results shows that FFME (B100) usage improved the CO_2 emissions 14,82% in the means of average CO_2 emissions compared to diesel fuel. In comparison with the diesel fuel, usually CO_2 emissions are decreased depending on the rate of biodiesel in the test fuels because of the lower elemental carbon to hydrogen ratio of biodiesel against to diesel fuel (Serin and Akar, 2013).

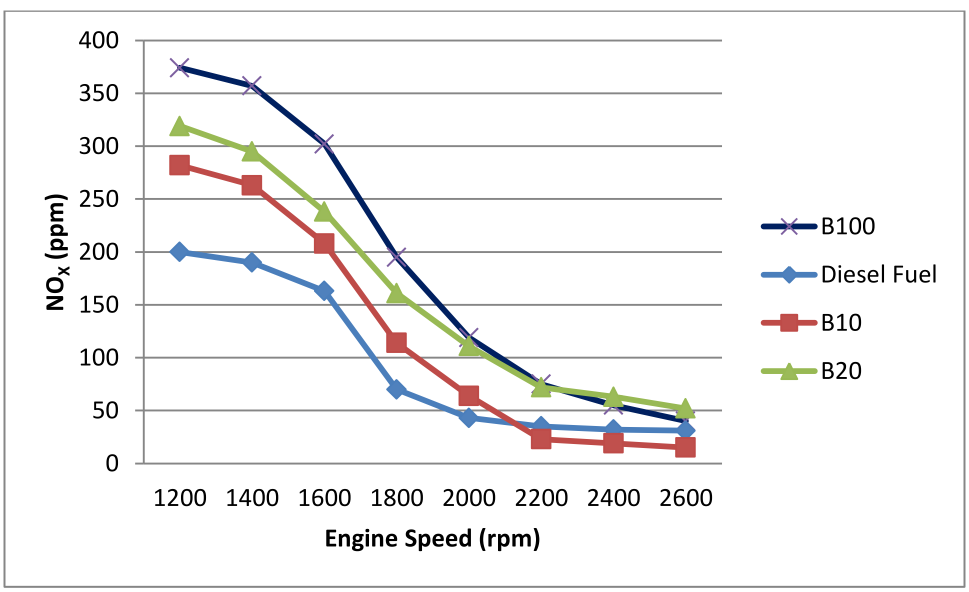

Figure 3. NO_X (ppm) characteristics of experimental fuels

Experiments shows that FFME usage in compression igniton engine increased the NO_X emissions. Experiment showed that FFME increased the NO_X emissions 98,56% in the means of average NO_X emissions. The reason for the increase of NOx emissions is the higher oxygen content of biodiesel, which provides better combustion, and as a consequence, the combustion temperature increases. NOx emissions are directly related with combustion temperature, thus, NOx emissions are increased (Ozcanli et al., 2015).

4. Conclusions

False flax (Camelina Sativa) biodiesel (FFME) and its blends with diesel fuel were used as fuel on compression igniton engine and emission characteristics of experimental fuels were determined. FFME usage increased NO_X and CO_2 emissions compared to diesel fuel however, FFME improved the CO emissions which has very dangerous effects on environment and human healt. Results showed that FFME might be alternative fuel or fuel additive for compression ignition engines.

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