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Preparation of Waste Cooking Oil as Alternative Fuel and Experimental Investigation Using Bio-Diesel Setup a Comparative Study with Single Cylinder Diesel Engine

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ABSTRACT

Recycled waste cooking oil is harmful to health, but it is not environmental friendly to dispose used cooking oil just like that. The best solution is to used it for industrial purposes, namely to reproduce into biodiesel.

This project is to produce biodiesel from waste cooking oil using pilot plant and the biodiesel tested in the laboratory. The pilot plants are continuous system to produce biodiesel. The biodiesel was blended with diesel oil to get B5 and B10 grade biodiesel. It produces biodiesel based on the American biodiesel standard ASTM6751. The application of this biodiesel has enabled the company to use its waste cooking oil without having to dispose it and this has save cost to the company. The other advantage is that it has significantly help to preserve environment and as well as conversion of waste to useful energy.

The biodiesel plant has also motivated the staff towards thinking about environment and also alternative energy thus sustaining its operation.

Index Terms:-Biodiesel, Waste cooking oil, Pilot plant, Alternative energy

INTRODUCTION

21st century has been facing many problems like energy sustainability, environmental problems and rising fuel prices. Conventional fuels are known for polluting air by emissions of sulfur dioxides, carbon dioxides, particulate matter and other gases [1]. This has resulted to increased research in alternate fuels and renewable source of energy. Moreover, energy consumption of the world is ever increasing; this has caused the fuel resources dwindle. The transport sector worldwide has considerably increased the fuel consumption reaching 61.5% of the total, especially in the last decade. Recent research expects that the amount of petrol in the world can be used merely for next 46years. Hence, interest in research for an effective substitute for petroleum diesel is increasing. Currently , India produces only 30% of the total petroleum fuels required for its consumption and the remaining 70% is imported, which costs about Rs.80,0000 million per year. It is evident that mixing of5% of biodiesel fuel to the present diesel fuel can save

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Rs.40, 000 million per year. Over last few years, Biodiesel (fatty acid methyl esters) has become the part of the equation in the 1990's as the effects of global warming began to get political acknowledgement, because of its benefits over petroleum diesel like significant reduction in greenhouse gas emissions, non-sulfur emissions and non-particulate matter pollutants, low toxicity, biodegradable and is obtained from renewable source [7] like vegetable oils, animal fat etc. Biodiesel is superior to fossil diesel fuel in terms of exhaust emissions, cetane number, and flash point and lubricity characteristics, without any significant difference in heat of combustion of these fuels [2]. Moreover, biodiesel returns about 90% more energy than the energy that is utilized to produce it.

PREPARATION OF BIODIESELS

Biodiesel Production:

As mentioned above biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste oils

Biodiesel can be processed from different mechanisms,Some of them are

1. Direct use or blending in diesel fuel
2. Micro emulsions in diesel fuel,
3. Thermal cracking of vegetable oils
4. Transesterification.

In this project, transesterification is focused. Almost all biodiesel is produced using base catalyzed transesterification as it is the most economical process requiring only low temperatures and pressures and producing a 98% conversion yield [3]. For this reason only this process will be described in this report.

Process of Transesterification

Transesterification is a chemical reaction used for the conversion of vegetable oil to biodiesel. In this process vegetable oil is chemically reacted with an alcohol like methanol or ethanol in presence of a catalyst. After the chemical reaction, various components of vegetable oil break down to form new compounds.

The triglycerides are converted into alkyl esters, which is the chemical name of biodiesel. If methanol is used in the chemical reaction, methyl esters are formed, but if ethanol is used, then ethyl esters are formed [4]. Both these compounds are biodiesel fuels with different chemical combinations. In the chemical reaction alcohol replaces glycerin.

Glycerin that has been separated during the transesterification process is released as a byproduct of the chemical reaction. Glycerin will either sink to the bottom of the reaction vessel or come to the surface depending on its phase. It can be easily separated by centrifuges, and this entire process is known as transesterification [5].

The process of transesterification consists of four basic steps.

- Acid treatment followed by settling process
- Base treatment followed by settling process
- Water washing
- Dehydration.

PREPARATION OF BIO-DIESEL FROM WASTE COOKING OIL:

Acid treatment carried out approx. 60°C. In this process 150ml of methanol and 2-3ml of sulphuric acid is added. Settling is carried out in Decanter for approx. 8Hrs.

Base treatment carried out approx. 70°C. In this process 250ml methanol and 7 grams of KOH/NaOH is added [6]. Settling is carried out in Decanter for approx. 8Hrs (in this process glycerin is settled at the bottom).

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Separate the glycerin and oil wash the oil with water.

Dehydration is carried at 120°C and biodiesel is obtained

PROPERTIES OF BIODIESELS

		WCO	biodiesel	
			B60-D40	B50-D50
Chemical formula	C12H23	C17H31O2	-	-
Flash Point (° C)	78	90	80	83
Fire Point (° C)	82	102	86	90
Calorific Value (kJ / kg)	42000	42650	42588	42600
Viscosity at 25°C (mm/sec)	5.2	4.9	5.0	5.1
Density(Kg/m3)	827	850	830	840
Sulfur contents (mg/kg)	57	8	10	12
Carbon (% w)	86.2	66.4	70	75
Ash Content (%)	0.008	0.00258	0.0032	0.0020

PERFORMANCE TESTS ON FOUR STROKE SINGLE CYLINDER DIESEL ENGINE

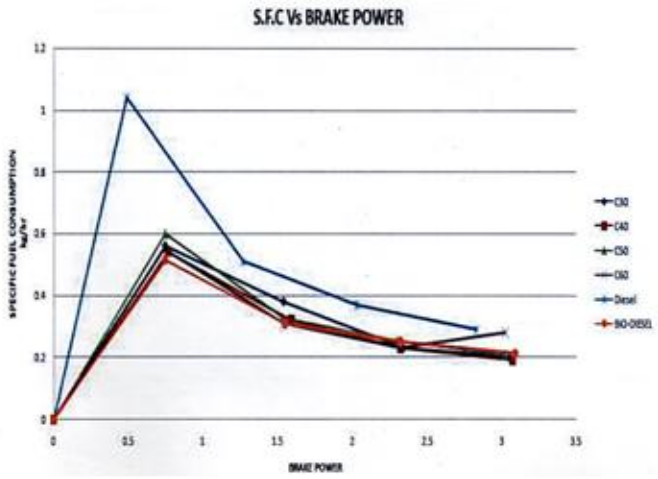
(Diesel: 70% - Biodiesel: 30%)

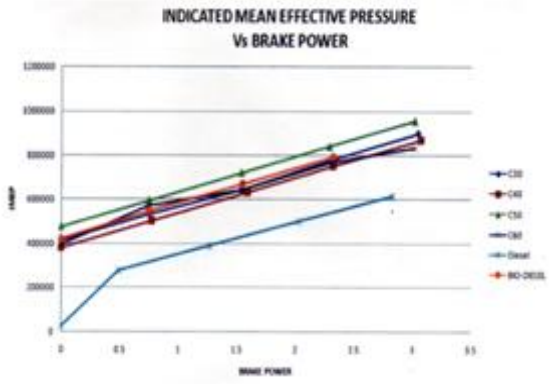
S.NO	Load (kg)	Time for 10cc in sec	F.C(kg/hr)	B.P(kw)	F.P(kw)	I.P(kw)	ηmech(%)	ηbth(%)	ηith(%)	IMEP(pa)	BMEP(pa)	SFC
1	0	86	0.35	0	3.5	3.5	0	0	77.7	557043.4	0	0
2	2	74	0.42	0.77	3.5	4.27	19.6	14.7	74.6	623889.1	111408.7	0.55
3	4	63	0.49	1.54	3.5	5.04	38.5	25.1	65.1	635030.6	222816.03	0.32
4	6	58	0.54	2.32	3.5	5.82	57.4	34.3	59.8	642987.7	335672.2	0.23
5	8	55	0.57	3.09	3.5	6.59	75.9	43.2	57.1	647762.5	447080.5	0.18

RESULTS

Performance Characteristics:

Performance charts are those which compare the performance parameters which are found on the engine for those produced diesels.





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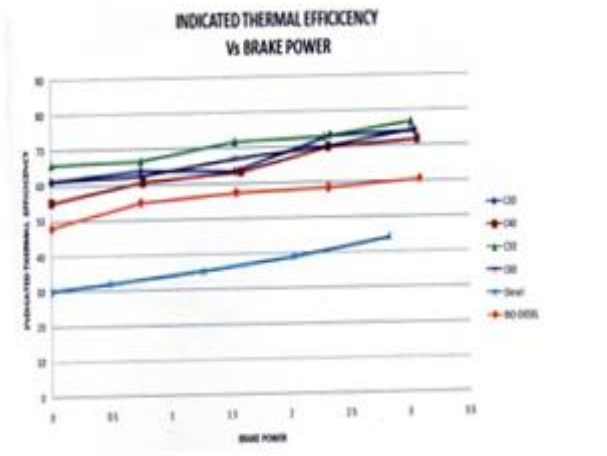

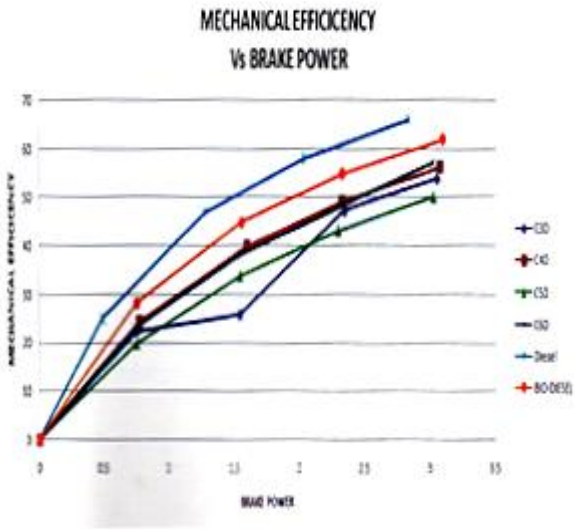

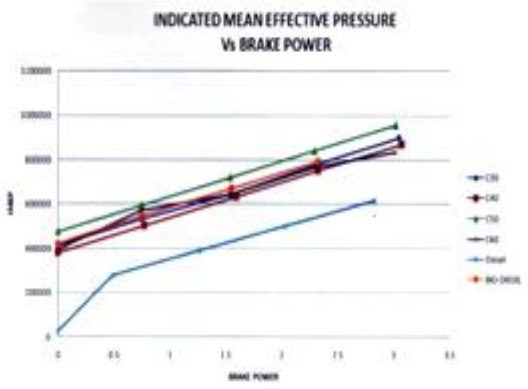

It is found that the optimum performance is achieved with BlendedBio-diesel at 70:30 ratios of palm Bio-diesel in comparison with conventional diesel considering engine performance parameters.

CONCLUSIONS:

The biodiesel produced showed viscosity, specific gravity and calorific value are well within the range of diesel oil and all the properties satisfy the B.I.S standards of biodiesel.

Flash and fire points of biodiesel are comparatively higher for biodiesel, thus the risk of fire hazards gets reduced and handling and storage of biodiesel is safer.
Bio-diesel can be used in the existing engine without any modifications to the existing engine except fuel tank.
Compare to the other fuels, engine run with Blended Biodiesel takes less mass of fuel.

Compare to the other fuels running cost of engine using Blended Biodiesel is better.
Compare to the other fuels the Engine run with Blended Biodiesel is having minimum frictional losses.

Fuel consumption of Blended Biodiesel is less compare to other fuels.

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