

Investigation on Performance of Diesel Engine by Using Waste Chicken Fat Biodiesel

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Abstract: Biodiesel is an alternative diesel fuel that can be produced from vegetable oils and animal wastes. Waste chicken fat can be used to produce biodiesel. The performance characteristics of a single cylinder diesel engine is made by using chicken waste biodiesel and blended with diesel fuel. An experimental investigation has been carried out for various blends B20, B40, B60 and the results were compared with diesel fuel. The biodiesel produced from waste chicken fat biodiesel was prepared by a method of transesterification. The effects of biodiesel addition to diesel fuel in the performance, emissions and combustion characteristics of a naturally aspirated DI compression ignition engine are examined. The engine performance was studied in a single cylinder 4-stroke diesel engine set up. Parameters like fuel consumption at different loads for pure diesel fuel and various combinations of blend with diesel fuel. Brake power, brake specific fuel consumption and brake thermal efficiency were calculated and there was a slight increase in performance fueled with different blends. The use of transesterified chicken waste oil can be partially substituted for the diesel fuel at most operating conditions in terms of the performance parameters and emissions without any engine modification.

Keywords: Transesterification; Single cylinder engine; Dual fuel; Performance.

1. Introduction

In recent years, the petroleum price is increasing rapidly; therefore, the researchers are seeking alternative fuel sources. Biodiesel has received much attention in the past decade due to its ability to replace fossil fuels, which are likely to run out within a century. Especially, the environmental issues concerned with the exhaust gas emission by the usage of fossil fuels also encourage the usage of biodiesel, which has proved to be ecofriendly far more than fossil fuels. Biodiesel is a fuel comprised of mono alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100 and meeting the requirements of ASTM D 6751. Biodiesel is made by trans-esterification process. This process converts vegetable oil and animal fat into esterified oil, which can be used as diesel fuel or mixed with regular diesel fuel. Biodiesel has been shown to produce lower tailpipe emissions than



regular diesel fuel. The best thing about biodiesel is that it can be produced from plants and animals which are renewable resources.

The engine test was made with chicken waste biodiesel Blend (10%) by varying the engine speed and was found that there was increase in specific fuel consumption due to a lower heating value of biodiesel. Waste chicken fat was collected from the slaughter house, and by heating moisture content were removed, dried fat was used directly in esterification reaction [1,2].

Experiment was conducted by using waste chicken fat biodiesel as an alternative fuel by the transesterification process by blending it in different ranges. The fuel consumption test of a constant speed IC engine was carried to evaluate for performance of the engine on both diesel fuel and chicken bio-diesel blends. This showed the difference between both the fuels [3,4].

Broiler slaughter waste has become a source of pollution throughout the world. Utilization of broiler slaughter waste of dry rendering process produce Rendered Chicken Oil (RCO), a cheap raw material for biodiesel production. Esterification and transesterification process were used to convert Rendered Chicken Oil to good quality biodiesel. The experimental working of biodiesel has been reported in [5].

Bio fuels are the major contributors of energy sources and they are the alternative fuels for fossil fuels. Chicken feather meal was used for the production of biodiesel. The processed chicken feather consists of fat content and was used to make biodiesel. Fat was extracted by heating and it was filtered under vacuum followed by transesterification reaction followed by separation of two phases. Acid value was found out by volumetric titration and they found that performance of engine was better in biodiesel than the diesel fuel [6].

The biodiesel as diesel fuel results in some advantages like minimal Sulfur and aromatic content, lubricity, cetane number, higher flash point, biodegradability and non-toxicity. On the other hand, higher viscosity and pour point, lower calorific value and volatility are the disadvantages. Further, their oxidation stability is lower, they are hygroscopic, and as solvents may cause corrosion in various engine components. For all the above reasons, it is generally accepted that blends of diesel fuel, with up to 20% bio-diesels and vegetable oils, can be used in existing diesel engines without any modifications. Experimental works on the use of vegetable oils or bio-diesels in blends with diesel fuel for diesel engines have been reported for example in References [7,8].

In this present study, chicken waste fat oil is considered as a potential alternative fuel for an unmodified diesel engine because it has high oil content for biodiesel production using a trans desertification process with the additives like methanol and sodium hydroxide [9]. Main aim of this study is to investigate the engine performance, of a diesel engine fueled chicken waste fat oil and its diesel blends compared to those of standard diesel. It is also hoped that the new data presented here will help in developing new predictive methods or procedures for this actual problem.

2. Methodology

2.1 Biodiesel Production Procedure

The biodiesel fuel used in this study is produced from transesterification of chicken waste fat oil. The chicken waste collected was cleaned by washing it in water and it is heated up to 120⁰C to lose all its moisture content and was strained which in turn filtered it. After filtration process purified chicken oil was obtained steps are shown in figure 1.

2.2 Biodiesel Properties

Table 1. properties of biodiesel in comparison with commercial diesel

Properties	Commercial Diesel	Biodiesel
Density (Kg/m ³)	0.83	0.87
Calorific Value (KJ/Kg)	42000	39830
Flash Point (0C)	72	170
Fire Point (0C)	80	180

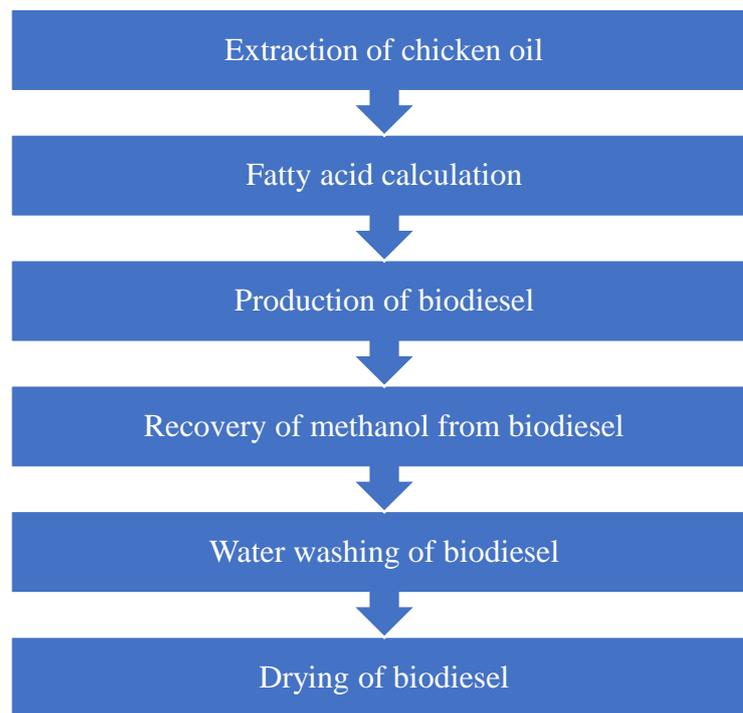


Figure 1. Steps in Extraction of biofuel from chicken fat.

Experimental Setup

2.3 Equipment and method

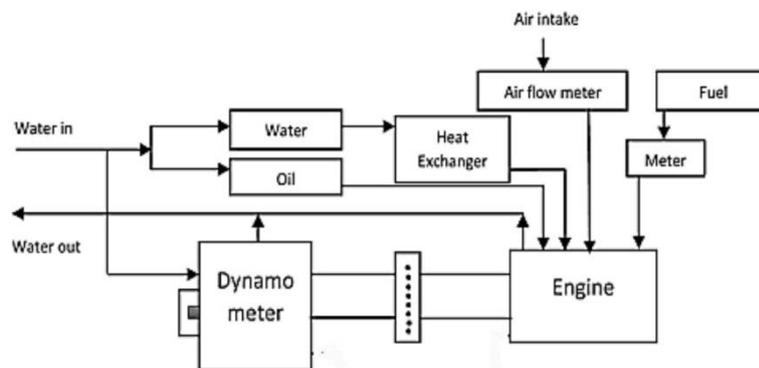
A single cylinder, Kirloskar Four stroke engine was used to perform the test. Its main parameters are shown in Table 2

Table 2. Specification of test engine

Parameters	: Specifications
Engine	: Four Stroke Single Cylinder
Make	: Kirloskar
Number of cylinder	: One
Power	: 5 HP
Speed	: 1500 rev/min
Bore	: 85 mm
Stroke length	: 110 mm
Compression ratio	: 17.5:1
Starting	: Cranking
Working length	: Four Stroke
Method of cooling	: Water cooled
Method of ignition	: Compression ignition
Dynamometer	: Eddy current

2.4 Engine Test Procedure

The experiments were carried out by using neat diesel as the baseline fuel (denoted as B0), 20% biodiesel + 80% diesel (denoted as B20), 40% biodiesel + 60% diesel (denoted as B40), 60% biodiesel + 40% diesel (denoted as B60) and 100% neat biodiesel (denoted as B100) at different engine loads from 0% to 100% rated engine load in approximate steps of 20%.

**Figure 2.** Schematic diagram of the engine setup

Before running the engine to a new fuel, it was allowed to run for sufficient time to consume the remaining fuel from the previous experiment. Engine performance parameters such as brake power (BP), fuel consumption (FC), brake thermal efficiency (BTE), brake specific fuel consumption (BSFC) for biodiesel in different blends were calculated.

3. Results and Discussion:

The addition of biodiesel as a fuel to the engine was most effective in rich combustion at different high engine loads. At low engine loads, the amount of fuel supplied to the engine was decreased, and the

overall mixture was further leaned out. Therefore, the addition of biodiesel resulted in a difference in the performance at different engine loads.

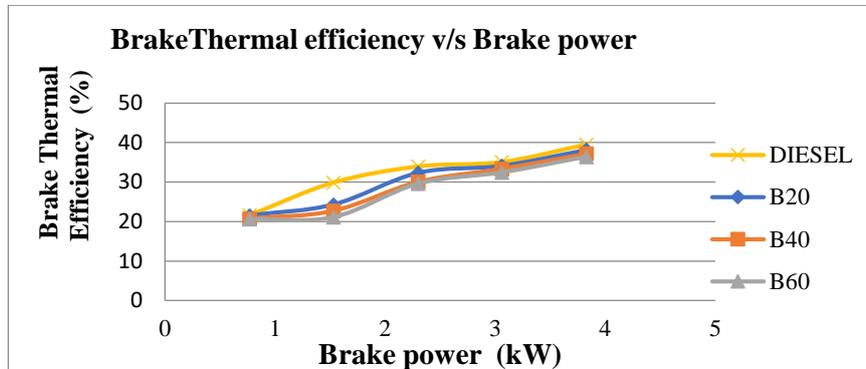


Figure 3. Variation of Brake thermal efficiency with Brake Power

Figure 3 shows the BTE variation of biodiesel and its blend with respect to the brake power of the engine. The brake thermal efficiency of the B20% blend was better than that of other blends. It was observed that the reduction in viscosity leads to improved atomization, fuel vaporization and combustion. This may also due to better utilization of heat energy, and better air entrainment. Further, the ignition delay time of the above blend is closer to that of diesel. As the burning of biodiesel in the blend was faster, the thermal efficiency was improved. The efficiency of B20% blended biodiesel at full load is from 36 - 39 %.

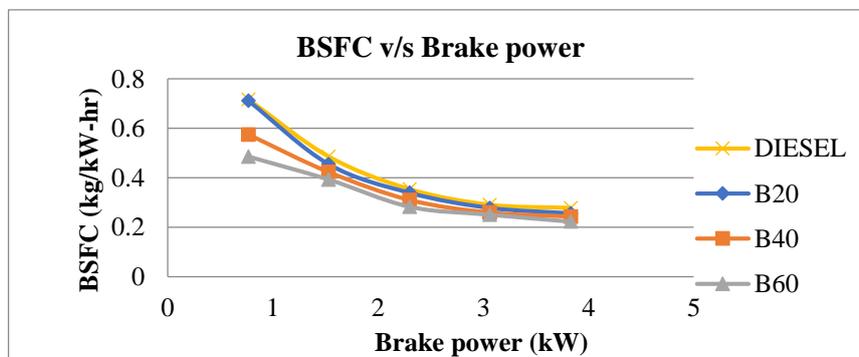


Figure 4. Variation of Brake Specific Fuel Consumption with Brake Power

Brake Specific Fuel Consumption (BSFC) is a measure of the fuel efficiency of any prime mover that burns fuel and produces rotation, or shaft, power. It is typically used for comparing the efficiency of internal combustion engines with a shaft output. Figure 4 shows the BSFC variation of biodiesel and its blends with respect to brake power of the engine.

4. Conclusion

Transesterification process improved the fuel properties of the chicken waste fat oil with respect to density, Calorific Value, flash point. The Brake Thermal Efficiency (BTE) of biodiesel and its blends are slightly higher than that of diesel at high engine loads, and keep almost same at lower engine loads. So, they give good results for BTE. BTE characteristics of B20 blend of chicken waste biodiesel approach to the diesel characteristics. The Specific Fuel Consumption (SFC) increases with increase in percentage of biodiesel in the blends due to the lower heating value of biodiesel. So, it gives a better result.

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