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Performance Analysis and Exhaust Evaluation of CI Engine using Waste Cooking Oil and Diesel Blend.

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Abstract –*The enhanced attention concerning essential of energy supplies, fuel sources and the ecological impact, environmental impact and demand of fuel etc., this all factors is increased to interest towards the new research of alternative sources of energy for fossil fuels. Due to the ecological trouble caused by the use of fossil fuels, attention has been paid to the production of biodiesel as an alternative to fuel. Energy consumption is rising while fossil fuels, the main source of energy, threaten their decline and corresponding their market value increases. To fulfill this requirement Biodiesels will play a major part as alternative to diesel oil/fuel since they are renewable and have similar properties. This paper objective is to give a clear idea and view on generation of Biodiesel from used waste cooking oil and to also analysis different method and result. Biodiesel is an environmentally, ecologically friendly alternative diesel fuel made from vegetable oils, waste cooking oil and animal fats etc.*

The current method of biodiesel production is the transesterification of the inedible oil with an alcohol (methanol or ethanol) in the presence of a catalyst or not. This paper aimed to give overview of biodiesel production from WCO and to study the different reaction; various methods and catalysts used and find the finer condition of its process. Also other variables are checked include reaction, properties such as temperature, density, ratio of alcohol to vegetable oil, catalyst, and intensity of mixing, purity of reagents etc.This study aims to make a comparative study of transesterification processes by different method use for biodiesel production. The results of this study suggest that the production of biodiesel can be carried out and its obtained were found comparable to pure biodiesel.

***Key Words*: *Biodisel1*, *Transesterification2*, CI Engine3, FFA4, WCO5 etc.**

1. INTRODUCTION

Due to climate change and air pollution caused by the combustion emissions of fossil fuels. Increase in shortage of petroleum resources all over world the environmental problems caused by the use of fossil fuels, so attention has been paid to search for some alternative fuels the production of biodiesel as an alternative to diesel.

Biodiesel can be making from any material that contains fatty acids, also various vegetable fats and oils, animal fats, waste greases, and edible oil processing wastes can be used as feed stocks for biodiesel production.

Now at present method of use for making biodiesel production is the transesterification process of the animal fats, edible oil etc. with an alcohol (methanol or ethanol) in the presence of a catalyst or not.

Biodiesel has become one of the good replacements to the problems of sustainable development, non-particulate matter pollutants, toxicity and biodegradability, energy security, and the significant reduction of greenhouse gases emissions.

Biofuel has unique properties very similar to those of fossil diesel, but with emissions of sulfur, carbon dioxide (CO_2) and much smaller particles. Biodiesel is now recommended as an alternative fuel because it has several advantages over conventional diesel. It is safe, renewable and non-toxic. The reduction of fossils fuels is clear allegation from the scientific community along with environment concerns. Therefore it is very essential to want the alternate source of energy which is environment friendly, having greater or equal efficiency than the fossil fuel.

Alternative new and renewable fuel has the ability to give remedy to social problems concern fuel. Among these renewable energy sources biodiesel is one of the best sources to use it in diesel engines without any modification.

A. Biodiesel can be prepared from many methods. Some of them are listed below
1) Thermal cracking
2) Micro emulsions
3) Direct using or blending
4) Transesterification

This study aims to make a comparative study transesterification processes for biodiesel production. These aim of paper focuses on the Trans esterification process. The Trans esterification is the most common process utilized in production of biodiesel. This Biofuel is defined as fatty acid methyl ester (FAME) derived from triglycerides (vegetable oil/animal fats) and an alcohol by using different with right ratio of catalyst.

Biodiesel production is the process of where producing the biofuel, through the chemical reactions of transesterification and esterification. For this require vegetable or animal fats and oils being reacted with short-chain of alcohols and added with catalyst (typically methanol or ethanol).

In this process sunflower, palm, olive, canola, soybean, rapeseen, cotton seed and peanuts oils, and animal-based lipid (e.g. butter). Waste animal factor oils are reacted with methanol, using a strong alkaline catalyst (sodium hydroxide NaOH or potassium hydroxide KOH). During this transesterification processes, the triglyceride is reacted with alcohol in the presence of a catalyst, usually a strong alkaline like sodium hydroxide.

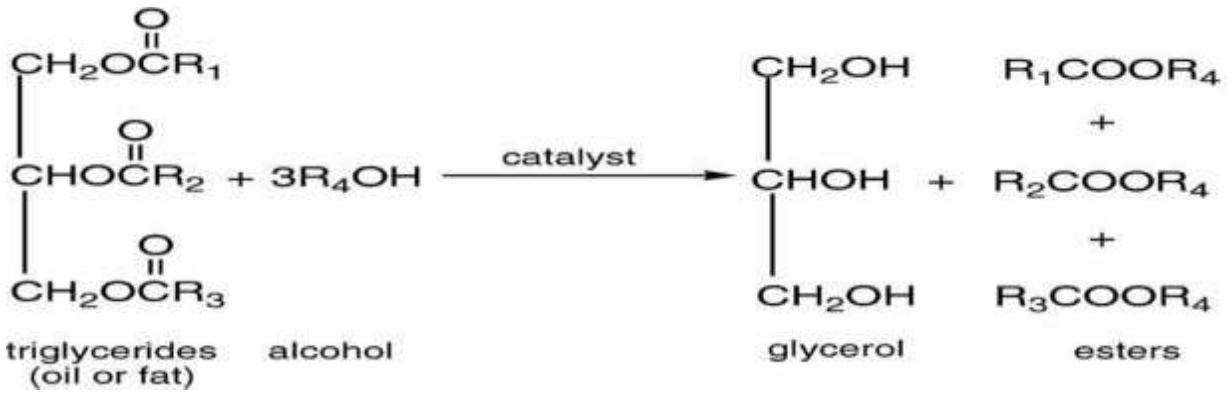

Fig 1.Transesterification reaction

The alcohol reacts with the fatty acids to form the mono-alkyl ester, or biodiesel, and crude glycerol. As shown in Fig 1.

So here studied following different methodology of making biodiesel.

1. Methodology 1

In This transesterification process we have used seven the biodiesel samples (A,B,C,D,E,F,G)and after the process of methanol evaporation the resultant biodiesels were left to lie for at least 8 hours. So separations were used to separate the top (methyl ester) and bottom (glycerol) layers of the biodiesel form given samples. The top layer was mainly composed of free fatty acid methyl esters. The bottom side deposit was mostly made up of glycerol, salts, soap, other impurities and excess methanol as it is a very polar compound i.e. it partitions more with polar glycerol as opposed to the non-polar methyl esters.

The samples(A,B,C,D,E,F,G,H) are prepared on different compositions of triglycerides and alcohol .as shown on table 1.

Here in the case sample B and E results in soapy formation shown in fig 2. This test shows that too much of catalyst results in increase in alcholysis and not composition of biodiesel.

The samples C and D are taken into research to analyses the properties and performance in engine. The samples C and D are taken into account and B20 (20% Biodiesel+80% Petroleum diesel) is prepared.

Table 1. Samples compositions

Sr.no	Samples	UCO (ml)	Methanol (ml)	KOH grams	Temperature (°C)	Glycerol	Bio diesel (ml)
1.	A	100	20	0.98	70	26.464	80
2.	B	100	15	1.6	70	-	-
3.	C	100	15	1.146	70	26.6	83.40
4.	D	100	17	1.207	70	29.20	82.8
5.	E	100	10	1.109	70	-	-
6.	F	100	12	1.153	70	27.648	79.35
7.	G	100	15	1.250	70	26.049	83.12

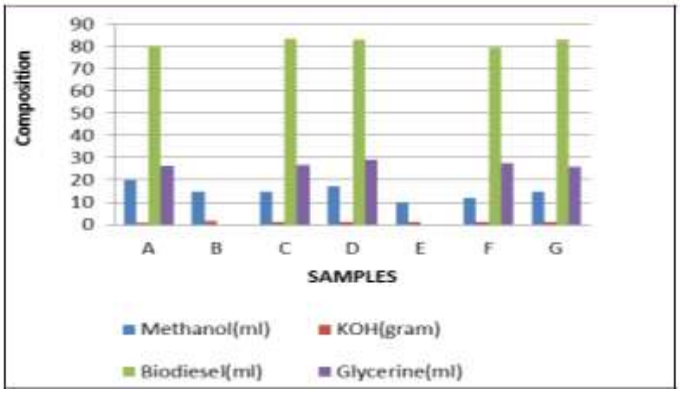

Fig.2 Composition chart

2. Methodology

The biodiesel is prepared from waste cooking oil sample collected from a local area. Here the biodiesel was characterized for its physical and fuel properties using ASTM standard methods for biodiesel fuel quality assurance. The arrangement of final biodiesel was defined by physical properties such as density, viscosity, flash point, water content and acid value.

Sr.no	Property	Value	unit
1	Density	87	g/cm3
2	Kinematic viscosity	35.4-40	mm2/s
3	Flash point	130	ºC min.
4	Asid number	0.80	mg KOH/g.
5	Water content	Max 0.005%.	---

Table .2 Main properties of WCO

RESULT:

Fig. 3 show two layer separation between glycerol and FAME (fatty acid methyl esters), at the top will be presence FAME and the at bottom is glycerol. To reduce the high viscosity of triglyceride (TG).Methanol and catalyst produce methyl ester and glycerol.

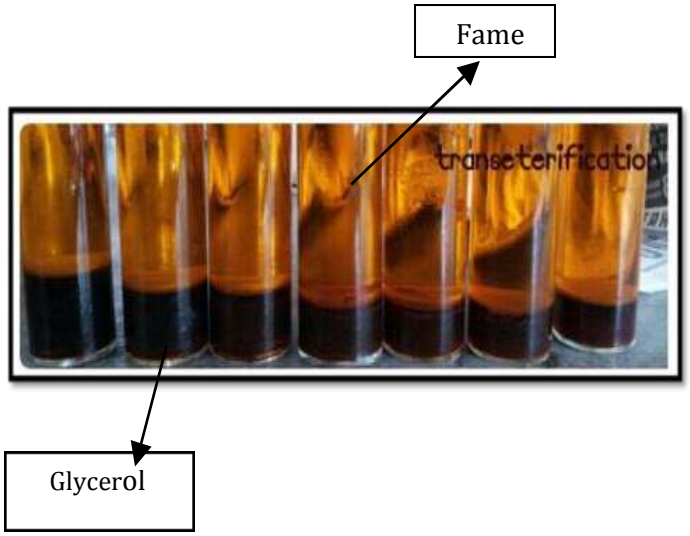

Fig. 3 Transesterification process result

3. METHODOLOGY

In this study, manufacturing of biodiesel was performed in a small batch reactor by transesterification of waste cooking oil with adding potassium hydroxide catalyst. The washing of biodiesel is implemented by two methods i.e. washing with distilled water and washing with vinegar. Valuation of waste cooking oil for finding the free fatty acid contents and their decrease with the glycerolysis in presence of Zncl as a catalyst to improve the transesterification was studied.

3.1 Effect of waste cooking oil on transesterification reaction

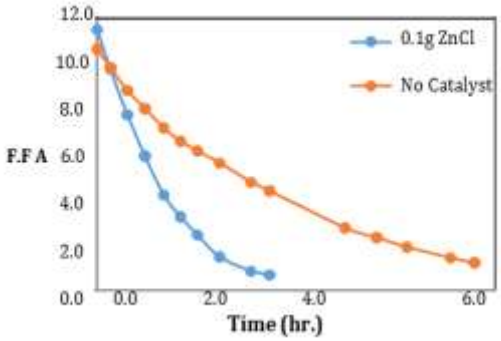

Fig. 4 Reduction of Fatty Acids by Glycerolysis.

The curve showed that with Zncl as catalyst the FFA get reduced in amount in low time and that without Zncl catalyst it required more time to reduce the FFA contents. Here consider the influence of FFA percent and the water content in the creation of biodiesel the water must not exceed 0.3% and with the FFA percent less than 3%w/w.

3.2Effect of the catalyst loading

This is studied that catalyst loading effects the changes of the triglycerides into monoglycerides.

The curve shows high yield of about 88% at 7g catalyst .It is finding that more increase in amount from 7g have no effect on the conversion of triglyceride.

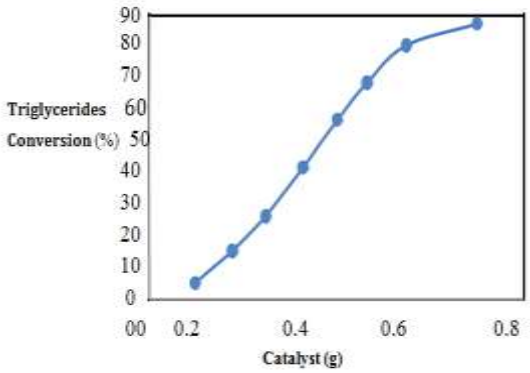

Fig. 5 Effect of the catalyst loading on the conversion of the triglycerides

3.3Effect of the molar ratio of ethanol to oil on Ethyl ester yield

The effect of mass ratio of ethanol to oil on the conversion to ethyl ester was investigated by experiments.

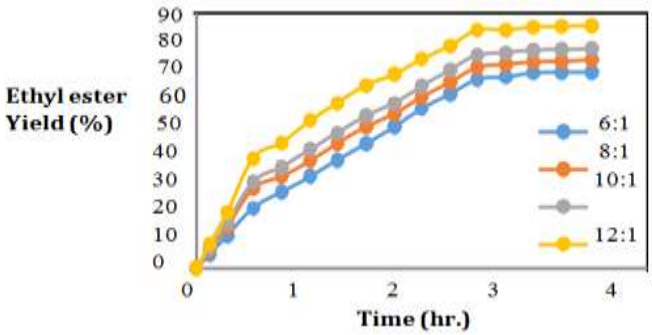

Fig. 6 Effect of the molar ratio of ethanol to wco on ethyl ester yield.

In this study conversion to ester was about 69% w/w with molar ratio of 6:1. High yield of (84%) ethyl ester was observed at 12:1 molar ratio.

4. Methodology

Density and compressibility are essential criterion for the increase of diesel engine operation. With this objective, these properties were reported for waste cooking oil biodiesel and its blends mixed with diesel. Here in this concept density measurements were carried out overen large ranges of pressure (0.1 to 140MPa) and temperature (293.15 to 353.15 K) compatible with engine applications.

Density measurements were carried out along various isotherms spaced at 20 K intervals (from 293.15 to 353.15 K) and for pressures (ranging from 0.1 to 140 MPa) in steps of 10 MPa.

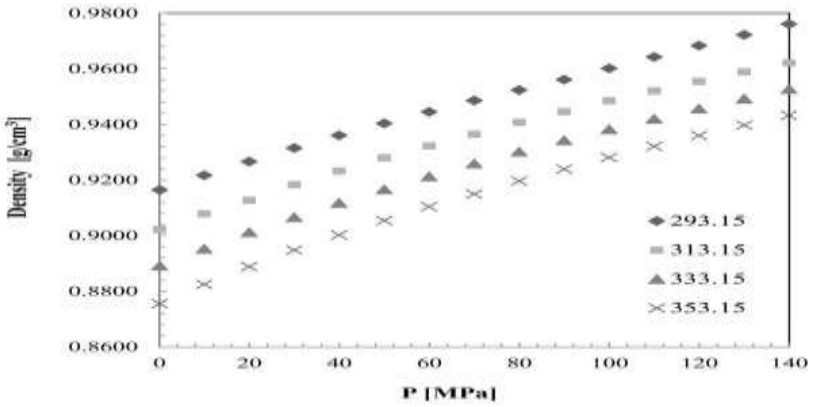

Fig. 7 Variation of the WCO biodiesel density as a function of pressure at different temperatures.

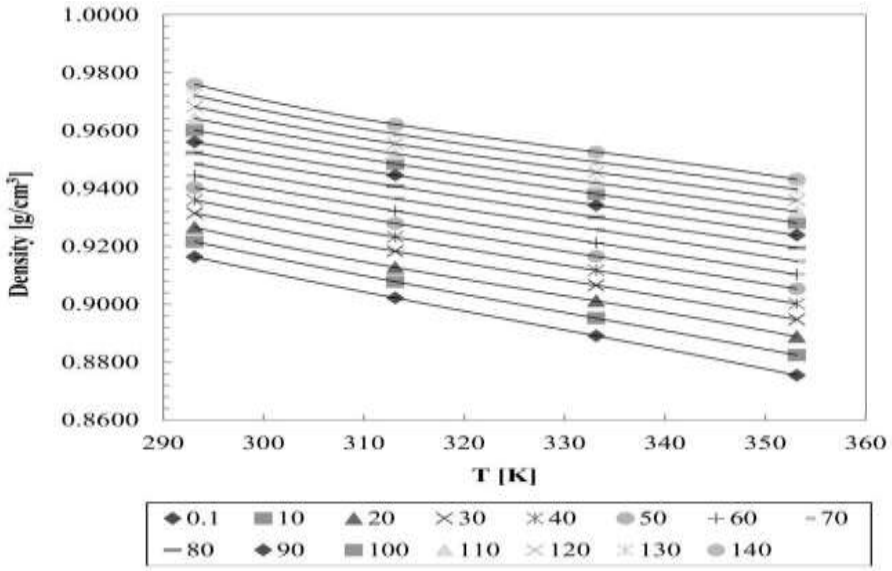

Figure 8 Variation of the fresh biodiesel density as a function of temperature at different pressures (0.1 to 140 MPa).

5. Methodology

This research objective to study the kinetic reaction of waste cooking oil by transesterification into biodiesel and find the best state of its process. The research was done by transesterification reaction in batch reactor. These results were used to calculate the yield of conversion and ester content of biodiesel sample.

5.1The effect of temperature:

This research is done in waste cooing oil to methanol (alcohol) volume ratio 170:80, here use catalyst concentration 1 wt. % KOH, and time required 60 minute. The temperature variation s maintain in 50, 60, and 66.5^{o}C so as the maximum temperature that can be reaching in the reaction process. As shown fig.9.

This graph show graphical of relation between temperature and the ester content in Fig.9 & we can see that if temperature increases so it little increases in the ester content of product.

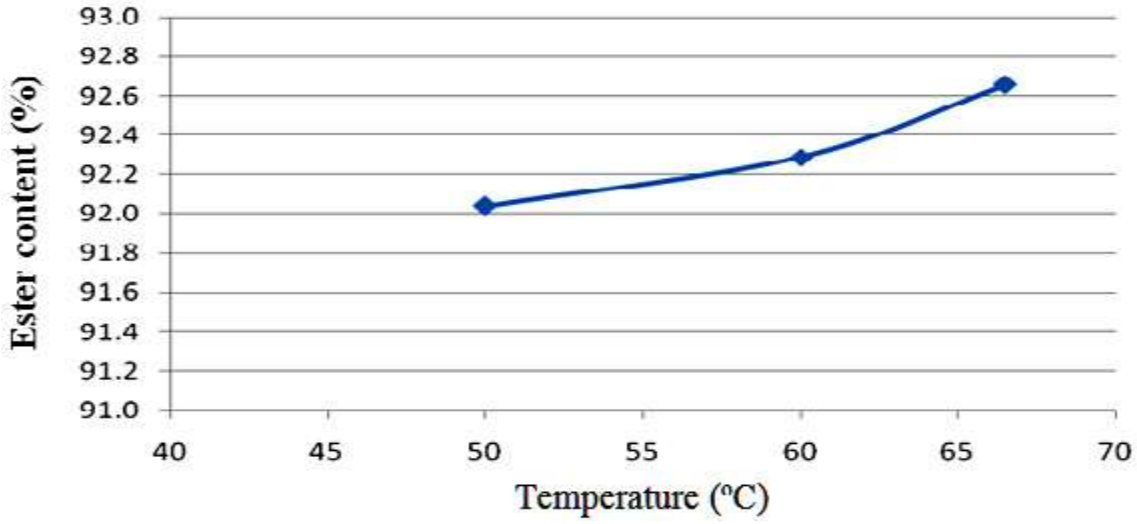

Fig. 9. The effect of temperature to the ester content of product

5.2The effect of catalyst concentration:

These research shows of graphic relation between catalyst concentration and the ester content can be seen in fig.10. And used catalyst concentration 1, 2, 3, and 4%.

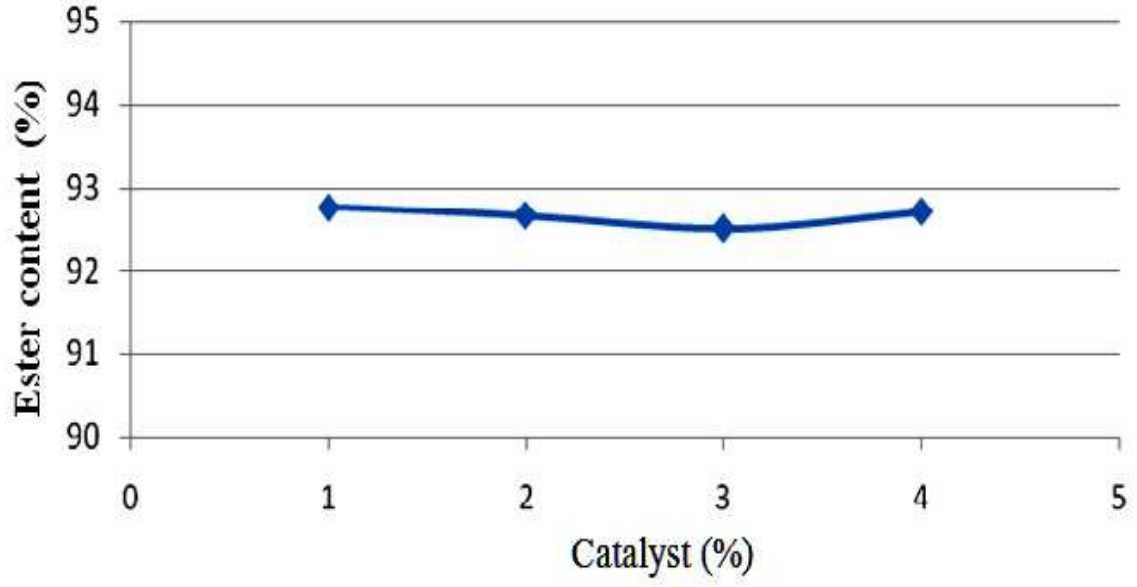

Fig. 10. The effect of catalyst concentration to the ester content.

This research was done at temperature 65^{0}C;of waste cooking oil to methanol volume ratio 200:50 (molar ratio 1:6.18) and reaction time 60 minute .So we can see that the graphic plot is almost constant with a little decrease. They said that there was no effect in molar ratio and catalyst concentration difference to the yield of biodiesel production.

Conclusion

Biodiesel is a good substitute fuel for diesel engines because it is ecologically friendly and renewable. From this above research it is cleared that Bio diesel is thus an excellent renewable fuel source. There is different methods use

for producing biodiesel, but the vegetable oil, waste cooking oil transesterification and fats is the method mostly used nowadays. The processing technology for producing bio diesel is well developed and presents little Technological risk.

All the researchers are focusing more on producing biodiesel using edible oils or waste cooking oil, but their use for biodiesel production has helped extremely to reducing its costs. It is an effective alternative with the potential to significantly improve the environment. Biodiesel is a very good diesel alternative fuel and is probably the best solution to greenhouse gas and pollution problems.

The above composition of final biodiesel was determined by physical properties such as density, viscosity, flash point, water content and acid value, it has concluded that the values of all properties were similar to that of standard specifications for biodiesel.

Furthermore, the concentration of catalyst and alcohol used in transesterification process are change which can effect on biodiesel production.

The optimum condition (the ester content 92.76%) of biodiesel production were obtained at temperature 66.5^{o}C, molar ratio of methanol to oil 6.18:1, and 1 wt.% of catalyst concentration and biodiesel product from second-used cooking oil is appropriate with standard.

The major advantage of Biodiesel compared to other alternatives such as natural gas or electricity, is that it can be used without modification in various fuel-based applications especially in existing diesel engines.

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