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Prospective of Chicken Fat Biodiesel as a Fuel for Diesel Engines

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Abstract - Fossil fuels have played an important role as an alternative fuel to conventional fossil fuel. There are many issues like air pollution, global warming and foreign oil dependence as far as fossil fuels are considered. This work aims to control the excessive fuel consumption and, in a way, tackle the issue of leftover animal waste. Performance of animal fat biodiesel is checked by introducing it to a variable compression ratio engine to find an optimum compression ratio at which the lowest emission levels and maximum efficiency can be obtained. Experiments were conducted with the mixture of animal fat biodiesel and performance characteristics and emissions are evaluated for fuel mixture, with additive and with heating. Finally, the results were analysed to find a fuel blend combination which can help in large reduction in oil demands, greenhouse emissions and improved fuel economy using biofuels.

Key Words: 1 Animal fat biodiesel, 2 FAME, 3 UHC, 4 Particulate Matter, 5 Opacity, 6 Glycerol

1.INTRODUCTION

Many investigations by various researchers have shown that using biodiesel in diesel engines can reduce unburned hydrocarbon (UHC), carbon monoxide (CO) and particulate matter (PM) emissions and increases nitrogen oxides (NOx) emissions. NOX formation during combustion is affected by higher temperature and oxygen content in the fuel or biodiesel. Recently, biodiesel have received a great attention because of its biodegradability and its classification as a resource for renewable energy. Biodiesel is composed of fatty acid methyl/ethyl esters (FAME) and is synthesized usually via vegetable oil (triacyl glycerol) trans-esterification with low molecular weight alcohols. The directives regarding the use of biodiesel around the world are mostly based on biodiesel-diesel blend. The addition of combustion enhancer additives is the most perceptible option to introduce the biodiesel as complete alternative for diesel and its availability and sustainability are the determinants in the popularization of biodiesel. Contrary to its advantages, the biodiesel has some disadvantages like higher viscosity, higher pour point, poor cold flow properties and lower volatility and gum formation in injector tips and combustion chamber when compared with diesel. Also, it creates problems of gum like deposits in the injector tips and combustion cylinder. Additives like Di ethyl ether and ethanol are expected to improve low temperature flow properties. Percentage of oxygen content in the biodiesel fuels is the most significant factor for Particulate Matter (PM) reduction when they are used as fuels.

1.1 Experimental Set up

The experimental set up consists of a Variable Compression Ratio (VCR) engine whose compression ratio can be varied from 5:1 to 20:1, with AVL make DI Gas analyser and AVL smoke meter to analyse the performance and emission characteristics. In this work, we investigate the emission and performance characteristics of fuels like diesel, blends of diesel-biodiesel with and without additive 2-Ethyl Hexyl Nitrate. The performance and emission characteristics like Brake Thermal Efficiency (BTE), Break Specific Fuel Consumption (BSFC), Pressure Vs Crank Angle Diagram (P-θ), Hydrocarbon (HC), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Oxides of Nitrogen (NOx), and Smoke Opacity values were experimentally found and later analyzed. All experiments were performed at time slots between 11 am to 3 pm and repeated a number of times to reduce the errors in readings. Also, all experiments were completed at a Compression Ratio of 18 (CR18). The engine specifications were given in the table below.

Engine Specifications

No: of Cylinders	1
Injection Type	Direct Injection
Cooling System	Water - Cooled
Bore	0.08m
Stroke	0.11m

Piston Offset	0.00002m
Connecting-rod Length	0.235m
Compression Ratio	18:1

Fuels Tested

1. Diesel (CR18D)

2. Diesel + 20% Animal Fat Biodiesel (CR18 B)

3. Diesel + 20% Biodiesel + 5% 2-EthylHexyl-Nitrate (CR18A)

1.2 Experimental Procedure

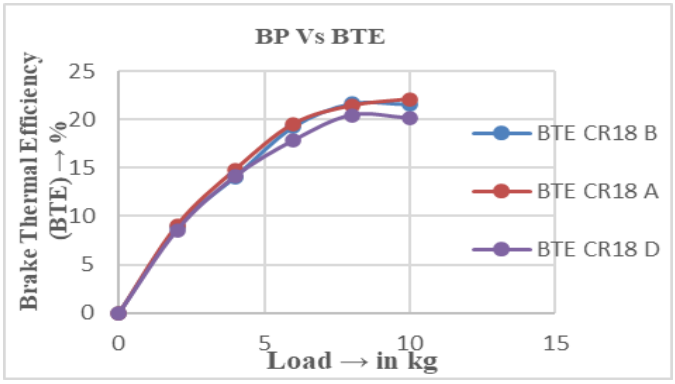
Initially diesel was tested in the VCR engine at a compression ratio of 18 for which the NOx levels were the lowest compared to other compression ratios. Then animal fat biodiesel was blended with diesel and then the emission and performance characteristics of fuel blends were measured at a rated speed of 1500 rpm at no load and varying Brake Power conditions. The outputs were accessed by various sensors attached to the VCR engine and the datas were recorded by the data acquisition software to the computer unit. The BTE, BSFC of the engine, as well as cylinder pressure values were obtained directly from the unit attached to the engine. The AVL DI gas analyzer gave a reading of the Emission parameter levels present in the exhaust. Then an additive 2 Ethyl Hexyl Nitrate was added to the fuel blend to improve its properties Each test was repeated three times and the values were averaged to improve reliability.

2. RESULTS AND DISCUSSIONS

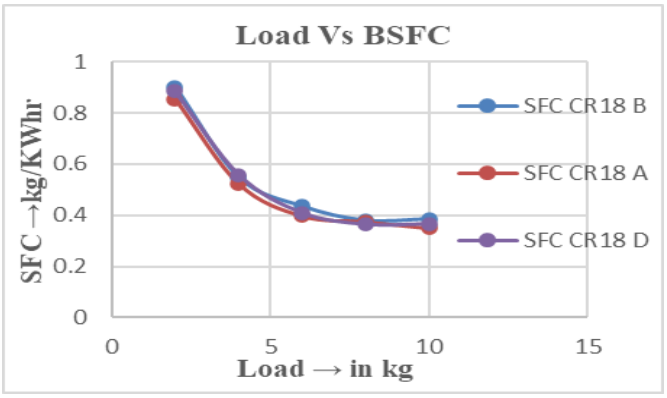
The results obtained from the experimental investigations on Performance and Emission parameters using Diesel (D), Chicken fat biodiesel blend (B20), and Chicken fat biodiesel blend with Additive (A) were analyzed and plotted in this section. The obtained results in BTE, BSFC, HC, CO and NOx emissions were found promising for the tested fuel with and without additive.

2.1 Performance Characteristics

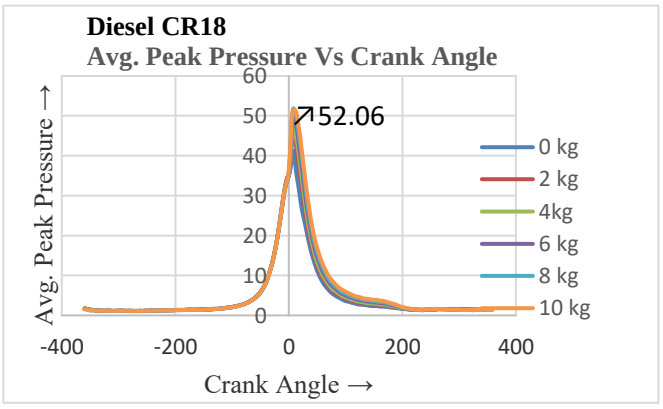
2.1.1 Brake Power Vs Brake Thermal Efficiency

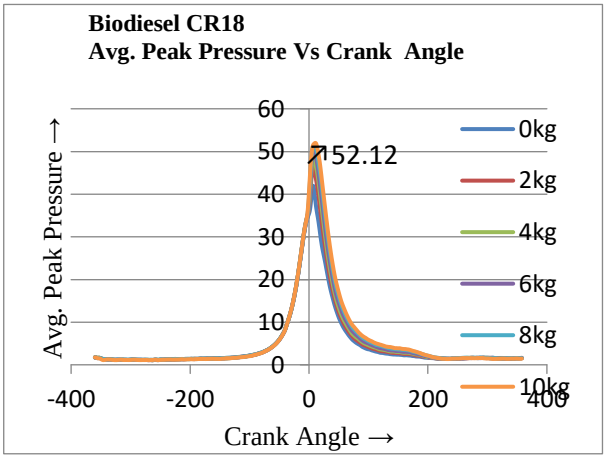


2.1.2 Brake Power Vs Brake Specific Fuel Consumption



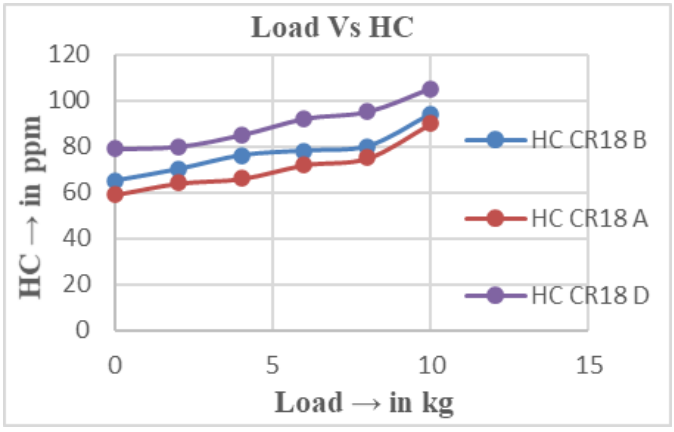
2.1.3 Pressure Vs Crank Angle



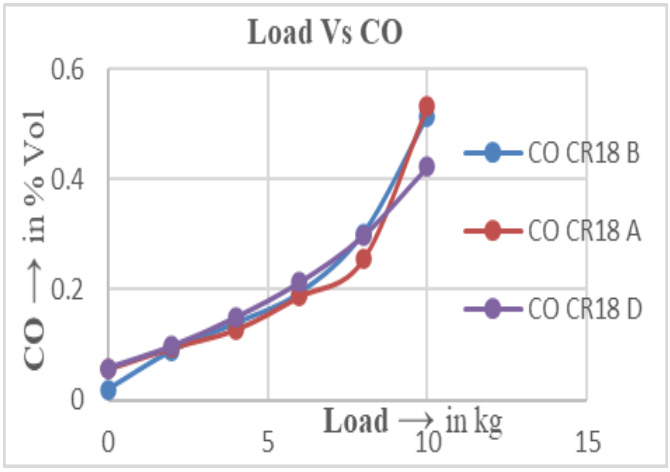


2.2 Emission Characteristics

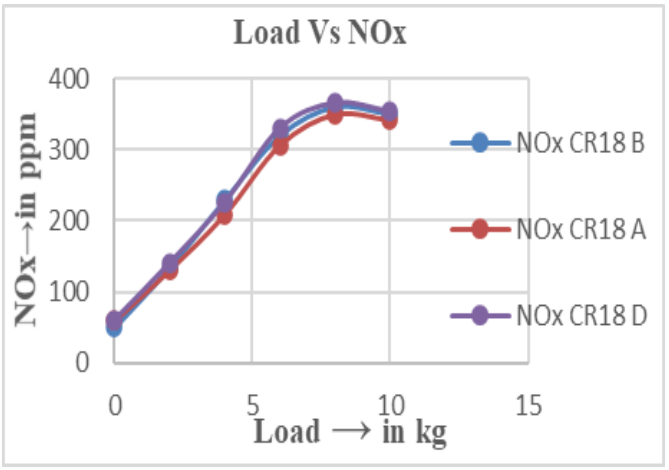
2.2.1 Brake Power Vs Hydrocarbon



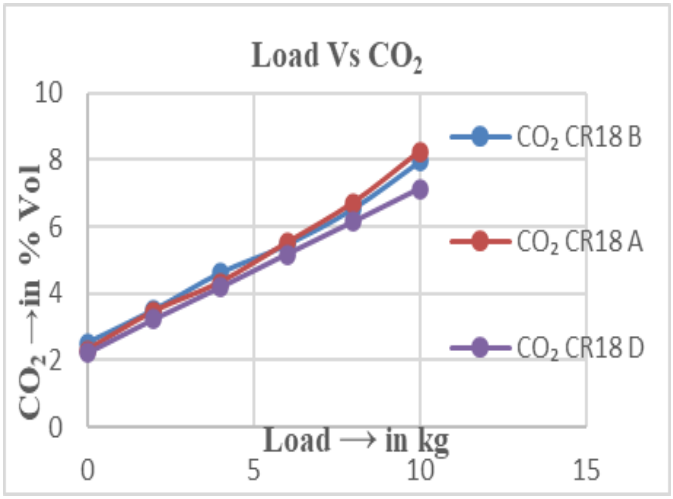
2.2.2 Brake Power Vs Carbon Monoxide



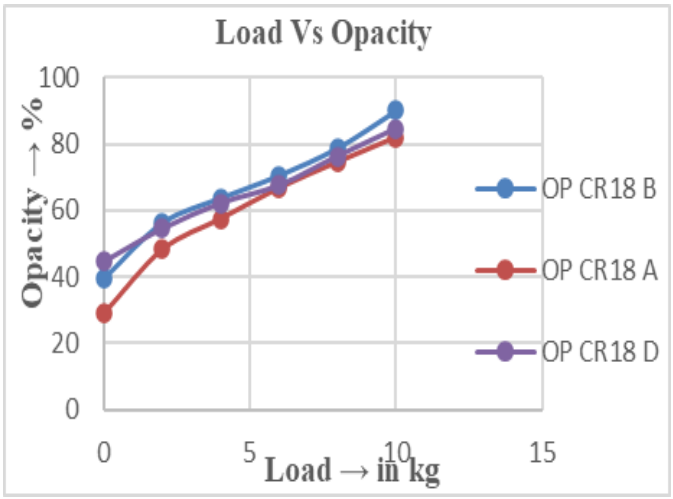
2.2.3 Brake Power Vs Oxides of Nitrogen



2.2.4 Brake Power Vs Carbon Dioxide



2.2.5 Load Vs Opacity



3. CONCLUSIONS

The results showed that the B20 biodiesel with chicken waste showed remarkable improvements in Performance and Emission characteristics and hence can be used in existing diesel engine as a good alternative fuel. Under same operating conditions the performance characteristics and emission results were more similar to that of diesel when B20 is used as the alternative fuel. It is also observed that the addition of 5% 2-ethylhexyle nitrate improves the emission characteristics of the B20 mixture by enhancing combustion characteristics. It is also observed that the smoke number is lower than normal diesel for biodiesel and biodiesel with additives. Overall, if produced commercially Chicken waste biodiesel can be used as a good alternative fuel in existing diesel engines and also the biodiesel production can help to reduce problems related to waste handling and disposal of chicken waste.

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