PERFORMANCE AND ANALYSIS OF DIESEL ENGINE USING CHICKEN OIL WITH DIESEL AS A BIOFUEL

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ABSTRACT

According to the survey of the oil and gas journal, crude oil production is exited to reach a peak within 2015 to 2030 and from then it is eventually going to decrease. Thus need to look at other options as far as energy need is concerned. The present study is focused on investigation of CI engine by using biodiesel which is produced from the waste chicken oil. Here waste chicken was taken to extract oil from it and that oil is used in the production of biodiesel. Esterification and Transesterification are the two major processes used in preparation of biodiesel. And the produced biodiesel was taken to check the properties of it such as calorific value, viscosity, density, flash and fire point. And also the property value meets the ASTM standard for biodiesel. After that the analysis were carried out for various biodiesel blends produced such as B20, B40. B60, B80 and B100 on engine. By the way engine performance and emission characterization are analyzed in brief. Results shows that the use of chicken oil biodiesel for substitution of diesel fuel was good without modification on engine upto B40. But the compression ratio of the engine should be modified for using other blends for better performance. By considering performance parameter the brake thermal efficiency increases and brake specific fuel consumption decreases on using chicken oil biodiesel (CBD) was observed. Slightly lower NOX and higher HC and CO emissions are noted on using biodiesel in engine emission test. However by compared to pure (D100) diesel fuel 22.03% higher NOX and 24.05% lower CO with 46.15% lower HC were observed with chicken oil biodiesel.

Keywords - *Biodiesel, Chicken oil, Engine performance, Engine emission, Esterification process, Transesterification process.*

1. INTRODUCTION

Increasing of petrol and diesel price day by day emerges to find a new fuel like some alternative fuels; this idea leads to get renewable energy source such as biodiesel for diesel engines. The biodiesel is one of the best alternative fuels which prepared from vegetable oil, animal fats, and recycled cooking oil. Biodiesel is renewable and environmental friendly alternative diesel fuel. The technical definition of biodiesel is mono alkyl esters of long fatty acids. The most important method to produce biodiesel is called transesterification. K Srinivasa Rao et al. [1] investigated DI-CI engine characteristics with preheated chicken oil biodiesel. They obtained performance and emission characteristics very close to petroleum diesel with preheated chicken oil biodiesel blend. NOX emissions are more for chicken fat biodiesel compared petroleum diesel. Jagadale S.S and Jugulkar L.M [2] studied single cylinder, 7.5HP power at 1500rpm constant speed, Kirloskar diesel engine characteristics using blends of chicken oil based biodiesel. They observed that thermal efficiency, specific fuel consumption, volumetric efficiency and mechanical efficiency of the engine with chicken oil biodiesel (CBD) blend with diesel are nearly equal to pure diesel. They reported that chicken is one of the cheap raw materials for making biodiesel. Kambiz Tahvildari A et al.[3]studied and determined properties of chicken oil biodiesel. They concluded that waste chicken fat is the one of suitable stock material for biodiesel production. Ertan Alptekin et al.[4]used one of the low cost feedstock such as chicken oil for biodiesel production. They studied the effect of catalyst type, reaction temperature and reaction time on the fuel properties such as density, viscosity, flash point, pour point, acid value and heat of combustion. Selva Ilavarasi Panneerselvam et al. [5] attempted to use chicken as low cost sustainable potential feed stock for biodiesel production. The study on the biodiesel production process, optimization of chicken showed that the quantity of

catalyst, amount of methanol, reaction temperature and reaction time are the main factors affecting the production of chicken oil methyl ester. The optimal values of these parameters for achieving maximum conversion of oil to ester depend on the chemical and physical properties of these fats.

Recently, because of a rapid increase of the price of petro diesel biodiesel is most widely accepted alternative fuel due to environmental advantages. Production biodiesel from other inexpensive feedstock may significantly reduce the cost of biodiesel. Demand for energy and its resources, is increasing every day due to the rapid outgrowth of population and urbanization. As the major conventional energy resources like coal, petroleum and natural gas are at the verge of getting extinct. Biodiesel production is a very modern and technological area for researchers due to the relevance that it is winning everyday because of the increase in the petroleum price and the environmental advantages. Biodiesel, an alternative diesel fuel, is made from renewable biological sources such as vegetable oils and animal fats. It is biodegradable and nontoxic, has low emission profiles and so is environmentally beneficial.

2. MATERIALS AND METHODS

Initially the waste chicken is taken and grinded into paste form. Then the paste is dried by placing it inside a micro-oven. After the paste is dried for a particular duration, it is obtained in powdered form. Then the powder is dissolved in ether solution. When the ether is added to the dry grives, the oil is extracted from it. The oil is made to undergo Free fatty test in order to determine the fat content in the oil. The fat should be removed from the oil for better performance of engine.

2.1. FREE FATTY ANALYSIS

Titration process: The materials required for the titration process are 2g of chicken oil, 0.25g of NaOH, 20ml of ethanol and a few drops of phenolphthalein. These solutions are taken in a burette and the titration process is carried out. The result of the titration process must be less than 1. Thus the fat content in the oil is analysed and removed.

2.2. ESTERIFICATION

The methanol's molar ratio and molecular weight are used for the calculation. This process refers to the addition of alcohol and heating it. Then, 14% of concentrated sulphuric acid is added to the oil obtained. The acid is to be added gently. After adding the acid the mixture is heated upto 80^oC. Adding the acid reduces the temperature of the mixture. Hence the temperature of the oil is maintained at a constant temperature of 80^0C by heating it continuously. The boiling point of methanol is 64^oC. So, the methanol in the solution alone evaporates. Then the methanol is condensed and reused.

2.3. TRANSESTERIFICATION

Transesterification or alcoholysis is the displacement of alcohol from an ester by another in a process similar to hydrolysis, except than alcohol is used instead of water. This process has been widely used to reduce the high viscosity of triglycerides. Instead of sulphuric acid, salt is used. Methanol amount is found by using a formula. The FFA content can be tested after half an hour which can be tested in a burette.

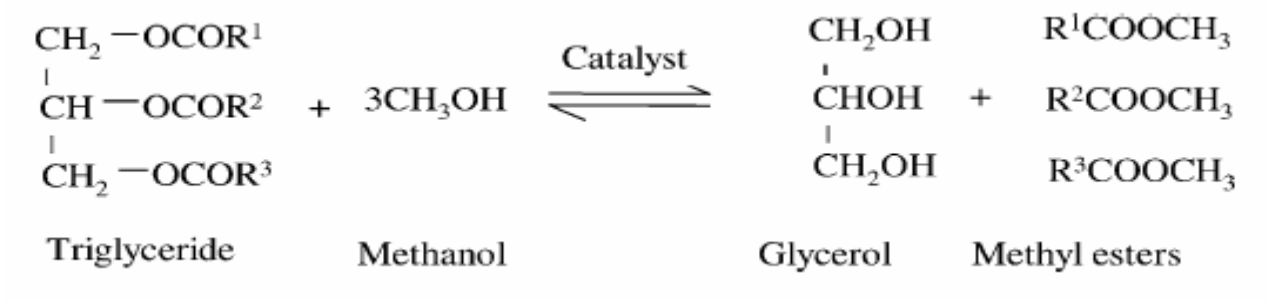

Fig-1: General equation for Transesterification

Then the mixture was left in a reactor itself for 5 to 6 hours without stirring, after that to check whether glycerin was produced or not by taking few sample mixture of it.

3. SEPERATION AND BLENDING

Thus the content obtained from the above process is in the form of solid. Then it is well stirred for a duration of one and half hours. Then solid form is obtained in powdery form after the complete stirring of the solid. After that, methanol and NaOH is mixed with the powder and sent into the reactor. The solution is well mixed inside the reactor and heated upto 70^{o}C and kept in the same temperature constantly for 2 hours. Again the methanol gets evaporated and the evaporated methanol is condensed and stored. The stored methanol is again reused for the process. The remaining oil is retained in the reactor. The colour of the retained oil is brownish coke. Then the oil is drained and kept it in a container for several hours at normal temperature for cooling purpose.

The oil comes to normal temperature after the duration. This oil is washed with mineral water to remove the impurities in the oil. And finally pure oil alone is obtained. The properties of the oil is studied and the oil is taken for the next process which makes the production of biodiesel. The comparison of the properties of the diesel with the properties of biodiesel blends are shown in the tabular column below.

The properties which are determined includes density, viscosity, calorific value, cetane number, flash point and fire point. The variation in the numeric values shows the results of the biodiesel which is prepared from the chicken oil. The properties should satisfy the standard limits of values which is required for a normal fuel. Based on this criteria, the combination of the solutions are made in the required amuout.

Table-1: Properties of diesel and biodiesel

S.No	PROPERTIES	D100	B20	B40	B60	B80	B100
1.	Density (kg/m^3)	830	836	846	857	869	880
2.	Viscosity at 40^{o}C (cSt)	2.57	2.96	3.42	3.88	4.63	5.76
3.	Calorific value (KJ/Kg)	42500	41100	39670	39000	38200	37880
4.	Cetane Number	48	54.6	53.5	56	57.1	58.3
5.	Flash point (^{o}C)	50	74	87	106	126	145
6.	Fire point (^{o}C)	72	91	104	127	142	162

Fig-2: Biodiesel, Pure diesel and chicken oil

The oil thus obtained is blended with the diesel in certain ratios. B20, B40, B60, B80 all refers to the percentage of the oil blended with the fuel to obtain a perfect biodiesel. Upto B40, the normal diesel engine runs without any major changes or defects. Above that (i.e. B60, B80, B100), slight modifications of the engine is required for better performance. The compression ratio must be changed for this criteria. The performance and analysis of the diesel engine running with the biodiesel is shown in the figures shown below.

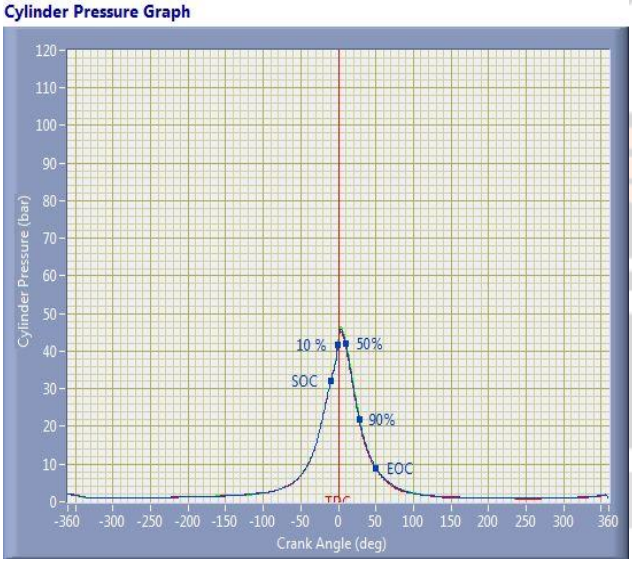

Fig-3: Cylinder pressure graph

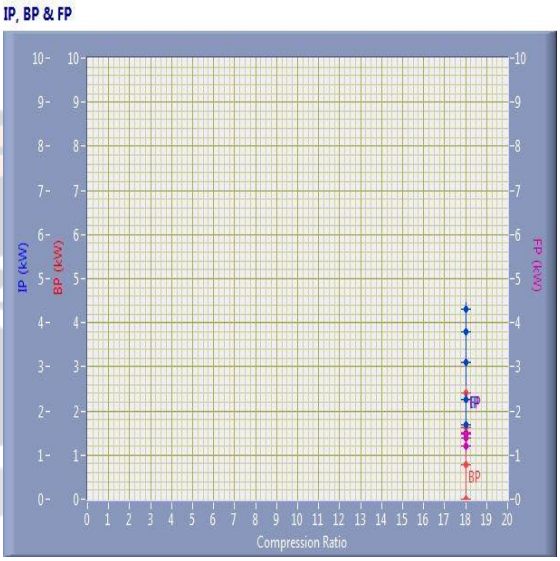

Fig-4: Indicated power, Brake power, Friction power

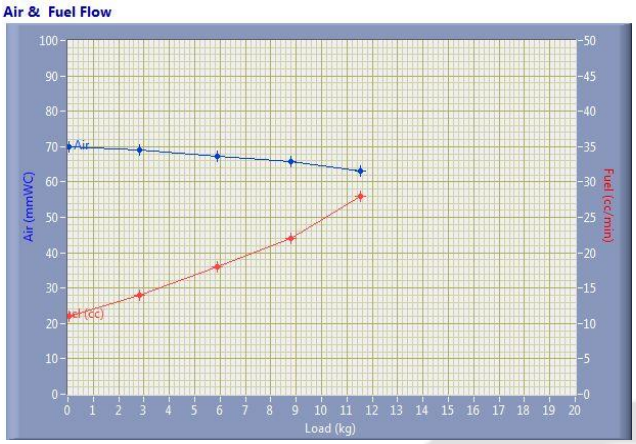

Fig-5: Air and Fuel flow

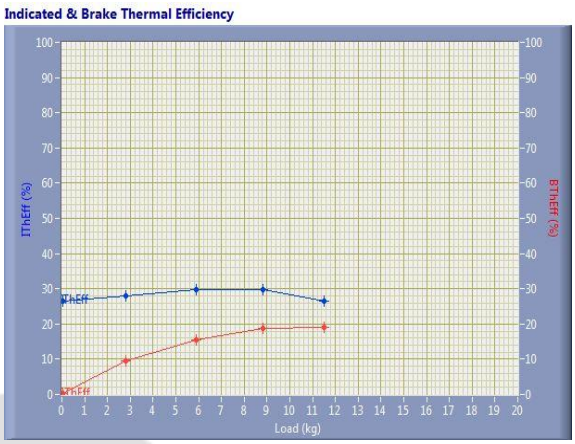

Fig-6 Indicated and Brake Thermal Efficiency

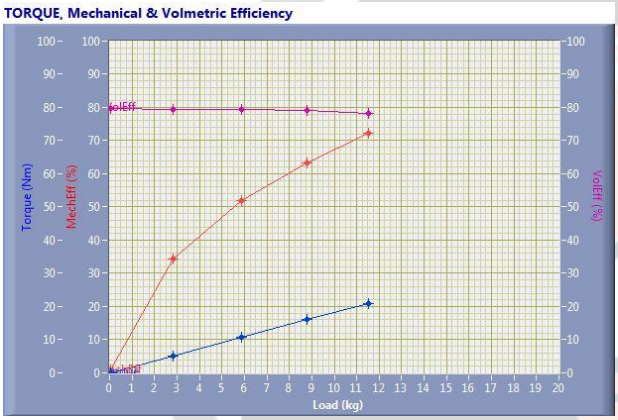

Fig-7: Torque, Mechanical and Volumetric Efficiency

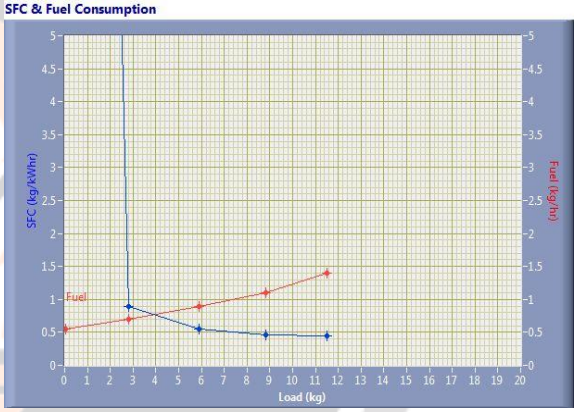

Fig-8: SFC and Fuel Consumption

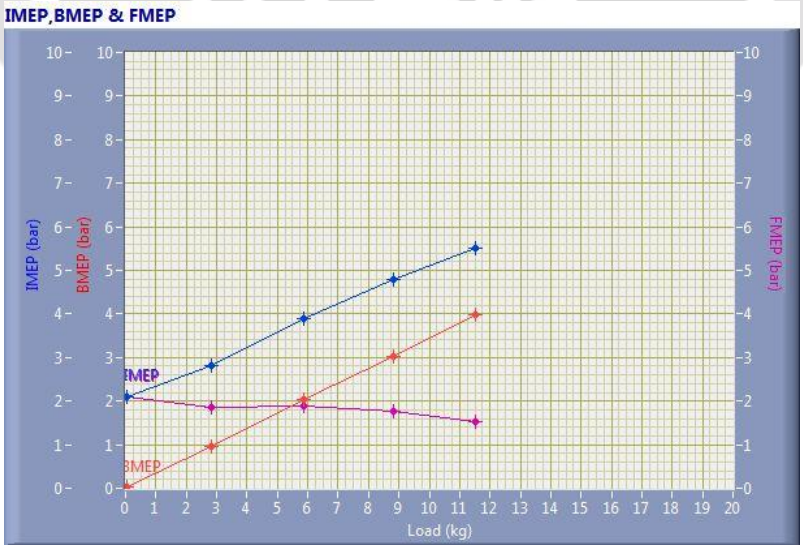

Fig-9: IMEP, BMEP and FMEP

4. CONCLUSIONS

Now, it is distributed as a suitable commercial combination all over the world, so, in these research properties of Chicken oil biodiesel was investigated. Whereas suitable stock material recognition for biodiesel preparation was studied. Waste Chicken oil is a suitable potential which was used as biodiesel stock material. After extraction of oil, it was blended with pure diesel and the performance was analyzed by undergoing standard fuel tests. Attractive and attentive results were obtained in the performance analysis. For biodiesel with above 50% chicken oil content, modifications in the engine's compression ratio is required.

5. REFERENCES

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