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Extraction of Biodiesel from Coconut Waste – Study of its Properties, Performance and Value Addition

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Abstract: ***The possible shortage of fossil fuels and environmental problems that the world is facing today requires long-term actions for sustainable development. The renewable energy sources appear to be one of the most efficient and effective solutions. One of the solutions is the extraction and usage of biodiesel. Biodiesel industry needs a cheaper and economical viable raw material such as coconut waste that can replace the currently used vegetable oil. Obtaining cheaper raw materials are one of the continuous targets of many biodiesel producing facilities since most of the production costs are attributed to raw materials. One of the main options is to use waste material from animal and plant sources. The coconut waste raw material is easily available from various coconut oil refineries. The coconut waste is used to produce biodiesel using ethanol and NaOH. The oil content of coconut waste varies from 10-11% weight. The biodiesel could be used as pure fuel or as a blend with petro diesel, which is stable in all ratio.***

Keywords: Coconut waste, Biodiesel, Transesterification, Diesel Engine, Pellets.

I. INTRODUCTION

Biomass is a renewable resource which implies that it a part of the flow of resources occurring naturally and repeatedly in the environment the term biomass generally refers to renewable organic matter generated by plants animal waste. Increased environmental concerns and depletion of fossil fuels have directed the scientists to work on alternative fuel sources that burn more cleanly and are renewable. Hence biofuel studies are becoming more important among other investigations the idea of using biodiesels as fuel for diesel engines is not new. Rudolph Diesel, the inventor of the Compression Ignition engine used peanut oil to fuel his engine at Paris exposition of 1900. The short-term tests were almost always positive, long-term use of neat vegetable oil lead to severe engine problems, such as deposition, ring sticking and injector chocking. High viscosity and a tendency for polymerisation within the cylinder appears to be at the root of many problems associated with the directives of these oil as fuels. Biodiesel has shown suitability as alternative diesel fuel as a result of improved viscosity and volatility relative to vegetable oil. Therefore, efficient Transesterification plays a vital role in the conversion of raw vegetable oil to the concerned ester of biodiesel. The chemical and physical properties of biodiesel closely resemble those of diesel fuel. Biodiesel's Cetane no, energy content, viscosity, and phase changes are similar to those of petroleum-based diesel fuel. Biodiesel also offers enhanced safety characteristics when compared to diesel fuel. It has a higher flash point and does not produce explosive air or fuel vapours. Moreover, it is biodegradable, less toxic. Biodiesel was extracted from rice bran oil and tests were carried out on diesel engine and found that 14 was the optimum compression ratio [1]. PODE was mixed with biodiesel and tested on single cylinder engines and found that emission of soot was reduced [2]. With slight modifications in the engine biodiesel can be used without any blending [3]. Biodiesel was produced using the neem seeds and found that it had similar characteristics [4]. Along with the biodiesel ethanol was used for combustion in the engine during which BSFC was produced on comparison levels [5].

II. WHY COCONUT WASTE AS RAW MATERIAL?

As a whole, the use of coconut waste as a raw material to produce the biodiesel should have positive effects in various aspects in order to justify their sustainable use. The following are some of the points that justify our project's aim: -

A. Environmental Advantages

1) Coconut oil based diesel does not contribute to the greenhouse effect; when burnt in a Diesel engine, coco diesel emits less Sulphur dioxide SO2.
2) Coconut oil emits 50% less particle matter (black smoke) than conventional diesel.
3) Coconut oil is biodegradable. The remaining waste is also degradable and can be used for other purposes.

B. Economic Advantages

1) Coconut oil based fuels yield more Km per litre used than other fuels for diesel engines.
2) The cost of coconut blended fuel is lower than the cost of other fuels for diesel engines.
3) A high percentage of the income from coconut based fuels will go to the local farmers in rural areas.

C. Mechanical Advantages

1) Coconut oil based fuels have better lubricating qualities than other fuels for diesel engines so it causes less wear on internal engine parts and prolongs engine life.
2) Coconut oil burns slower than other diesel fuels so it pushes the piston all the way down the cylinder instead of a rapid explosion at the top of the stroke resulting in an even power release, less fuel use, less engine wear and a quieter running engine.
3) Coconut oil-fuelled Diesel runs cooler due to less internal friction and the slower burn rate than the other fuels. Therefore, the use of coconut oil waste can be reused effectively and the extracted fuel will result in the above-listed benefits.

III. BIODIESEL PRODUCTION

A. Raw Material

The raw material used in obtaining the biodiesel is the last form of coconut oil collected at the end of the coconut oil extraction process. The waste oil is obtained during the filtering process of the coconut oil. This waste is the form of froth appearing on the top surface of the oil in the coconut oil processing machine.

B. Transesterification

1) Coconut oil is extracted from the coconut waste.
2) To the coconut oil, equal proportions of ethanol is added.
3) For the mixture, about 5% quantity of sulphuric acid is added.
4) The mixture is taken in a round bottom flask and is kept on a magnetic stirrer for about 60 minutes at 60ºC.
5) Then the mixture is transferred to separating funnel where the esters and the fatty acids form a separate layer.
6) The ester is separated and used for blending.

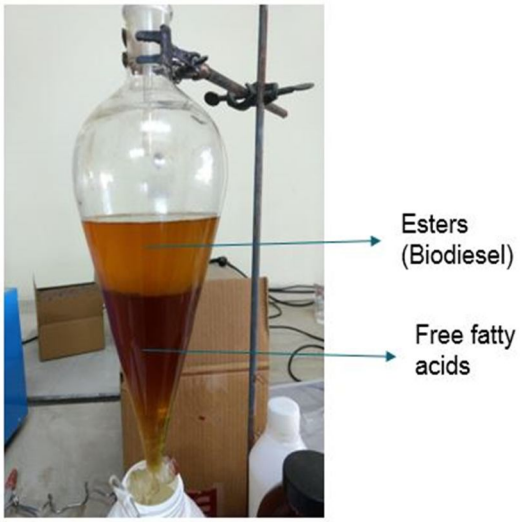

Fig 1 Separation of biodiesel

C. Blending

The blends are made by mixing diesel and esters at various proportions like:

1) 10%
2) 20%
3) 25%

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IV. VALUE ADDITION

The value addition can be further performed using the other wastes like coconut shell, coconut fibres and semi-solid oil waste. Pellets can be made out of these wastes. The coconut shell and coconut fibres are powdered fine enough so that they can form a proper binding. The semi-solid waste and the powdered material are mixed with glycerin (binding agent). The mixture is filled in hollow PVC pipe and rammed so that the materials remain packed. The rammed pellet is dried for 2-3 days. These pellets can be used as external burning source. Hence all the remaining wastes are converted into useful pellets.

V. MEASUREMENT OF FUEL PROPERTIES

The physical and chemical properties of the blends of the biodiesel are measured and compared with diesel. The properties are mentioned in the Table 1.

Table 1 Properties of fuel

Fuel Property	B10	B20	B25	Diesel
Density (Kg/m^3)	846.31	839.4	835.6	900
Flash point(°C)	35	38	40	52
Fire point(°C)	42	46	48	60
Calorific Value (KJ/Kg)	39612.2	37662	35213.2	42275

VI. ENGINE PERFORMANCE AND TESTING

The single cylinder four stroke diesel engine was used for testing various blends of biodiesel, specification and make of the engine used for experimentation is given in Table 2. The test rig can be used to calculate engine brake power, air consumption, fuel consumption, heat balance, thermal efficiency, volumetric efficiency etc. The test was conducted by varying loads. The readings generated were tabulated and used for calculations.

Table 2 Engine Specifications

Make	Kirloskar
Engine Type	4-Stroke Diesel Engine
Rated Power	5 HP @ 1500 RPM
Bore	80mm
Stroke	110mm
Cylinder Capacity	553cc
Starting	By Hand Cranking

VII. RESULT AND DISCUSSION

Comparison of engine parameters with Diesel

The comparison of the listed engine parameters above of the biodiesel with different amounts of blending and pure diesel is as follows –

A. ήV vs load –

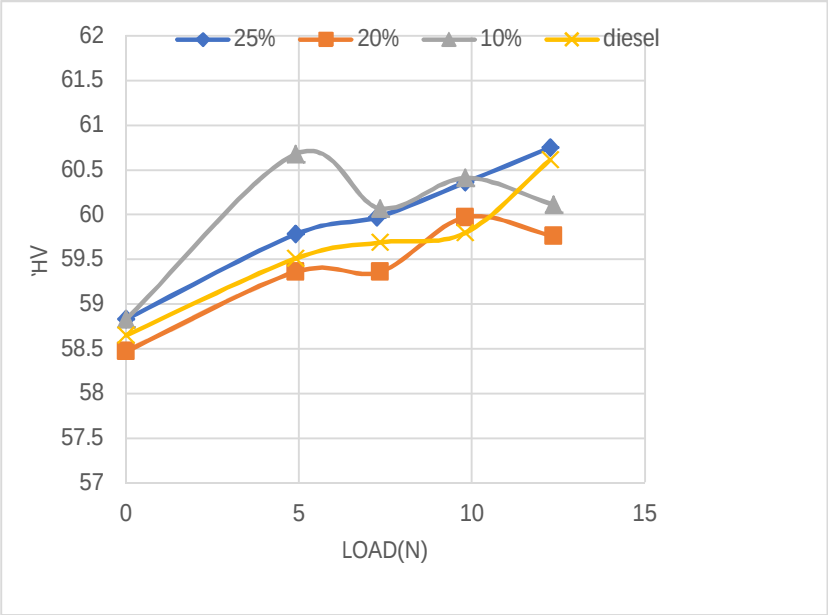

Fig 2 - ήV vs Load

The plot shown in fig 1 compares the Volumetric efficiency vs Load for different blends; 25% blend and 10% blend have higher efficiency than that of diesel at large range of loads. 20% blend has slightly lower efficiency than diesel. Though the efficiency of 10% is less for higher loads, it can be considered for usage since is produces lesser emission. By our experimentation; the present 10% blend can be replaced by 25% blend thereby reducing the usage of diesel by 25%, lesser emission and also higher efficiency.

B. BSFC vs load –

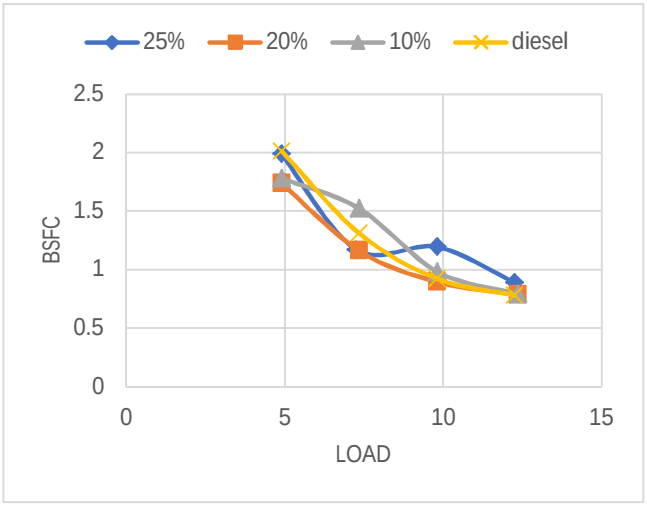

Fig 3 – BSFC vs Load

The plot shown in fig 2 compares the BSFC vs Load for different blends. 20% blend has lower BSFC at lower loads when compared to diesel. At higher loads the BSFC is almost equivalent as that of diesel. 10% blend has higher BSFC at almost all loads. Even 25% has higher BSFC but only at higher loads. But in order to keep up to the govt. norms, we can prefer the use of 20% blend.

C. BP vs Load –

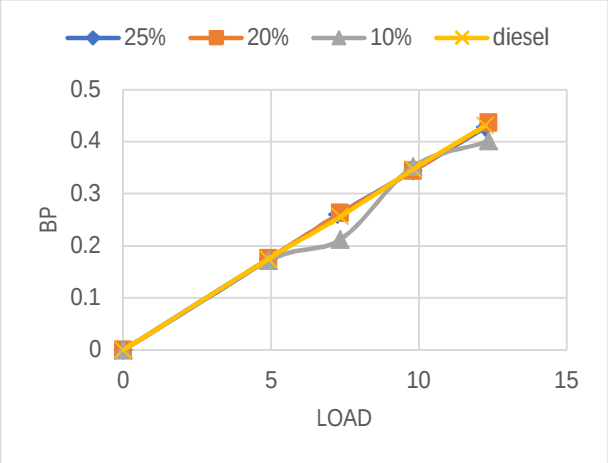

Fig 4 – BP vs Load

The plot shown in fig 3 compares the BP vs Load for different blends. We can observe that the BP of 25% and 20% blend are almost equivalent to diesel while 10% blend has lesser brake power thereby reducing the efficiency, hence it is a disadvantage. So our experimental blend of 25% biodiesel can be used. As a whole from the comparisons, it is possible to use 25% blend of biodiesel and can be standardized thereby saving enormous amount of diesel usage. The other advantages include increased efficiency and reduced environmental impact.

VIII. CONCLUSION

This work exhibits the generation and test examination of engine performance utilizing diesel fuel as baseline and biodiesel mixes, for example, B10, B20 and B25 separately Pellets were also prepared using the wastes of coconut. The experimental results of this project work can be summarized as follows.

A. Biodiesel can be produced from the coconut waste using the process of transesterification.
B. Physical properties of the blended biodiesel were examined and found to be on par with diesel.
C. Contrasted with diesel fuel, motor torque and brake control for biodiesel mixes were diminished, for the most part, because of their particular lower heating values. The BSFC values for biodiesel mixes were higher when contrasted with diesel fuel because of lower heating values and higher densities.
D. In examination with the diesel fuel, biodiesel blends delivered lower sound levels because of numerous components incorporating increment in oxygen content, lessening in start delay, higher consistency, lubricity etc.
E. The reuse of the coconut waste is carried out by making pellets which act as burning fuel in the industries whether it may be for heat generation or in furnace.

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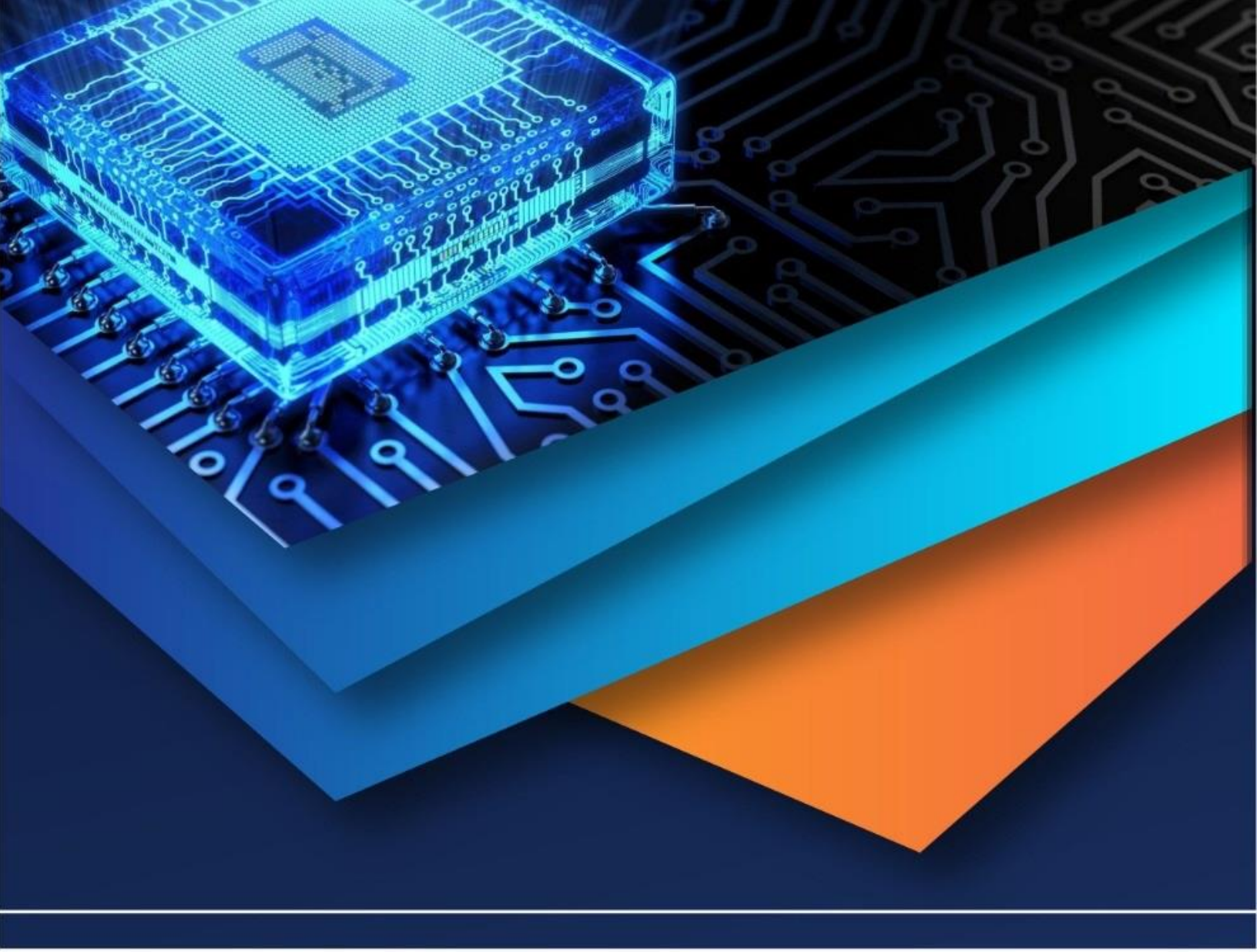

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