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MICROWAVE ASSISTED PRODUCTION OF BIODIESEL FROM WASTE COOKING OIL AND ITS PERFORMANCE CHARACTERISTICS IN A CI ENGINE

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Abstract

Global environmental concerns and decreasing resources of crude oil have prompted demand for alternative fuels. Biodiesel, which is synthesized from renewable resources is biodegradable and contributes a minimum amount of net green house gases or sulphur to the atmosphere. In this work microwave assisted transesterification of waste cooking oil was carried out in the presence of methanol as a reagent and mixture of potassium hydroxide and sodium hydroxide as the catalyst. Application of the radio frequency microwave energy offers a fast, easy route to the valuable biofuel with advantages of enhancing the reaction rate and improving the separation process. Secondly optimizing the biodiesel from changing the parameters are oil to alcohol molar ratio, catalyst concentration, reaction time, microwave power. In order to reduce the viscosity, the WCO were under the transesterification produced biodiesel blend with diesel.

Three various blends of biodiesel and diesel were prepared and its important properties such as viscosity, density, calorific value and flash point were evaluated and compared with that of diesel. The blends were then tested in a direct injection diesel engine in 10% ,20% and 30% blends with a reference diesel fuel. Tests were performed under a set of engine operating conditions. It was found that blending biodiesel with diesel reduces the viscosity. Blending of biodiesel with diesel has been shown to be an effective method to reduce engine problems associated with the high viscosity of WCO. The experimental results also show that the basic engine performance such as power output and fuel consumptions are comparable to diesel and the emissions of CO,CO2 and NOx from the biodiesel/diesel blends were also found slightly higher than that of diesel fuel.

I. INTRODUCTION

Nowadays, most of the waste cooking oil (WCO) is poured into the sewer system of the cities. This practice contributes to the pollution of rivers, lakes, seas and underground water, which is very harmful for environment and human health(2).

Only a small amount of the waste cooking oil is properly collected and recycled. In this situation the WCO may be an alternative option to be used as diesel substitute in diesel engines. Most of the WCO are from Vegetable oils that are normally used for cooking or food frying purposes. The high viscosity of these biofuels deteriorates the atomization, evaporation and their fuel mixture formation characteristics leading to improper combustion and higher smoke emissions.(1)

It creates operational problems such as difficulty in engine starting, unreliable ignition and decrease the thermal efficiency . In long term use, these fuels might caused carbon deposits, ring sticking, fuel pump failure, etc. The literature also shows that a large amount works have done into evaluating the conversion the WCO to biodiesel . The use of biodiesel as fuel for compression ignition engines has many environmental advantages; however, the production of biodiesel involves the use of a toxic, flammable liquid methanol and caustic compounds like sodium hydroxide or potassium hydroxide. It also presents several problems when compared with petroleum diesel such as low temperature properties, greater emissions of some oxygenated hydrocarbons and higher production cost. There are some other methods to reduce the viscosity of vegetable oils. Fuel blending is one of the methods. It has the advantages of improving the use of vegetable oils with minimal processing and economic.(5).WCO used in industrial or household frying undergo degradation by thermolytic, hydrolytic and oxidative reactions. These process being responsible for changes in the chemical and physical properties, as compared to neat oil. cooking oil

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reported in the literature used various origin of vegetable oils or WCO and in many cases the WCO oil are collected after frying a wide variety of meat, fish or vegetable products. The waste frying oil is then blended with other waste oils and being processed for further application. No study has been reported focus on the waste frying oil variation of specific cooking habit and foods(7). This study aims to compare performance and emissions from diesel engine when fuelling with a conventional petroleum diesel fuel and blends of biofuels from waste cooking oil with petroleum diesel. To ensure the uniformity of the WCO on performance and emissions, oils for WCO were chosen from the same retrospective uses. In this experiment, WCO blended fuel was used in diesel engine to evaluate engine performance and exhaust emissions.

2 EXPERIMENTAL SET UP AND PROCEDURES

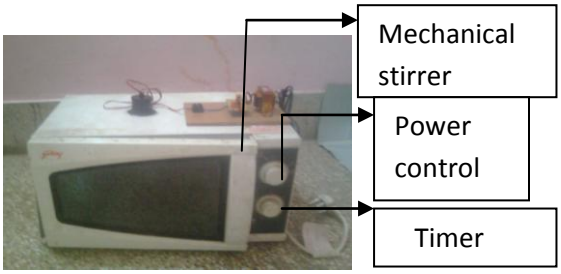

Fig.1. Microwave oven with Mechanical stirrer

Fig 1 shows the arrangement of microwave oven with mechanical stirrer .The mechanical stirrer was consists of 12V DC motor, Shaft, Transformer, supply. The power supply was to be controlled by power controller. The temperature range can be varied by temperature controller. The power range of microwave oven is 1200W.

Table1. specifications of the Microwave oven.

INPUT	OUTPUT	DIMENSION
220V, 1200W	700W	262mm(H), 452mm(W)

2.1.ENGINE SPECIFICATIONS

Table.2 specifications of the engine.

Make	Kirlosker AV1 model
Number of cylinders	1
Number of strokes per cycle	4
Combustion chamber	Direct injection
Cooling system	Water cooled
Compression ratio	16.5:1
Bore x Stroke(mm)	80 x 110
Max power(HP)	5

2.2.PROCEDURE

1.100ml of waste cooking oil was first preheated to a temperature of 60° C using microwave oven.

2.Then 6:1 oil to alcohol molar ratio (24 ml methanol) was mixed thoroughly with the 1gram (0.5gmKOH, 0.5gm NAOH) catalyst.

3.This mixture was then transferred to preheated oil contained in a conical flask

4.It is then stirred well for nearly 2 -4 mins by using mechanical stirrer .

5. After the heating of that mixture it is then transferred to the separating funnel and kept for overnight(12 hours) for the separation of glycerol from biodiesel.

6.After that separating the biodiesel and glycerol.

7.Finaly the biodiesel purification process was conducted.

2.3. BIODIESEL PURIFICATION

The purification step is one of the most important for obtaining a good quality biodiesel. After the transesterification reaction , the mixture is allowed to separate into two layers by settling in the separating funnel. The upper layer consisted of methyl esters, whereas the lower layer is purified by gently washing with distilled water (at about 60° C) until the washing water has a pH value similar to that of distilled water. for this operation several washing steps are needed, using a volume of water about ¼ th that of the biodiesel volume. In the first washing steps, a few drops of phosphoric acid are

added to the washing water to accelerate the neutralization and precipitate any potassium from the catalyst still existing in biodiesel. In each washing steps the pH is measured in the washing water coming out from the bottom of the separating funnel, until it is neutral.

2.4 FUEL PROPERTIES OF THE TESTED FUELS

Table.3. fuels properties of the tested fuels.

Test no	Fuel	Fuel blended (volume%)
1	A	10%biodiesel and 90% diesel.
2	B	20% biodiesel and 80% diesel.
3	C	30% biodiesel and 70% diesel.
4	D	100% biodiesel

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Table. 4. properties of the above mentioned tested fuels.

Properties	A	B	C	D
Viscosity at 40◦c(Cst)	3.43	3.39	3.74	4.13
Calorific value(KJ/kg)	44886	44230	43630	40870
Specific gravity	0.844	0.85	0.86	0.92
Flash point (° c)	84.8	86	88	131
Cloud point (° c)	15	15.6	16	13
Pour point (° c)	8	8.36	8.5	9

2.5.OPTIMIZATION OF BIODIESEL

By varying four parameters optimizing the biodiesel to find the higher yield of the biodiesel. Such parameters are amount of alcohol, amount of catalyst concentration, microwave exit power, reaction time.

EFFECT OF AMOUNT OF ALCOHOL

The amount of the alcohol was to be varied, while the other parameters have to be kept constant. About 100 ml of WCO was taken, 0.5 gm of NaOH, 0.5 gm KoH, microwave power was to be maintained at 800W.The time of the reaction was 2 min. The amount of the alcohol to be varied are 18ml, 20ml, 22ml, 24ml.From each experiment the yield of the biodiesel was calculated from graph1. The high yield of the biodiesel was obtained at 24ml.

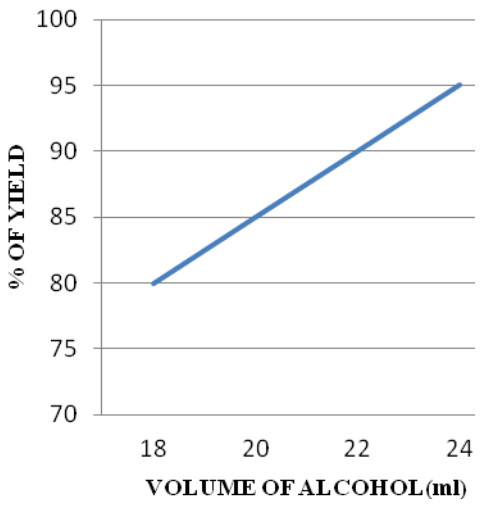

Fig.2.Effect of Amount of Alcohol

EFFECT OF AMOUNT OF CATALYST

Amount of the catalyst was varied about 0.25gm,0.5gm,0.75gm,1gm,while the other parameters are 24ml methanol, power 800watts,reaction time 4mins are kept constant.

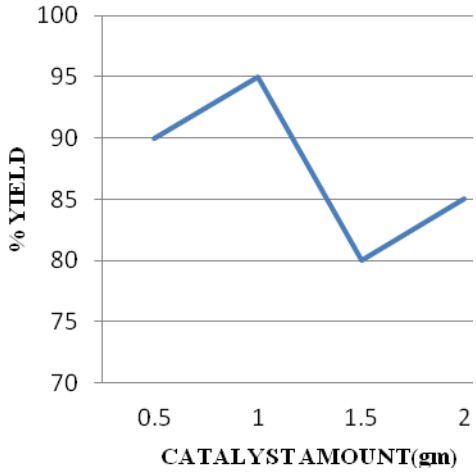

Fig.3.Effect of Amount of catalyst

EFFECT OF VARIATION OF REACTION TIME

The reaction times to be varied are 2mins,4mins,6mins,8mins. While the other parameters are kept constant. From each experiment the yield of biodiesel formed is calculated. The high yield of biodiesel was obtained at 4 min of reaction time from graph 3.

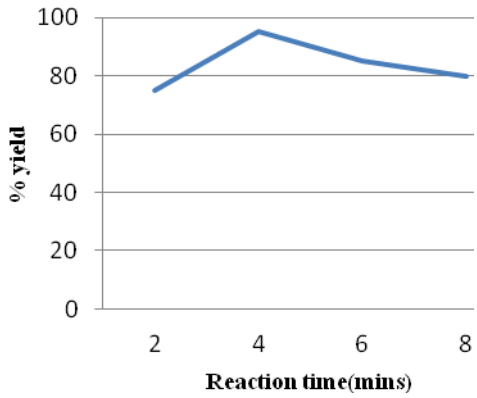

Fig.4. Effect of variation of reaction time.

EFFECT OF VARIATION OF MICROWAVE POWER

The microwave power was to be varied from 200W,400W,600W,800W. While the other parameters are kept constant.

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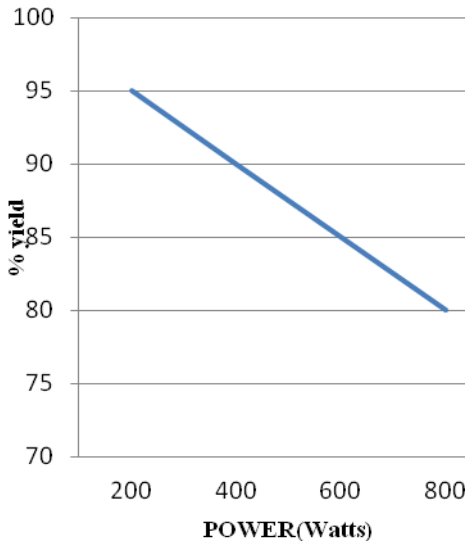

Fig.5.Effect of variation of microwave power

3.RESULTS AND DISCUSSION

3.1 PERFORMANCE CHARACTERISTICS OF ENGINE FUELLED BIODIESEL BLENDS

The experiments investigation was carried out for different blends of fish methyl esters(biodiesel) and performance, emission, combustion test was carried out for different blends.

Fig. 6. shows the specific fuel consumption variations with various tested fuels blend at variation of loads. Fuel consumption is decreasing with increasing of load.B100 has the higher specific fuel consumption compared to the other blends.B10 has slightly lower fuel consumption when compared to B20.

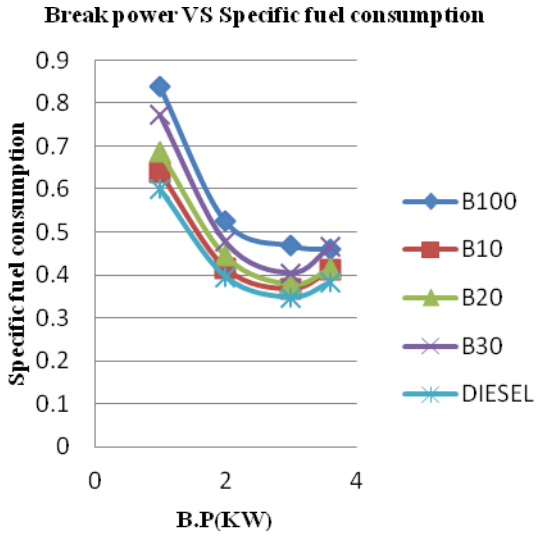

Fig.6.Break power VS specific fuel consumption

Fig.7.shows the break thermal efficiency variations with various tested fuels blend at variation of loads. Efficiency is gradually increasing with increasing of loads.B10 has the higher efficiency when compared to other blends.B20 has slightly lower efficiency compared to B10.

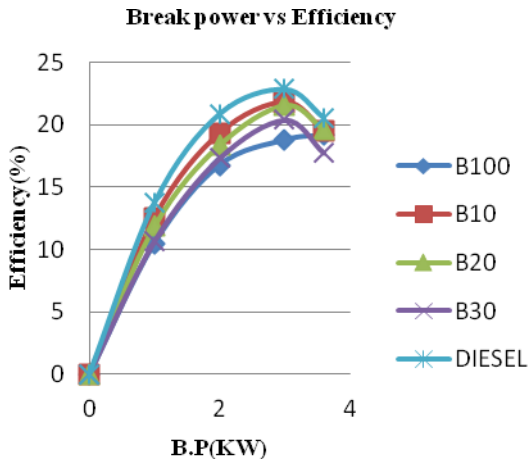

Fig.7. Break power VS Efficiency

Fig 8. shows the total fuel consumption variations with various tested fuels blend at variation of loads. Total fuel consumption is gradually increasing and then decreasing with respect to increasing of loads.B30 has the higher total fuel consumption when compared to other blends.B100 has the lower total fuel consumption.

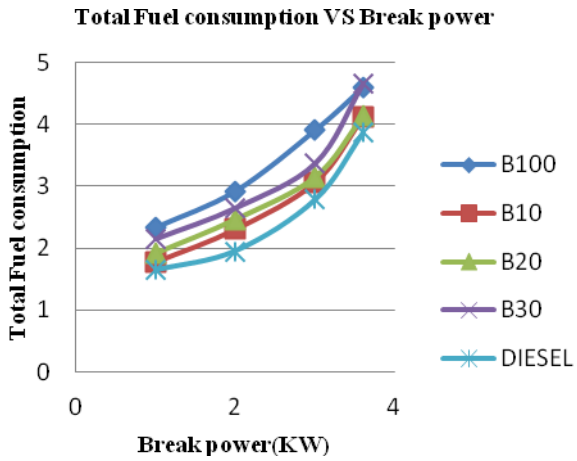

Fig.7. Total fuel consumption Vs Break power

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4.CONCLUSION

The experimental results shows that the blends of biodiesel with the diesel gives the good performance, emission. B10 has the higher efficiency compared to other blends. The properties of the biodiesel was closely matching that of diesel. The engine power output and the fuel consumption of the engine are almost same when the engine was fuelled with the blends of biodiesel with diesel. Compared to other oil waste cooking oil was economic one to produce biodiesel , and easily can produce biodiesel. They are environment friendly, biodegradable, renewable.

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