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Measurement and Comparison of the Total Response of Bio-fuelled CI Engine with & without an additive

P.V.CHANDRAN

Lecturer (HG), Department of Mechanical Engineering, S.N.Polytechnic College, Kanhangad

Abstract: Availability of pure air is everyone's right, not only of the human beings but all animals living on the globe. The main source which pollutes the air is exhaust emissions from diesel engines. Also, the extensive use of fossil fuels results in its depletion and increase of green house gases and global warming. In this present context, the use of bio diesel produced from waste coconut oil is analyzed and conducted an experimental investigation of its performance and emission characteristics while using in a diesel engine with and without the additive. The additive used is 1heptanol which is readily available. The load test is conducted at different fuel injection pressure and angle and for B20, B40, B50, and B100 blends with 5%, 10% and 15% of heptanol. The doping of additive and higher injection pressure and angle gives better results, in both performance and emissions. Hence waste coconut oil biodiesel with heptanol can successfully be substituted for diesel fuel in future.

Keywords: Waste Coconut Oil, Biodiesel, Injection Pressure, Injection Angle, Heptanol.

I. INTRODUCTION

The atmospheric air is the only agent which connects all kinds of livings on the earth. Air is the fundamental factor which maintains life on earth. As such, pure oxygen is a fundamental right of every living on the globe. The quality of air or oxygen which we takes for breathe depends on the decision we takes and our involvement in the environment. Out of the various pollutions in the world, the most significant is the air pollution, because the bad effects of this is experienced by all the animals. The United Nations say that 92% of the oxygen in air is not in the pure form. In 2016, over 10 lakhs of people succumbed to death for various diseases due to the air pollution alone. This rate increases every year. More than this slaved to permanent disabilities. Every year in the world 5000crores of dollars are investing to fight against this disaster. The secondary effect of the air pollution is the huge increase in the risk of greenhouse gases and consequent effect of global warming and climate change. This deteriorates the total economy of the countries. Major effect of the air pollution is experienced by a section of economically poor people. The emissions through the various developmental works of roads, buildings, bridges and other sources pollutes the air at a rate more than by the industries. However, when comparing with the emissions from vehicles, all these are secondary sources. Hence the main source which pollutes the air is exhaust emissions from diesel vehicles used for passengers and goods services. Every year, a huge increase is recorded in the number of passenger vehicles and goods trucks in India.. It is found that the emission from the diesel vehicles is the main cause for the half of the total immature death recorded in the world. In this case, the capital of India, Delhi stands 6thplace. To solve these problems, it is essential to reduce the population density of vehicles, or find some other alternative fuels which reduce the emission of dangerous pollutants. Taking into consideration the various aspects, the best alternative fuel which can replace fossil fuels is bio diesel produced from vegetable oils. Vegetable oils blended with diesel in various proportions with a suitable additive will definitely give good results as well as solve the environmental problems associated with the use of fossil fuels. The waste coconut oil biodiesel with heptanol is a suitable and an efficient and economic fuel that can be used in place of pure diesel.

II. MOTIVATION

The detailed and meticulous review of the various works carried out in this area shows that a lot of works have been carried out by eminent scholars using various kinds of bio diesels, with and without additive. But only minor investigations are done on waste coconut oil, which is abundantly available in our country, with a suitable additive. As the fuel injection pressure and angle are two important factors which influence the power output of a CI engine, no works have been carried out to assess the performance of a bio-fuelled CI engine with varying pressure and angle. Therefore in this article, we are analyzing the various properties of different blends of waste coconut oil biodiesel and

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the effects of heptanol in the performance and emission of a diesel engine. A detailed load test is conducted on a single cylinder four stroke diesel engine using the waste coconut oil biodiesel with and without heptanol at different injection pressure and angle. The performance and emission of the engine at the conditions of different injection pressure and angle with and without additive is measured and also a comparative study is carried out. Comparison is done in terms of the percentage increase in BTE and BSFC and emission of the engine with additive and without additive at different injection pressure and angle.

III. MATERIALS AND METHODS

1.WASTE COCONUT OIL – BIODIESEL

The oil extracted from waste copra is called waste coconut oil. This oil cannot be used for any domestic purposes or as edible oil. The dehydrated pork or dehydrated nut of coconut is called copra, which is the initial raw material form used to produce waste coconut oil. Some types of such copra as shown in figure are used for this purpose.

Fig. 1 Waste Copra

In totality while using coconut waste oil as a raw stock for producing biodiesel, it should have various positive effects in the society.

Environmental benefits are – (1). It does not contribute anything towards the green house effect and it emits a very less amount of SO_2. (2) The emission of black smoke in this oil is 50% less than traditional diesel fuel. (3). This oil is fully bio-degradable. Economic benefits are-(1). It gives more mileage than any other biodiesels. (2). Its cost is lower than other fuels. (3). It will improve the economical conditions of the local farmers.

Mechanical benefits are – (1). It has better lubricating quality and therefore less internal friction. (2). It burns slowly and hence pushes the piston all the way down the cylinder, less engine wear and noiseless running.

Procedural steps to produce Biodiesel from waste copra

1. Small broken pieces of unused waste copra are dried in the sunlight for 3 to 4 days and the oil is extracted with the help of an oil expeller.
2. This oil is kept in a container for one day and its fatty acid composition is tested and obtained from gas chromatograph analysis.
3. After filtration of oil, it is poured into the biodiesel production unit through an inlet oil feeder.
4. Before pouring the oil, it must be ensured that the fatty content of the oil is tested properly.
5. If the fat content is below 3%, along with the oil, a catalyst is also added. (NaOH of 8 gm. per litre and Methanol 100ml per litre).
6. If it contains more than 3% fat, H_2SO_4 (8 to 12 ml per litre) and methanol of 100 ml per litre added as catalyst.
7. Heat the oil container at a temperature range of 60 to 65^0C for 100 to 120 minutes.
8. At this time due to some chemical reaction, biodiesel is separated and it floats at the peak segment of the container.
9. At bottom, the settled glycerin is first taken out through the drain cock and then the biodiesel.
10. This biodiesel is again purified by water distillation.
11. It is carried out in another chamber which is heated to about 120^0C for 1 to 2 hours after adding water and some coloring substances. This process is repeated up to no color change of added co lured water collected out. Then the pure bio diesel is taken out from the chamber and stored in air tight cans.

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Table 1. Properties of pure diesel & biodiesel.

Properties	Diesel	Biodiesel (B100)
CV in MJ/kg	42.0	34
Viscosity in cSt	4.1	3.5
Relative Density	0.85	0.88
Flash point in ^{0}C	54	100

Fig.2: Equipment for Bio-diesel Production.

IV. ADDITIVE USED: HEPTANOL

1 Heptanol is found in alcoholic beverages. It is also found in a few essential oils eg: Rosa ragosa, present in roasted peanut, phi brandy, rice bran, Banana, cherry, orange, pineapple etc. 1Heptanol is a flavoring agent. Watery colorless liquid with an alcohol odour. It will floats on water. It is prepared from heptaldehyde by reduction with iron filings in dilute acetic acid. In another way as, reaction between pentane and ethylene oxide in presence of anhydrones $Alcl_3$. Its IUPAC (International Union of Pure Applied Chemistry) name is Heptan-1-oil and its densityis0.8187 gm/cc, melting point of -34.6^{0}C and boiling point is 175.8^{0}C. Its structural formula is $CH_3(CH_2)_6OH$ or ($C_7H_{16}O$).

Heptanol is available at a market price of Rs.120/kg with a purity of 98%. It is a transparent colorless liquid.

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Fig.3. Sample of 1 heptanol

Hazard statements about Heptanol;
1. Combustible liquid.
2. Cause skin irritation.
3. Cause eye irritation.
4. Harmful to aquatic life.
5. It is very danger as it reacts with oxidants and strong acids.

V. RESULTS & DISCUSSIONS

Table 2. Summary table of Results

Injection Pressure& Angle(psi,^{0}C)		B20		B40		B50		B100	
		Without Additive	With Additive	Without Additive	With Additive	Without Additive	With Additive	Without Additive	With Additive
BTE	175 23	22.6	24	21	23	21.5	24	18	23.5
	225 26	23	25	22	25.5	21.5	26	19	25
BSFC	175 23	1.13	1.11	1.15	1.10	1.5	1.14	2.5	1.19
	225 26	1.10	1.10	1.19	1.10	1.2	1.10	2.5	1.14
CO	175 23	0.09	0.06	0.09	0.05	0.03	0.03	0.01	0.03
	225 26	0.08	0.06	0.08	0.05	0.03	0.08	0.009	0.05
HC	175 23	104	89.5	94.5	92	85	87	83	89
	225 26	98	90	93.5	90	84	90	80	92.5
CO_2	175 23	5.61	3.04	2.99	3.04	3.12	3.06	3.1	2.95
	225 26	5.5	3.02	2.92	3.08	3.02	3	3.03	3.03
NO_x	175 23	696	230	217	219	222	216	217	202
	225 26	618	220	216	218	219	216	209	213

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VI. CONCLUSION AND FUTURE SCOPE

CONCLUSION

1. For lower blends (B20 &B40) with additive, CO is decreased by around 44% and for higher mixes (B50, B100), it is increased by 66% to 82%. The change in injection pressure and angle has little effect in CO exhaust.
2. For B20 and B40 with additive, 2.6% to 14% of decrease in the release of HC, while for B50, B100, it is increased by 6.7% at 175psi and 13% at 225psi.
3. For all mixes with additive, CO_2 release is decreased by 4.8% to 44% from lower to higher mixes. At 225psi, CO2 is decreased by 1.9 to 2.5%.
4. For B20 with additive at 175psi, 66.9% reduction in NOx is recorded. At 225psi, it is 64%.
5. The highest BTE is recorded for B50 and B100 with 15% additive at 225psi pressure and 26^0 angle. The percentage increase of BTE compared withB20 at 175 psi, at 23^0angle without additive is 10.6%. But in case of BSFC no significant change is recorded.
6. The percentage increase in BTE with the increase of injection pressure and angle is 10.86% for lower blends and it is 6.38% for higher blends.
7. The increase in injection pressure and angle shows an increase in BTE but no notable changes in BSFC.
8. The use of biodiesel with additive helps to reduce environmental pollution.
9. A percentage increase of 26 in BTE is recorded for B100 at 175 psi with additive of 15%, meanwhile at 225psi; an increase of 38% in BTE is achieved.
10. It can be concluded that if the various properties of waste coconut oil biodiesel such as density, viscosity, flash point, fire point, CV etc.are improved by the addition of suitable additive, the performance can further be improved.

FUTURE SCOPE

1. Better technologies are to be developed to modify the properties of biodiesel blends.
2. To make the biodiesel and its additives more economically available, research and technological activities are to be undertaken.
3. The use of waste coconut oil-biodiesel with heptanol experimentation may be carried out with multi-cylinder diesel engine at various fuel injection pressures.

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