Waste cooking oil Biodiesel and its Blends as an alternative fuel for C.I engine

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Abstract - The aim of the present work is to study the effect of the addition of waste cooking oil biodiesel derived from waste cooking oil. For these experiments, several samples were synthesized using the blends of waste cooking biodiesel, kerosene, and diesel. Then other samples were prepared by adding B40D60, B80D20 and B40D50K10. Raw diesel and Waste cooking biodiesel were also selected as a reference fuel. The test has been conducted on single-cylinder diesel engine and performance parameter like BTE, BSFC, BSEC, Air fuel ratio and Emission temperature of fuel sample were investigated, the results were analyzed. Finally, the results of B40D50K10 may suitable to replace diesel fuel for CI engine.

Keywords: BTE, BSFC, Air fuel ratio, WCO.

I. Introduction

The production of 'Biodiesel' is an option in contrast to diesel fuel from waste edible oil. Biodiesel production from waste oils is an attractive option to produce biodiesel economically, but high free fatty acids (FFA) in waste oils are a serious bottleneck for the process of Transesterification**.**[1]Biodiesel is a fuel made up by mono-alkyl-esters of long-chain fatty acids, derived from vegetable oils or animal fat. It can be used in compression ignition engines for automotive propulsion or energy generation, as a partial or total substitute of fossil diesel fuel. Biodiesel can be processed from different mechanisms.[2] Vegetable oils and their derivatives are attractive as alternative fuels, fuel extenders, and an additive for compression ignition (diesel) engines because they also enhance engine performance. Worldwide there is interest in biodiesel as a renewable transportation fuel and blending agent.[3] These days, many used cooking oils from restaurants were re-used by street sellers to fry their food. Those waste oils commonly just throw away. Whereas waste oils which have not any treatment first will pollute the environment. One of the ways to treat waste oil is by converting to biodiesel.[4]Waste frying oils (WFO) is considered a promising alternative in biodiesel synthesis, due to their low cost and high availability. Besides, WFO use reduces competition with food demand. The cost of WFO is two to three times lower than refined vegetable oils. Their use would also reduce the costs of removal and treatment of this residue.[5]Biofuels are less pollutant than fossil fuels because they emit less harmful chemical substances during combustion and their production processes tend to be cleaner. The use of ethanol is regarded as one of the main mechanisms to fight global warming, as it reduces the emission of carbon dioxide (CO2).[6] The acceptance of biodiesel quality by the markets and consumers is of considerable significance. The biodiesel stability may be affected by a large number of parameters which can be categorized by oxidation, thermal and storage stability parameters.[7] The ignition delay of used cooking oil (UCO) biodiesel decreases with an increase in the percentage of UCO in the blend and is less when compared to that of petroleum diesel. The peak pressure of UCO biodiesel and its blends is higher than that of diesel fuel. The maximum rate of pressure rises and maximum heat release for UCO biodiesel and diesel are similar. With an increase in the percentage of UCO biodiesel in the blend, these parameters decrease. Higher exhaust gas temperature of UCO biodiesel which increases with percentage UCO in the blend. Increased oxygen content which improves combustion is a reason given for this[8] The main challenges are its cost and availability of fats and oils resources. By collecting used frying oils and converting them to biodiesel fuel, the cost of biodiesel is significantly lowered and the negative impact of disposing used oil to the environment reduced.[9] The majority of studies have found sharp reductions in particulate emissions with biodiesel as compared to diesel fuel. The oxygen content and the

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absence of aromatic content in biodiesel have been pointed out as the main reasons. Under cold-start conditions, the mentioned reduction could be eliminated or even reversed to result in a certain increase. The emission of aromatic and polyaromatic compounds, as well as their toxic and mutagenic effect, has been generally considered to be reduced with biodiesel. However, no conclusive trend has been found regarding the emissions of oxygenated compounds such as aldehydes and ketones[10]

The objective of the present work is to study the effect of the addition of WCO in diesel engine. For these different fuel blends have been prepared and their physical and chemical properties have been examined. Then the fuels were tested on a single cylinder diesel engine for their performance evaluation

II. MATERIALS AND METHOD

Table 1: *The following materials were used in The present study*

SL. NO.	Material	Manufacturer.
1	Waste Cooking oil Biodiesel	Prepared in the chemistry lab , BIT Sindri
2	Diesel	Local fuel station
3	Kerosene	Local supplier
4	Ethanol	Loba Chemie, laboratory reagents and fine chemicals
5	KOH	Loba Chemie, laboratory reagents and fine chemicals

In the process of frying, the oil undergoes many reactions leading to the formation of many undesirable compounds such as polymers, free fatty acids, and many other chemicals. This poses a lot of challenges in the trans-esterification of UCO. The pre-treatment of the UCO to remove these chemicals is not practical; hence the oil is heated and filtered to remove solid particles before trans-esterification.[9]The waste cooking oil (WCO) in adequate quantity was taken in a large beaker and any Impurities or dust particles present in it was removed using a sieve. Then the WCO was heated up to 50°c. A solution of KOH and Methanol was prepared in another beaker. (for a sample of 500ml WCO,100ml of methanol and 4.4gm KOH solution was prepared).The above solution was added to the heated WCO and it was stirred using a magnetic stirrer until a reddish black color of homogenous solution appears. Then the mixture is allowed to settle down for 2 days, during which glycerine precipitated and settled down at the bottom of the vessel. Thus, we get two separate layers, one of biodiesel and another of glycerine. That is separated in different vessels.

The pure biodiesel obtained was blended in various proportions with petroleum diesel and Kerosene to get the following samples for its performance and emission test on diesel engine

Table 2 Test Fuel Nomenclatures

SL. NO.	Material	Manufacturer.
1	B100	100% biodiesel
2	B40D60	40% biodiesel and 60% diesel fuel
3	B80D20	80% biodiesel and 20% diesel fuel
4	B40D50K10	40% biodiesel,50% diesel and 10% kerosene fuel
5	D100	100% biodiesel

Physio-chemical Studies

Diesel-WCO biodiesel and kerosene oil were blended into a homogenous solution and five fuel tests samples are prepared for various testing. The properties like Density, viscosity, calorific value, Exhaust temperature were calculated.

The Engine

A single-cylinder, four-stroke 5HP diesel engine was chosen for the experiment. The drag and the stroke lengths are 80mm and 110 mm individually. The engine kept running on four diverse burden conditions and at full load with a consistent speed of 1500rpm.

Performance Test

The following engine performance parameters were computed for above five fuel samples Torque, Brake power, Brake thermal Efficiency, Brake specific fuel consumption, brake specific energy conversion, brake mean effective pressure, air-fuel ratio, and volumetric efficiency.

Emission Test

Exhaust temperature has been measured according to the applied load at rated speed.

III. TEST ENGINE SPECIFICATION

The experiment was analyzed in a single-cylinder four-stroke diesel engine attached with a dynamometer. The specifications of the diesel engine have been given below in table 3.

Figure 1: Test Engine

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TABLE 3: Specification of Testing Engine.

Item	Specification
Engine Manufacturer	Ganga Precision Industries Coimbatore
Fuel Type	Diesel
Number of cylinders	1
Maximum Power	5HP
Maximum RPM	1500

3.2 *TEST PROCEDURE*

Initially fuel tank of the test engine was drained, then the drained system gets refilled with pure diesel fuel before the commencement of required test, it is necessary to make the engine free from air bubbles that might be collected in the fuel supply system, the engine runs without load for 15 minutes for warm-up and stability. Engine stability was determined by exhaust temperature stability. Then the load 4 kg was applied with the help of rope brake dynamometer and gradually load increased. After 2 minutes for same load and rpm, the fuel line tap was kept closed to detach the fuel tank supply to the diesel engine and fuel was allowed to be consumed from the pipette. Thus, the fuel consumption was determined by measuring the time consumed by the engine for a constant volume of fuel consumption, during the process all data were recorded. Every test was repeated to get more accurate value and the mean value was considered and the final calculations were made.

IV. RESULTS AND DISCUSSIONS

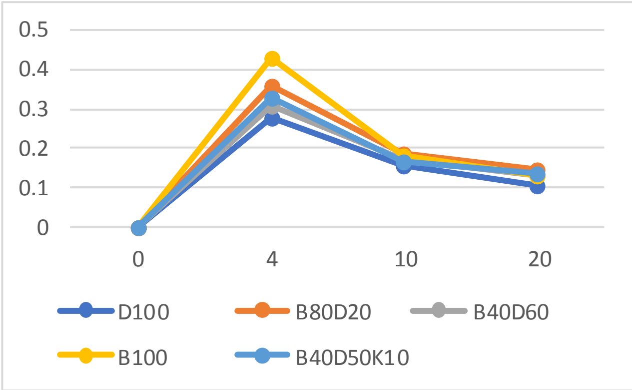
Characterization of oil samples:

Density, calorific value, Viscosity, and an acid value of samples are shown in Table 4

Table 4: Properties of Waste cooking oil biodiesel, diesel, and its blends.

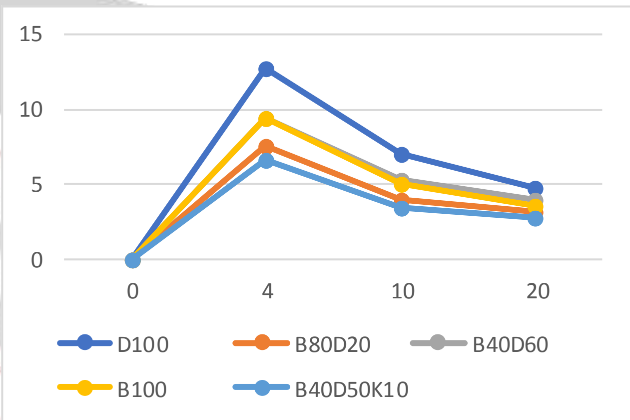
Samples	D100	B80D20	B40D60	B40D50K10	B100
Density	832	911.4	878	895.8	926
Calorific value	4.012	5.062	7.378	4.837	6.579
Viscosity mm2 /s	2.2 - 4.2	3.83	3.59	3.86	5.3 – 5.89
Acid value	0.24	0.87 - 1.4	0.49 - 0.68	0.80 - 1.2	1.29 - 3.56

Graph 1: BSFC Vs Load



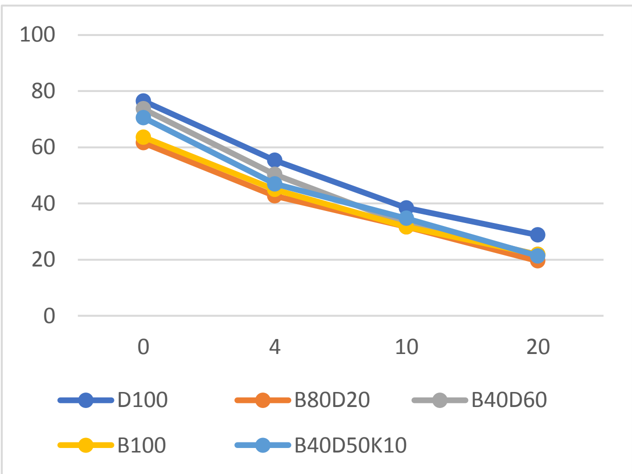
Graph 1 represents the plot between brake specific fuel consumption rate and load at constant speed 1500. As the load increases brake specific fuel consumption decreases exponentially. The rate of fuel consumption B80D20 is slightly higher than that of other blends in comparison.

Graph 2: BSEC Vs Load.



Graph 2 represents the plot between brake specific energy consumption rate and load at constant speed 1500. As the load increases brake specific energy consumption decreases exponentially. The rate of fuel consumption D100 is slightly higher than that of other blends in comparison

Graph 3: Air fuel ratio Vs Load



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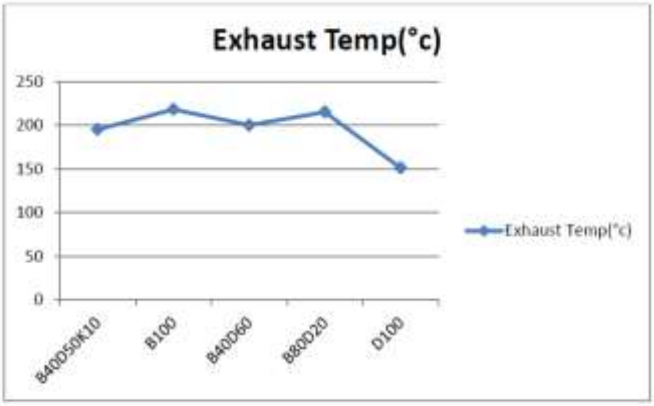
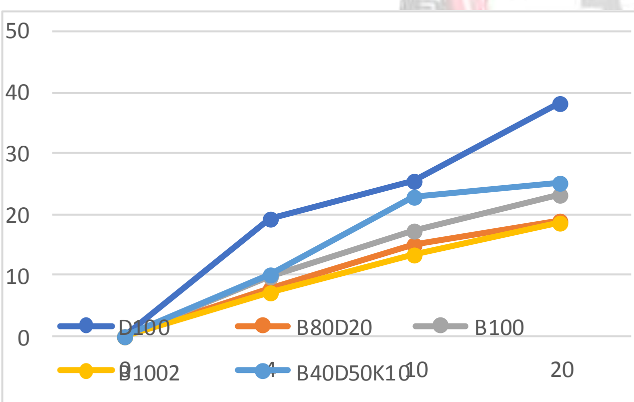
Graph 3 represents the plot between brake specific energy consumption rate and load at constant speed 1500.it was found that the air-fuel ratio is higher for diesel fuel with comparison to other blends at rated load and speed.

Graph 4: Exhaust Temperature Vs. Fuel blends at 20kg load.



Graph 4 represents the plot between exhaust gas temperature and load while increasing the load exhaust gas temperature increase. We all are aware of this that higher the load more fuel will be required and more fuel has to be burn for more power. The plot of WCO biodiesel and its blends has higher exhaust temperature with comparison to diesel fuel.

Graph 5: BTE (%) Vs. Load



Graph 5 represents the plot between brake thermal efficiency and the load. We can observe from the plots that the blend of WCO biodiesel with kerosene and diesel has efficiency similar to diesel at certain load condition as compare to the other blends of WCO biodiesel blends

V. CONCLUSIONS

In my present study which is a part on ongoing research project related with the WCO biodiesel, it is aimed to use waste cooking oil biodiesel as an alternative fuel for C.I Engine, for this purpose WCO biodiesel and its blends were synthesized and its properties were investigated and compared with conventional Diesel fuel. Different fuel blends using waste cooking oil biodiesel, kerosene, and Diesel were synthesized and their performance has been tested on a single cylinder diesel engine of constant rpm and at different loads.

It is found that fuel consumption for various blends of WCO Biodiesel is slightly lower than that of diesel. The performance of sample B40D50K10 (blend of 40% Biodiesel and 10% kerosene with diesel 50% by volume) gives a satisfactory result at a lower load. Brake power and brake mean effective pressure is found to be nearly same for both the diesel as well as with kerosene blended WCO biodiesel at lower load condition. Exhaust gas temperature for kerosene blended biodiesel is found to be higher than that for diesel. Among all the fuel blends, B40D50K10 has satisfactory brake thermal efficiency at lower load comparing to other blends tested on C.I engine. This test also suggests that the diesel can be replaced by waste cooking biodiesel blends as an alternative fuel for C.I Engine.

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