Investigations on the Performance and Emission Characteristics of Enzymatic Coconut Oil-Diesel Blends in a DI Diesel Engine

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Abstract

As there is a significant increase in vehicle population and subsequent decrease in natural fuel resources ,the world is in the need to look for alternative fuels which can be substituted for the usage of the conventional fuels. so biofuels are now in the focus of researchers which have been seen as a reliable alternative for the conventional fuels. In this investigation, The biodiesel from the coconut (cocus nucifera) oil has been prepared by using the process of enzymatic transesterification process. Coconut oil is colorless or yellowish which is having a good taste and smell. It is used to produce biodiesel by using enzymatic transesterification process and the produced bio diesel is blended with diesel by various proportions The proportions are B0(100% Diesel),B10(10% Biodiesel &90 % Diesel),B20(20%Biodiesel&80%Diesel).Subsequently the fuel properties and performance parameters like flash point fire point, viscosity, density, calorific value brake specific fuel consumption, brake power, indicated power brake thermal efficiency and mechanical efficiency have been determined by fuelling the above blends in the kirlosker computerized IC engine. The emission characteristics like CO,CO_2, NO_X and HC contents have also been measured using gas analyzer .the obtained results are then compared with the diesel(B0).According to the results the suitable blend may be selected and can be used for commercial purpose.

Keywords - *Diesel, Coconut oil bio diesel, enzymatic transesterification, kirloskar engine, lipase, performance and emission characteristics.*

I. INTRODUCTION

Now a days it is important to carry out number of research attempts to replace the conventional fuels with the alternative fuels due to which the usage of conventional fuels and their effects can be reduced.E.E.Mak Mensah et al studied the feasibility of blending of two bio diesels made from coconut(cocus nucifera) and neem seed(Azadirachta indicajus) oils without the need for diesel for blending .they found out the various property values like viscosity ,density and percentage of free fatty acids in coconut oil and also in neem oil bio diesel blends[1].

Samina C.Tupufia et al have broadly described the various phenomenon associated with the enzymatic transesterification of coconut oil bio diesel. They determined that there is a rapid rate of conversion of coconut oil into biodiesel when the addition of lipase concentration and the subjection of ultrasonic assistance in the process of enzymatic transesterification[2].

A.M.Liaquat et al investigated the effects of coconut oil biodiesel blended fuels on the engine performance and emission characteristics. They found that the torque and brake power have been decreased where as the specific fuel consumption has been increased when the bio diesel blends have been used [3].

M.A.Kalam et al investigated the engine performance and emission analysis using envo diesel and coconut biodiesel blended fuel. They found that envo diesel and coconut biodiesel blend has reduced the brake power compared to the ordinary diesel fuel. They also found that the emissions like HC, smoke, CO and NOx have been decreased in the usage of envo diesel and coconut oil biodiesel blended fuel [4].

1.1. COCONUT OIL (cocus Nucifera):

Coconut oil can be derived from coconut trees which can be seen in everywhere in tamilnadu.The components of coconut oil are mainly triglycerides and the free fatty acids. The free fatty acids are mainly containing acids like lauric acid, myristic acid and palmatic acid.

II. METHODOLOGY

- Enzymatic Transesterification.
- Preparation of various blends.
- Engine Testing.

A. *Enzymatic Transesterification*

At first 300ml of coconut oil is taken in the 500ml conical flask and 75 ml of ethanol is added to the 300ml of coconut oil which is already present in the conical flask. Then the mixture is stirred in the conical flask by using the magnetic stirrers for30 minutes. Then 30 mg of lipase (lipase from aspergilous niger) is added to the mixture. The mixture now is to allowed to stir for around 7 hours. After these 7 hours of stirring the mixture is allowed to to settle down. After an overnight, it is can be seen that the mixture would be separated as biodiesel at the top and the glycerol at the bottom. Then the biodiesel at the top would be separated to make the blends.

B. *Preparation of Various Blends*

The pure coconut oil bio diesel is to be blended as per the following properties to obtain the test blends.

B0-100% Biodiesel.

B10-10% Coconut oil Biodiesel &90% Diesel.

B20-20% Coconut oil Biodiesel & 80% Diesel.

The properties of fuel blends have been measured and tabulated in table 1.

C. *Engine Testing*

The engine which is used here for the investigation is the kirlosker computerized IC engine. The procedure for carrying out the performance analysis is as follows:

- At first the fuel tank and subsequently the lubrication system has to be checked.
- The loads amounted on to the engine should have been removed.
- By cranking, the engine should be started.
- Wait up to the pickup of the engine to an optimal speed.
- Cooling water should be allowed to flow through the engine.
- The load by means of electrical eddy current dynamometer should be applied.
- The corresponding time taken for the 10cc of fuel consumption by the engine should be noted down.
- The rpm for various loads should be noted down for various blends.

III. RESULTS

A. *Performance Analysis*

From the observed readings, the performance of engine for various loads and various blends are calculated by using following formulae,

1) ***Brake power (kW):***

$$B.P = (2\pi NL \times 9.81 \times L_D)/ 60{,}000$$

Where, N – Speed of engine (rpm),
L – Load (kg),
L_D – Dynamometer arm length (92.5 mm).

2) ***Brake Mean Effective Pressure (bar) :***

$$BMEP = (Bp \times 60) / (\pi \div 4\ d_c^2 \times L_S \times (N/n) \times \text{No. of. Cylinder} \times 100$$

Where, d_c- cylinder diameter (0.080m)
L_s- Stroke Length (0.11m)

3) ***Specific fuel consumption(kg / kw hr):***

$$BSFC = (3.6 \times 10 \times \text{fuel density}) / (Bp \times \text{fuel flow} \times 1000)$$

Where, Fuel flow – Time taken for 10CC fuel consumption
Fuel density – 830 kg/ m^3 (F_d).

4) ***Brake Thermal Efficiency (%):***

$$\eta_{BT} = (Bp \times 60{,}000 \times Vcc) / (10 \times 0.06 \times F_d \times CV)$$

Where, CV– Calorific value

5) ***Total Fuel Consumption (kg/hr) :***

$$TFC = (Vcc \times 3600 \times \text{sp. gv. of fuel}) / (t \times 1000)$$

Where, Vcc = 10 cc of fuel

6) ***Indicated Power (kW):***

$$IP = BP + FP$$

Where, Friction Power (FP) = from graph.

7) ***Mechanical Efficiency (%):***

$$\eta_{MECH} = (BP) / (IP) \times 100$$

The calculated performance parameters are tabulated in Table 4. The graphs shown in Fig.7, Fig.8 and Fig.9 compare the performance parameters between various blends.

B. *Emission Analysis*

The emission parameters are measured directly from the Gas analyzer - i3sys shown in Fig.10. It has the capability to measure four exhaust gas emissions namely CO_2, CO, HC and NO_X. CO and CO_2 are measured in terms of % of sample where as HC and NO_X are measured in terms of ppm. The emission measuring probe was placed at the emitting smoke from the engine and the emission parameters were noted and tabulated in Table 5.

The graphs shown in Fig.11, Fig.12, Fig.13 and Fig.14 compare the emission characteristics of various blends.

IV. TABLES

Table 1: Properties of Blends

	Viscosity at 40^0C	*Density*	*Calorific Value*	*Flash Point*	*Fire Point*
UNIT	cSt	Kg/m^3	MJ/kg	^0C	^0C
Biodiesel	3.32	823	38.7	128	161
Diesel	3.12	821	42.12	75	82
B10	3.41	825	42.34	84	91
B20	3.43	826	41.57	88	95

Table 2: Calculated Performance Parameters for various blends

Blends	*Load (kg)*	*BP (kW)*	*IP (kW)*	*BSFC (kg/kW hr)*	*η_{BT} (%)*	*η_{MECH} (%)*
B0	5	0.712	1.20	0.4710	20.42	59.16
	10	1.44	1.97	0.3192	27.12	73.09
	15	2.14	2.61	0.2685	26.41	81.99
	20	2.86	3.33	0.2176	25.50	85.88
B10	5	0.711	1.21	0.4944	21.12	58.67
	10	1.41	1.99	0.3531	28.31	70.85
	15	2.16	2.64	0.2766	30.12	81.81
	20	2.87	3.36	0.2263	29.16	85.41
B20	5	0.72	1.23	0.5000	21.02	58.53
	10	1.42	2.02	0.3757	28.26	70.29
	15	2.17	2.67	0.2929	30.01	81.27
	20	2.85	3.39	0.2382	29.12	84.07

Table 3: Emission Parameters for Various Blends

Blends	*Load (kg)*	*Co (%)*	*Co_2 (%)*	*HC (ppm)*	*NO_X (ppm)*
B0	5	0.066	0.53	24	491
	10	0.063	0.68	22	611
	15	0.049	0.71	21	857
	20	0.029	0.76	20	1044
B10	5	0.064	0.55	23	495
	10	0.058	0.67	21	618
	15	0.044	0.69	20	863
	20	0.023	0.79	17	1051
B20	5	0.062	0.56	21	510
	10	0.055	0.70	20	623
	15	0.041	0.80	19	871
	20	0.021	0.82	18	1061

V. FIGURES

Fig.1: Heating of Coconut Oil and Ethanol Mixture

Fig.2: Bio Diesel at Top & Glycerol at bottom

Fig.3: Experimental Setup-Kirloskar Engine

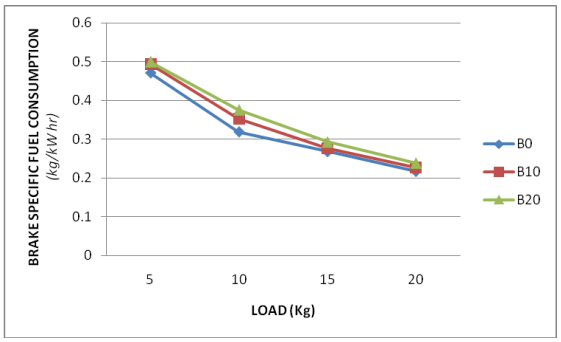


Fig.4: Load vs. BSFC

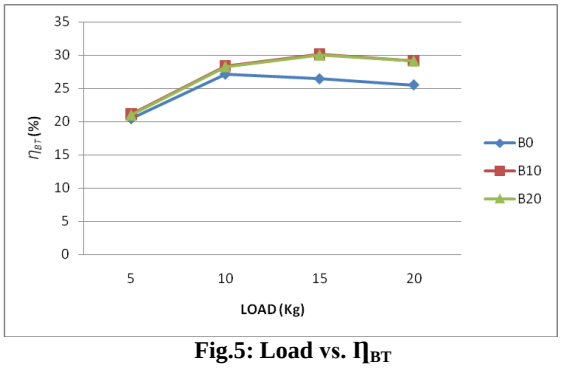


Fig.5: Load vs. η_{BT}

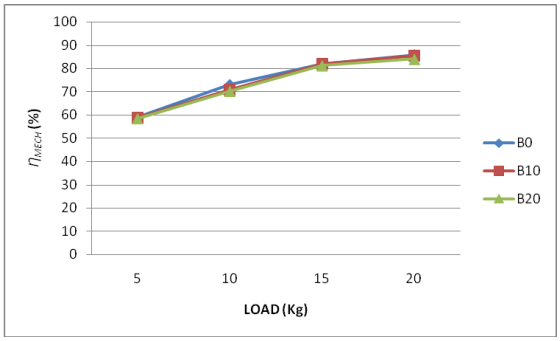


Fig.6: Load vs. η_{MECH}

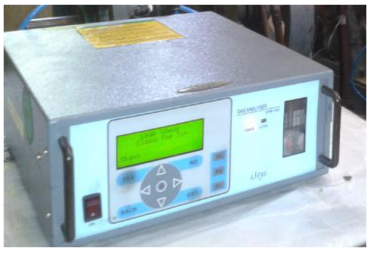


Fig.7: i3sys Gas Analyzer

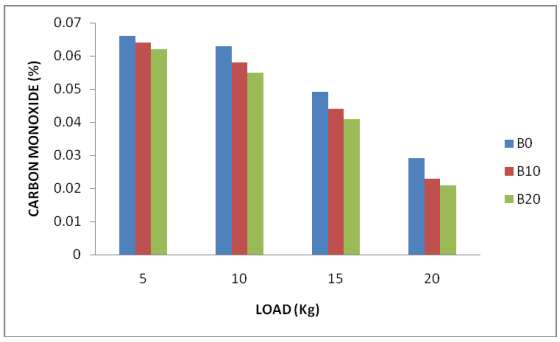


Fig.8: Load vs. CO

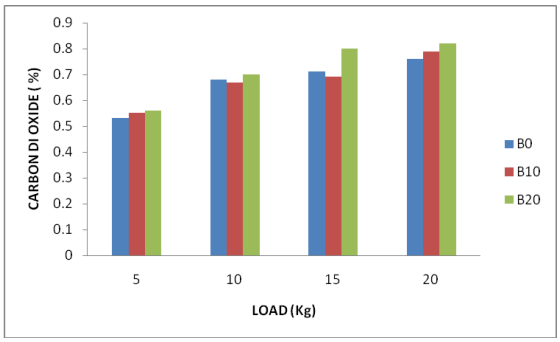
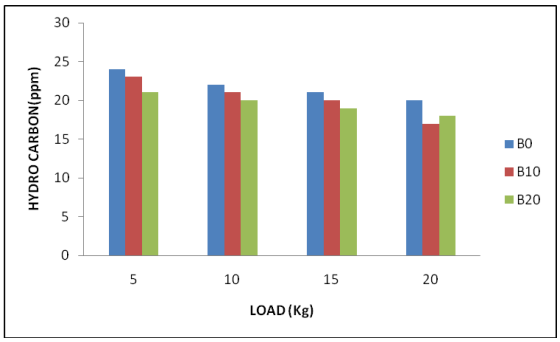


Fig.9: Load vs. CO_2



Fg.10: Load vs. HC

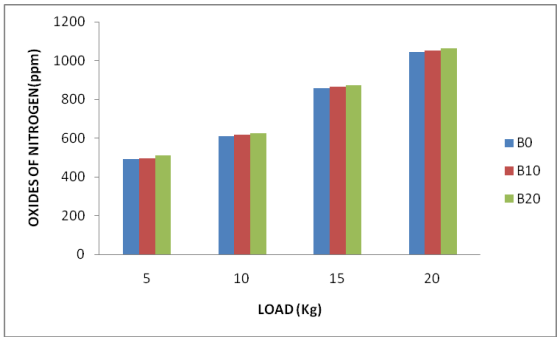


Fig.11: Load vs. NO_X

VI. CONCLUSION

The investigation has been done on diesel blends B0(pure Diesel),B10(10% Biodiesel &90% Diesel) and B20(20% Biodiesel&80% Diesel) and the following observations have been done.

- The brake specific fuel consumption (BSFC) is decreasing with increasing in load. The brake specific fuel consumption of all the blends are in almost equal range.
- The brake thermal efficiency is increases with increase in load.
- Mechanical efficiency is increases with increase in load.
- Carbon monoxide content is decrease with increase in load. Carbon monoxide emission decreased as compared to that of diesel.
- Carbon di oxide content is increases with increase in load. Carbon di oxide emission slightly increases compared with diesel.
- HC content decreases as load increases.HC emission decreases as compared with diesel.
- NOx emission has been highly increasing as compared with diesel.
- Biodiesel up to B20 blend with diesel is showing almost equality in performance and improved emission characteristics and so B20 blend could be recommended for commercial purposes.

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